Analysis on the Long Run Relationship Between the Economic Growth and Determinants of selected North African Countries

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Abstract:

This paper develops and tests a panel cointegration model to examine the interaction between economic growth and its determinants of selected North African Countries. The analysis is applied to five heavily indebted North African countries-namely Algeria, Egypt, Mauritania, Morocco, and Tunisia. The results based on Pedroni cointegratioan and fully Modified OLS (FMOLS). The tests proposed by Pedroni suggest that servicing a heavy debt could have an adverse impact on economic growth and capital inflow which in turn worsens the debt problem.

Key Words: Relationship, long Run, Economic Growth and African Countries.

Introduction:

The sharped and sustained increase in the proportion of developing countries resources given to the service of their foreign debt. The debt service ratio is influenced by the rate at which development occur affecting economic development. The inflow of capital at

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substantial rates will significantly reduce the need for external borrowing. Due to the amount of resources devoted to debt service positively related to the size of the debt economic growth will increase, through the impact of capital inflows will reduce the ratio of debt service.

At the global scene, external debt and foreign direct investment (FDI) have been considered as major sources of capital financing. FDI is the main form of capital inflow to many countries while nations experiencing account deficit are advised to borrow funds, external debt, from the international community to boost their economic growth (Malik, Hayat and Hayat, 2010). Unfortunately, external debt and its repayment have become a hindrance to several developing North African countries' economic growth like in Algeria, Egypt, Mauritania, Morocco and Tunisia. As noted by Malik et al., (2010), in the past thirty years it has been seen that foreign debt had been the major culprit in the decline in investment and growth performance of many countries. International debt can be likened to unnecessary tax paid by future generations on wasted services; in addition, the rise of debt servicing ratio can adversely affect economic growth of any country (Chowdhury, 1994).

Houssou and Heidhues (2005) stated that the international donor community has provided assistance to debtor countries to reduce their external debt trap to spur economic growth, alleviate poverty, and achieve external viability. This support has taken the form of

concessional financing provision from IFIs, and debt relief from official donor creditors, such as the Paris Club. It should be pointed out that these measures have produced great success in reducing the external debt burden of most middle-income countries. Nonetheless, many poor countries continue to experience unacceptable levels of poverty and heavy external debt burden due to a combination of factors, including policies of inappropriate development, poor external debt management policy, give up the structural adjustment and reform economy, the decline of their terms of trade, and poor governance. In North Africa, high levels of external debt service have negatively affected savings and foreign exchange earnings resulting in the crowding out of public investment. This scenario, in return, has also affected the provision of social services for the populace in the affected countries. This study advances the argument that the real problem that impedes the process of economic development in the North African countries is the challenge of inadequate real resources for capital formation, due to high external debt servicing. In many instances, the countries are compelled to resort to high levels of foreign borrowing in order to mitigate the effects of worsening economic conditions. However, further foreign borrowings have aggravated the debt trap as most of these countries have a history of debt service arrears and difficulties.

Many resources that could have been channeled back in the form of investments have instead been used to service external debt. Some of

the countries in North Africa have problems of funds available for debt-service commitments which, in their countries and economic systems have almost collapsed as they grappled to free themselves from the debt trap.

Clearly, the mounting debt stocks in the North Africa countries have discouraged the inflow of foreign direct investment as a result of fears of macroeconomic distortions. Ironically, instead of attracting outside capital, much needed national capital is fleeing to the rich countries either for debt servicing purposes or for safe keeping. Against this background, high debt-service commitments have not only made the North African economies to perform poorly, but also to rely heavily on foreign sources of budgetary support, thereby creating an unending cycle of economic crisis. In a nutshell, this study will develop a simultaneous equations model to test the process of interaction between (FDI) inflows, external debt service and economic growth in three North African countries of Algeria, Morocco and Egypt; and tests for any possible feedback effects.

The influence of inflation on debt stock, debt redemption, and debt servicing in the economies of North African countries has been neglected by previous research (Maitheme , 2006; Cohen, 1997) , indicating that there are theoretical and empirical gaps. Unsurprisingly, this study intends to uphold this feature because of the macroeconomic impact on these economies. In a way, this glaring vacuum needs to be

filled and thus justifying the need for a conscious research of this nature. In much the same way, the results of the worsening exchange rate of the five key economies of Algeria, Egypt, Mauritania, Morocco, and Tunisia and how they are related to economic growth, debt stock, debt redemption, and debt servicing have not been captured in any existing researches (Yaqub (1994), Kransey (2002) and Sharul (2005) on this field. Therefore, this study is expected to fill these theoretical and empirical gaps. Furthermore, extant literature on North African countries is silent on the impact of exchange rate of economic growth during the debt crisis episode in the region. For this reason, the issue needs to be explored, as well.

Literature Review:

Actual per capita GDP growth from a country may experience adverse effect by of the countries may have problems by whichever aspects - of a bigger international borrowing stocks or the effects of debt-service on public spending. Cunningham (1993) used the production function to explain the relationship of GDP growth and debt burden. Only external public debt burden is included in this model though Cunningham model includes nation`s total debt burden. As a national debt and external debt affect the economy different way, to make the analysis more specific only external public debt is included. While Lyoha (1999), used external debt stock to GNP and total external borrowing service payments of export of merchandise and services to

capture the external borrowing overhang and crowd out respectively in the investment equation.

Cleassens et al., (1996) showed that, countries in regions of Africa, especially the Sub-Saharan Africa, current economic problems resulted into poor growth performance and incessant challenges in servicing external debt. Even though literature on external borrowing, barely the reasons specific countries are unable to use funds borrowed to produce sufficient output, and alternative reasons for international aid in broadly speaking, to maintain that it affects countries positively than negatively (Moyo, 2009). It is most times stated that increase in a nation's country's international borrowing which is above a certain critical threshold can result to an untenable debt and inability for the country to honour its payment obligation. There are possibilities that the borrowing country may lose its credit worthy rating, resulting to a leading to a abrupt turn-around of its fortunes including reduced capital flows. In addition this in turn causes a currency and funding problems and bigger output loss, thereby creating the need for more foreign borrowing.

Just as debt service payments are important in explaining future movements in foreign debt, investment-income remittances are similarly a key factor in predicting foreign direct investments. This is so because the income remittances are in some way 'returns' on the FDI outlay. Hence, when the foreign investment remittances are high compared to

what was earlier invested (or the export earnings, or the outside reserves), the host country experience a serious investment burden or crisis (Ezirim et al., 2006). This is so much so since there would be a need for foreign exchange (generated through exports or reserves) to cover the requirements of income remittance out of the country. This also applies when the country needs to settle debt service obligations. From this perspective, debt service payments and investment remittances are thus "returns" from the same portfolio of assets (debts and equity securities). One should note that when the remittances are so much that the host country suffers huge drain of investible capital, it succumbs to the tyranny of investment burden or crisis.

Cunningham (1993) explored the relationship between national borrowing stock burden and economic growth for sixteen countries for the period of 1971-2007. The study shows that the growth of the country's debt burden has a negative or adverse effect on the economic growth. Cunningham also posited that when a country is considerably indebted to foreigners, this depressingly affects both labor and capital efficiency. In much the same way, Chowdhury (1994) examined the connection between level of debts and economic growth for Bangladesh, Indonesia, Malaysia, Philippines, South Korea, Sri Lanka and Thailand for the time of 1970-1988. The study findings showed that the external debt leads to mismanagement in exchange rate. However, these research findings also show that foreign debt does not affect the GNP growth rate.

Amoateng and Amoako-Adu (1996) utilizing data pooled into time series and cross sectional form examined the relationship between external debt servicing, economic growth and exports for thirty-five African countries during 1971-1990. The study by Amoateng and Amoako-Adu shows that that there is a unidirectional and positive causal relationship between external debt service and GDP growth after excluding exports revenue. Fosu (1996) examine the afliation between economic growth and external debt for the sample of sub-Saharan African countries for the period 1970-1986. The study shows, on average, a heavily indebted country faces about one percentage reduction in the GDP annually. In another study, Fosu (1999) utilized an augmented production function to examine the impact of external debt on economic growth in sub-Saharan Africa for the 1980 -1990 time. The study showed that there is a negative relationship between debt and economic growth. The study also indicated that a rather weak negative impact of debt on investment levels.

Malik, Hayat and Hayat, (2010), show that external debt is negatively and considerably related with economic growth. The data suggests that increase in external debt will lead to decline in economic growth. Furthermore, the study found that the debt servicing has also significant and negative impact on GDP growth. As the debt servicing tends to increase, there will be fewer opportunities for economic growth. The study examined the relationship between external debt and

economic growth in Pakistan for the period of 1972- 2005, using time series econometric technique.

Perasso (1992) examined twenty middle-income highly indebted nations for the 1982-1989 periods, examined the causal effects between economic growth and international borrowing stock. The study results show that relevant country policies national policies have a stronger impact or effect on public increasing investment and growth in severly indebted countries compared to decreasing debt-servicing requirements. Similarly, Cohen's (1993) examined the relationship between international borrowing and investment of less developing countrys in 1980s. Cohen's research indicates the level of small effects of the degree of stock of debts on the country's investment. He contested that real flow of net transfers impact on investment. The study also shows the actual debt.

Empirical Model:

The empirical model is used for the panel cointegration test model to examine the interaction between economic growth and its determinants follows the work of Metwally and Tamaschke (1994), Cunningham (1993), Iyoha (1999), Karagol (2002), and Patenio and Tan-Cruz (2007). The simplest model based on the Cobb-Douglas production function is also presented and the model is then extended based on the existing literature. A growth model from the traditional growth accounting framework and the production function gets the

standard neoclassical form with a negligible change that has human capital in the Cobb-Douglas production function as follow:

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} [A(t)L(t)]^{1-\alpha-\beta}, 0 < \alpha < 1. \qquad (1)$$

Where Y is real output at time t; K and L are the stocks of physical capital and labour, respectively, at time t; H is the stock of human capital; A is a similar measure of physical capital; α and β are the share of capital and human capital on output. A is a labor-augmenting factor following the level of technological progress and competence in the economy and t indicates time. This equation hardly shows that at any moment time, the net outcome of the economy associates on the amount and quality of physical capital employed , the quantity of labour employed, and the average level of skills of the labour force. Output can only increase if *K, L, A*, or *H* also increases, and continuous increase in output per worker can only occur if the stock of capital per worker or the average quality of labour or of capital also increases perpetually.

It implies that $\alpha + \beta < 1$ shows that there are declining returns to all raw capital labour; and labor-augmenting technologies are believed to grow in accordance to the functions given as:

$$L(t) = L(0)e^{nt} \qquad (2)$$

$$A(t) = A(0)e^{gt+P\theta} \qquad (3)$$

where n is the exogenous rate of growth of the labor force, g is the exogenous rate of technological progress, P is variety of vector of

debt service, investment and other determinants that can influence the level of technology and efficiency in the economy, and θ is a vector of coefficient relevant to these variables.

Demetriades and Law (2006) declared that variable *A* relies on exogenous technological developments and ranks of other variables. Variable *A* in current study differs from variable *A* used by Gregory *et al*. (1992). This adjustment is expected to be especially related to the empirical cases of the association among debt service, investment and others determinant and economic growth. The technological developments are supported by increase in investment spending and debt service that be likely to play a part in economic growth (Ramirez and Nazmi, 2003) and also contribute to the efficiency of others determinant (North, 1990, Nelson and Sampat, 2001).

In order to investigate a long-run relationship between the GNP and debt service, FDI inflows and other determinants for the selected of North African countries, we proposed the empirical **Model** to include the debt crisis and the interaction term is as follows:

$$lnGNP_{it} = \beta_0 + \beta_1 lnDS_{it} + \beta_2 lnFDI_{it} + \beta_3 lnED_{it} + \beta_4 lnXGS_{it} + \beta_5 lnSAV_{it} + \beta_6 INF_{it} + \beta_7 ER_{it} + \beta_8 (lnFDI_{it} * DC_{it}) + \beta_9 (lnSAV_{it} * DC_{it}) + e_{it}$$

Where:

Endogenous Variable:

$lnGNP_{it}$ = Rate of growth of GNP (valued at constant process) in period t

Predetermined Variables:

$lnDS_{it}$ = Debt service payment in period t

$lnED_{it}$ = External debt stock in period t

$lnFDI_{it}$ = Foreign Direct Investment net inflows in period t

$lnSAV_{it}$ = Rate of growth of domestic savings in period t

$lnXGS_{it}$ = Rate of growth of exports of goods and services in period t

DC_{it} = The dummy of debt crisis in period t

INF_{it} = Inflation rate in period t

ER_t = Exchange rate in period t

$(lnFDI_{it} * DC_{it})$= The interaction of Foreign Direct Investment net inflows and the dummy of debt crisis

$(lnSAV_{it} * DC_{it})$= The interaction of the rate of growth of domestic savings and the dummy of debt crisis

β_0 = constant term

$\beta_1, \beta_2, \beta_3, \ldots\ldots \beta_9$ = the coefficient show how much a one unit increase in each individual variable will affect the growth rate of economic growth.

it = a panel series data

ε_t = an error term.

Before we conduct tests of cointegration between those variables, it is necessary to perform unit root tests. Unit root and cointegration tests in the time series dimension suffer from low power and/or size distortion. The addition of the cross-section dimension however, brings an improvement in the power of unit root and cointegration tests by acting as repeated draws from the same distribution.

In order to examine the possibility of panel cointegration, it is necessary to determine the rate of growth of GNP and the independent variables evolve at unit root processes. There are several unit root tests specifically for panel data which have been introduced in past decades. Among them are Quah (1992, 1994), Levin and Lim (1992), Maddala and Wu (1999), Hadri (2000), Levin, Lin and Chu (2002), and Im, Pesaran and Shin (1997, 2003). This panel unit root test is a continuation of the univariate unit root test identified earlier but has low power like the augmented Dickey-Fuller test (Said and Dickey, 1984). The panel unit root test in the above has the specification for a null hypothesis; and (serves) as an alternative and methodology to identify problem such as heterokedasticity and different correlations. Each panel unit root test data has its own benefits and limitations and for this study we have chosen the Levin, Lin and Chu version (LLC); and Im, Pesaran and Shin's (1997; IPS hereafter), which are based on the well-known Dickey-Fuller procedure. This LLC test is not only considered as simple

when estimation is carried out, but has also been widely used in empirical studies.

The next step is to test for the existence of a long-run relationship between real per capita GDP growth rates and the independent variables. For panel cointegration, the tests suggested by Pedroni (1999, 2004) are employed. We will make use of seven panel cointegrations by Pedroni (1999, 2004), since he determines the appropriateness of the tests to be applied to estimated residuals from a cointegration regression after normalizing the panel statistics with correction terms.

Pedroni (1999, 2004) extends the Engle and Granger (1987) two step strategies to panels by using ADF and PP principles. The cointegration equation is estimated individually for every panel member. Residuals are examined with respect to the unit root feature. If the null hypothesis is discarded, the long-run equilibrium holds, but the cointegration vector may be different for each cross section. Additionally, deterministic components can become individual specific. The residuals are joint either the within or the between dimension of the panel, enhancing the panel and group mean statistics (Pedroni, 1999). First order autoregressive parameter is restricted to be identical for all cross sections when comes to panelstatistics. If the null is not accepted, the parameter is less than 1 in absolute value, and the variables in question are cointegrated for all panel members. In the group statistics, the autoregressive parameter is permitted to have different cross section,

as the statistics amount to the average of individual statistics. If the null is rejected, cointegration holds minimum one individual. Hence, group tests propose an additional source of heterogeneity among the panel members (Dreger and Reimers, 2005). To a certain point, the statistics are distributed as standard normal with a left hand side rejection area, excluding the variance ratio test. Standardization factors begin at the moments of Brownian motion functionals. The causes imply the number of regressors in case constants or trends are included in the cointegration relationships.

Pedroni (1999) has proposed seven tests further separated into two sets of panel cointegration statistics intended to test the null hypothesis of cointegration in the variables in Equation (4.27) against the alternative hypothesis of cointegration. Gutierrez (2003) states that the first category of four statistics we consider is what Pedroni labels as within-dimension statistic or Panel *t*-statistic including a variance ratio statistic, a non-parametric Philips and Perron type ρ-statistic, a non-parametric Phillips and Perron type *t*-statistic and a Dickey-Fuller type *t*-statistic. Next category of three panel cointegration statistics is defined as a between-dimension statistic or Group *t*-statistic containing a Phillips and Perron type ρ-statistic, a non-parametric Phillips and Perron type *t*-statistic and finally an Augmented Dickey-Fuller type *t*-statistic.

we adopt FMOLS procedures from Christopoulos and Tsionas (2003, 2004). As to obtain asymptotically efficient regular estimates in

panel series, non-exogeneity and serial association limitations are handled by utilizing complete modified OLS (FMOLS) established by Pedroni (1996). The descriptive variables are cointegrated with a time inclination that results into a long-run equilibrium relationship between these variables through the panel unit root test and panel cointegration test, we advanced to estimate the Equation (4.3) by the method or fully modified OLS (FMOLS) for heterogenous cointegrated panels (Pedroni, 1996, 2000). This method let reliable and competent estimation of cointegration vector and accounts the difficulty of non-stationary regressors, along with the drawback of simultaneity biases. It is prominent fact that OLS estimation give in biased outcome owing to the regressors are endogenously determined in the *I*(1) case.

Empirical Results:

As with standard co-integration tests this is necessary to discern that the stationarity properties of the data is to make sure that erroneous inferences are not made. Testing for stationarity in panel data is different to some extent from conducting unit root tests in standard individual time series; these differences are discussed below.

Coakley *et al*.(1996), Coakley and Kulasi (1997) and Oh *et al*. (1999) reported in their studies that conventional unit root tests like the ADF test have been found to have low testing powers. The failure to refuse null of a unit root in a data by conventional ADF unit root test might be because of low testing power of the test. Panel unit root test is

found to have higher power than the individual unit root ADF tests. The panel unit root tests take into account both time series and the cross-sectional variations in data and they augment the power of the tests due to increased quantity of observations that are on hand in the panel setting.

For determining the existence of a unit root in a panel data setting and to verify the outcomes from the individual unit root of the ADF tests, we have utilized the panel unit test on the panel data which is based on the procedure of Levin *et al.* (2002) and Im *et al*. (1997) (LLC and IPS, respectively). The LLC and the IPS tests are made in a way that the null hypothesis tested plus all the series in the panel, including a unit root against the alternative that none of the series have a unit root. Hence, this test permits for heterogeneity in the panel, for instance in lag order or precise value for autoregressive parameter, all the series ought to share the similar stationarity properties.

When applying LLC and IPS test we have to be mainly cautious in deciding on the lag length for the ADF tests, because underestimate the correct number of lags might take to lack in power. We also employed the Akaike's Information Criterion (AIC) in selecting the suitable number of lagged differences term for five tests statistics to compute our results. The AIC is acknowledged for choosing the maximum pertinent lag length (Shrestha and Chowdhury, 2005).

McKinnon's tables provide the cumulative distribution of the LLC and the IPS test statistics.

Table 1 accounts the output of the LLC and the IPS panel unit root tests for the data on real GNP ($lnGNP_{it}$), debt service ($lnDS_{it}$), external debt stock ($lnED_{it}$), net exports ($lnXGS_{it}$), FDI inflow is a proxy of foreign direction investment ($\ln FDI_{it}$), domestic saving ($lnSV_{it}$), inflation (INF_{it}) and exchange rate (ER_{it}) for both the situations of constant and constant with time trend term. The tests are run for the full sample of the five North African countries, namely Algeria, Egypt, Mauritania, Morocco, and Tunisia for the period 1970-2013.

Table 1 shows the outcomes of the LLC and the IPS panel unit root tests at the level demonstrates that all variables are *I*(0) in the constant of the panel unit root regression. These findings noticeably demonstrated that the null hypothesis of a panel unit root in the level of the series cannot be thrown out at different lag lengths. We supposed that there was no time trend. Thus, we tested for stationarity permitting for an unvarying plus time trend. In the absence of a constant plus time trend, yet again we found out that the null hypothesis of having panel unit root was in general rejected in all series at level form.

As discussed above, we found out that the majority of the variables are non-stationary with and without time trend specifications at

level by applying LLC and IPS tests which are also functional for heterogeneous panel to test the series for the existence of a unit root. The outcomes of the panel unit root tests established that the variables are non-stationary at level.

Further step is to test if the variables are co-integrated using methodology of Pedroni (1999, 2001, and 2004) as explained earlier for Equation 1.This explores if on the long-run steady state or cointegration presences between the variables and to verify the statement of Oh *et al*. (1999) and Coiteux and Olivier (2000) that the panel cointegration tests have plenty high testing power than conventional cointegration test. As the variables are found to be integrated in the same order *I*(1), we remain persistent with the panel cointegration tests projected by Pedroni (1999, 2001, and 2004). Cointegrations are performed for constant and constant plus time trend and the results of cointegrations examination are summed up in Table2.

Panel v is a non-parametric variance ratio statistic. Panel-*p* and panel-*t* are similar to the non-parametric, Phillips-Perron *p* and *t* statistics respectively. Panel-*adf* is a parametric statistic which has its foundation on the augmented Dickey-Fuller ADF statistic. Group-*p* is similar to the Phillips-Perron p statistic. Group-*t* and group-*adf* are similar to the Phillips-Perron *t* statistic and augmented Dickey- Fuller ADF statistic, respectively. The statistics of Pedroni (2004) are one-sided tests with critical value of 1.64 ($k < -1.64$, entails rejection of the

null), with the exception of the u-statistic that has a critical value of 1.64 ($k > 1.64$ implies rejection of the null). Note that means and variances that compute the Pedroni statistics are reported in Pedroni (1999).

Table 1 Panel Unit Root Tests

	Level				1st Different			
	Constant		Constant + Trend		Constant		Constant + Trend	
	LLC	IPS	LLC	IPS	LLC	IPS	LLC	IPS
$lnGNP_{it}$	0.32539 (0.6276) [0]	-0.96039 (0.1684) [0]	1.06138 (0.8557) [0]	-0.44947 (0.3265) [0]	-24.6012*** (0.0000) [0]	-4.24249*** (0.0000) [0]	-23.4803*** (0.0000) [0]	-3.08743*** (0.0010) [0]
$lnDS_{it}$	1.46174 (0.9281) [0]	-0.34233 (0.3661) [0]	2.42817 (0.9924) [0]	0.02972 (0.5119) [0]	-9.70673*** (0.0000) [0]	-15.0489*** (0.0000) [0]	-7.52590*** (0.0000) [0]	-13.4931*** (0.0000) [0]
$lnED_{it}$	-1.14985 (0.1251) [0]	-0.99333 (0.1603) [0]	1.32106 (0.9068) [0]	-0.56130 (0.2873) [0]	-7.72797*** (0.0000) [0]	-6.62313*** (0.0000) [0]	-7.43844*** (0.0000) [0]	-6.60728*** (0.0000) [0]
$lnFDI_{it}$	-0.45140 (0.3258) [0]	-0.90516 (0.1827) [0]	0.95384 (0.8299)	-0.77031 (0.2206) [0]	-10.6220*** (0.0000) [0]	-8.29381*** (0.0000) [0]	-8.00817*** (0.0000) [0]	-7.14151*** (0.0000) [0]
$lnXGS_{it}$	-0.20155 (0.4201) [0]	-0.59739 (0.2751) [0]	3.60193 (0.9998)	-0.88147 (0.1890) [0]	-3.15852*** (0.0008) [0]	-3.20916*** (0.0007) [0]	-8.36041*** (0.0000) [0]	-9.92836*** (0.0000) [0]
$lnSAV_{it}$	3.06855 (0.9989) [0]	1.49430 (0.9325) [0]	19.1155 (1.0000) [0]	-1.02631 (0.1524) [0]	-22.5777*** (0.0000) [0]	-3.51748*** (0.0002) [0]	-32.5374*** (0.0000) [0]	-3.08151*** (0.0010) [0]
INF_{it}	1.51369 (0.9349) [0]	-0.68496 (0.2467) [0]	-2.16452 (0.0152) [0]	-1.09078 (0.1377) [0]	-20.0090*** (0.0000) [0]	-28.6687*** (0.0000) [0]	-27.0112*** (0.0000) [0]	-33.5422*** (0.0000) [0]
ER_{it}	0.46745 (0.6799) [0]	2.46352 (0.9931) [0]	-1.19640 (0.1158) [0]	-1.12455 (0.1304) [0]	-7.05057*** (0.0000) [0]	-5.98515*** (0.0000) [0]	-6.46564*** (0.0000) [0]	-4.60606*** (0.0000) [0]

Note: The number in ( ) denote probability value. The lag length is selected on the basis of the Akaike's Information Criteria (AIC) where we indicate maximum lag order (k) in autoregression and then we select appropriate lag order in accordance with the AIC. For LLC *t*-stat all reported values are distributed N(0,1) under null of unit root or no cointegration.

Table 2: Panel cointegration tests for heterogeneous panel

	Constant	Constant + Trend
	Model (with interaction)	**Model (with interaction)**
Panel-*v*	-2.243*	3.503*
Panel-*ρ*	3.155*	3.728*
Panel-*t*	2.504*	-3.224*
Panel-*adf*	2.723*	3.139*
Group-*ρ*	4.317*	4.468*
Group-*t*	1.768**	2.632*
Group-*adf*	2.629*	3.124*

Notes: All statistics are from Pedroni's procedure (1999) which is the adjusted values can be compared to the N(0,1) distribution. ***, **, * indicates rejection of the null hypothesis of no-cointegration at 1%, 5%, and 10% level of significance.

In constant level, we analysed that Equation (1) with interaction term indicate that all 7 statistics refuse the null hypothesis of non cointegration at the 1% level of significance except for the group-*t* which is significant at the 5% level. Outcomes indicate that independent variables show cointegration in the long run for a group of North African countries respective of real per capita GDP. The panel highlights non-parametric (*t*-statistic) and parametric (*adf*-statistic) statistics and group statistics that are similar to the IPS-test statistics, the null hypothesis of non cointegration is rejected at the 1% and 5% level of significance.

In the panel cointegration test for Model with constant plus trend level, the results indicate that all 7 statistics refuse the null hypothesis of non cointegration at the 1% level of significance. It is indicated that

independent variables obey cointegration in the long run for a group of North African countries respective of real per capita GDP. Though the statistics favors cointegration, along with Pedroni`s (1999) view that the panel non-parametric (*t*-statistic) and parametric (*adf*-statistic) statistics are consistent in constant plus time trend, a long run cointegration among our variables in North African countries is concluded at the end. As a whole in Table 2, it is shown that most of the panel statistics are trustworthy in constant plus time trend as measure up to to the panel statistic in constant. It is highlighted by the panel non-parametric (*t*-statistic) and parametric (*adf*-statistic) statistics as well as group statistics that are analogous to the IPS-test statistics, the null hypothesis of non cointegration is refused at the 1% level of significance.

As the last section confirms all variables among the North African countries are cointegrated. Strictly, there long run equilibrium is present between the variables. This section describes the estimated long-run equation. Following Pedroni (2000 and 2001), cointegrating descriptive variables for the data is estimated with the help of Fully Modified OLS (FMOLS) methodology.

Dreger and Reimers (2005) pointed out that it is essential to note that the panel cointegration tests don't offer an estimate of the long run relationship. More or less, the cointegration vector should be common for the panel members, as basic economic principles are involved. Moreover, hypothesis testing is a critical issue. Actually the asymptotic

distribution of the OLS estimator drives by nuisance parameters. This is a severe issue when comes to panel environment, as the bias can accumulate with the size of the cross section. As Pedroni (2000) described, the problem increased in a panel setting by the potential dynamic heterogeneity over the cross-sectional dimension. Particularly, increase in dimension leads second order biases to be take place by the poor performance of the estimators designed for large samples as they are averaged over the panel's members. That is the purpose behind the modification of FMOLS method make inferences in cointegrated panels with heterogeneous dynamics as the cross-sectional dimension turn larger even in short time series (Aisen and Veige, 2011).

Table 3 shows that the estimate of coefficient for debt service ($\boldsymbol{lnDS_{it}}$) for Algeria, Mauritania, Morocco, and Tunisia are negative (-21.53, -14.40, -7.16, and -2.55, respectively) and statistically significant at the 5% level. An estimate of coefficient for debt service for Egypt is statistically insignificant. The estimate coefficient for FDI inflows ($\boldsymbol{lnFDI_{it}}$) for Algeria, Morocco and Tunisia are positive (36.59, 6.65, and 2.38, respectively) and statistically significant at 1%, and 5% level. The estimate of debt stock ($lnED_{it}$) is negative for all countries [-0.03(Algeria), -0.11(Egypt), -0.03 (Mauritania), -0.01 (Morocco), and -0.03 (Tunisia)] and statistically significant at 1% level. These results

show that debt stock lift GNP, that descript a long run cointegration between that variable and GNP in selected North African countries.

The estimate of net exports (**$lnXGS_{it}$**) is positive for all countries [0.09(Algeria), 0.11(Egypt), 0.01 (Mauritania), 1.04 (Morocco), and 0.09 (Tunisia)] and statistically significant at 1% and 5% level. These outcomes show that exports increase GNP per capita, which means that there is a long run cointegration between that variable and GNP per capita in selected North African countries.

The estimate of domestic saving ($lnSAV_{it}$) is positive for four countries [0.46 (Egypt), 0.14 (Mauritania), 0.24 (Morocco), and 0.50 (Tunisia)] and statistically significant at 1% level. These findings show that domestic saving increase GNP, that describes a long run cointegration between that variable and in four North African countries except for Algeria. The same scenario was happen for inflation (**INF_{it}**), where the estimate coefficition is negative for all the North African countries [-0.23 (Algeria), -0.22 (Egypt), -0.20 (Mauritania), -0.07 (Morocco), and -0.25 (Tunisia)] and statistically significant at 1 per cent level.

The estimated coefficient of the exchange rate (**ER_{it}**) is negative gor four countries [-0.55 (Algeria), -0.36 (Egypt), -0.21 (Mauritania), and -0.02 (Morocco)] and statistically significant at 1 per cent level.

Table 3: FMOLS (Individual) Results, Dependent variable: GNP per capita ($lnGNP_{it}$)

Indicator/country	Algeria	Egypt	Mauritania	Morocco	Tunisia
$lnDS_{it}$	-21.53** (-2.37)	-0.85 (-0.24)	-14.40** (-2.34)	-7.16** (-2.59)	-2.55** (-2.11)
$\ln FDI_{it}$	36.59*** (6.73)	0.04 (0.82)	10.61 (1.32)	6.65** (2.70)	2.38* (2.80)
$lnED_{it}$	-0.03*** (-9.82)	-0.11*** (-5.49)	-0.03*** (-5.49)	-0.01*** (-5.88)	-0.03*** -(3.67)
$lnXGS_{it}$	0.09** (2.39)	0.11** (2.51)	0.01*** (5.35)	1.04*** (8.49)	0.09*** (6.87)
$lnSAV_{it}$	1.74 (1.30)	0.46*** (5.37)	0.14*** (9.60)	0.24*** (8.45)	0.50*** (3.68)
INF_{it}	-0.23*** (-11.91)	-0.22*** (-6.43)	-0.20*** (-7.83)	-0.07*** (-4.87)	-0.25*** (-5.99)
$lnER_{it}$	-0.55*** (-5.03)	-0.36*** (-7.06)	-0.21*** (-5.16)	-0.02*** (-8.94)	-0.73 (-0.85)
$(\ln FDI_{it}*DC_{it})$	-0.72** (-2.65)	-0.02** (-2.49)	-0.16** (-2.32)	-0.52** (-2.87)	-0.20** (-2.28)
$(\ln SAV_{it}*DC_{it})$	0.07** (2.20)	0.02** (2.50)	0.13** (1.99)	0.43** (1.94)	0.20** (2.37)

Note: The null hypothesis for the *t*-ratio is $H_0=\beta_i= 0$; Figures in parentheses are *t*-statistics (*) and (**) significant with 95% (90%) confidence level;

Table 3 above also presents the interaction term between FDI inflows with dummy of debt crisis **($\ln FDI_{it}*DC_{it}$)** and domestic saving with dummy of debt crisis **($\ln SAV_{it}*DC_{it}$).** Every variable reported that tests reject the null hypotheses of non cointegration at the 1 per cent and

5 per cent level of significance. For interaction term between FDI inflows with dummy of debt crisis **(lnFDI_{it}*DC_{it}),** the estimate of coefficient is negative [-0.72 (Algeria), -0.02 (Egypt), -0.16 (Mauritania), -0.52 (Morocco), and - 0.20 (Tunisia)] and statistically significant at the 5 per cent level. Therefore, a long run relationship between interaction variable (FDI inflows with dummy of debt crisis) and GNP is signified. For the interaction term between domestic saving with dummy of debt crisis **(lnSAV_{it}*DPC_{it}),** the estimate of the coefficient is positive [0.07 (Algeria), 0.02 (Egypt), 0.13 (Mauritania), 0.43 (Morocco), and 0.20 (Tunisia)] and statistically significant at the 1 per cent level. The interaction variable (domestic saving with dummy of debt crisis) positively affects GNP and implies that there is a long term cointegration.

The estimated coefficient of the exchange rate **(ER_{it})** is negative gor four countries [-0.55 (Algeria), -0.36 (Egypt), -0.21 (Mauritania), and -0.02 (Morocco)] and statistically significant at 1 per cent level.

Table 3 also presents the interaction term between FDI inflows with dummy of debt crisis **(lnFDI_t * DC_t)** and domestic saving with dummy of debt crisis **(lnSAV_t * DC_t).** Every variable reported that tests reject the null hypotheses of non cointegration at the 1 per cent and 5 per cent level of significance. For interaction term between FDI inflows with dummy of debt crisis **(lnFDI_t * DC_t),** the estimate of coefficient is positive [0.72 (Algeria), 0.02 (Egypt), 0.16 (Mauritania), 0.52

(Morocco), and 0.20 (Tunisia)] and statistically significant at the 5 per cent level. Therefore, a long run relationship between interaction variable (FDI inflows with dummy of debt crisis) and GNP is signified. For the interaction term between domestic saving with dummy of debt crisis **($\ln SAV_t * DPC_t$),** the estimate of the coefficient is positive [0.07 (Algeria), 0.02 (Egypt), 0.13 (Mauritania), 0.43 (Morocco), and 0.20 (Tunisia)] and statistically significant at the 5 per cent level. The interaction variable (domestic saving with dummy of debt crisis) positively affects GNP and implies that there is a long term cointegration.

Table 4: FMOLS (Group) Results, Dependent variable: GNP ($lnGNP_{it}$)

$\ln DS_{it}$	$\ln FDI_{it}$	$\ln ED_{it}$	$\ln XGS_{it}$	$\ln SAV_{it}$	INF_{it}	ER_{it}	$(\ln FDI_{it} * DC_{it})$	$(\ln SAV_{it} * DC_{it})$
0.88*	0.04*	0.10*	0.16*	0.37*	0.02*	1.06*	0.02*	0.05*
(11.19)	(6.86)	(10.09)	(4.95)	(5.65)	(4.52)	(3.56)	(4.69)	(4.71)

Note: The null hypothesis for the *t*-ratio is $H_0=\beta_i= 0$; Figures in parentheses are *t*-statistics (*) and (**) significant with 95% (90%) confidence level;

Table 4 shows all the variables detailed that tests reject the null hypotheses of non cointegration at the 1% level. All the variables show a positive coefficient [0.88 **($\ln DS_{it}$),** 0.04 **($\ln FDI_{it}$),** 0.10 **($\ln DE_{it}$),** 0.16 **($\ln M_{it}$),** 0.37 **($\ln SAV_{it}$),** 0.02 **(INF_{it}),** 1.06, **(ER_{it}),** 0.02 **($\ln FDI_t * DC_t$),** and 0.05 **($\ln SAV_t * DC_t$)**] and statistically significant at the 1 level.

Thus, it has been discovered that the panel groups give bigger estimation coefficient and better significance (1 per cent level) that would be the best depiction of the average long-run relationship. Hence, it is accomplished that all variables are cointegrated and have a long term relation.

Conclusion:

This paper examines the nature of each variable in panel unit root test as well as equation. In general, we could say that the integration order of the series are consistently *I*(1). For this reason, panel cointegration (Pedroni; 1999 and 2004) approach is applicable. Section 5.2 provides the panel cointegration test based on Pedroni's procedure (1999 and 2004). Generally, we found that all the variables are cointegrated in the model. Therefore, the long run equation is extracted from the Fully Modified OLS (FMOLS) analysis (Pedroni; 1996, 2000, 2001).

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