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DYNAMICS OF EXPORTS, INFRASTRUCTURE, AND GROWTH IN GCC: VARS AND CAUSALITY TESTING

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Abstract:
The paper is concerned with analyzing the dynamic effects of exports and infrastructure on GCC[ii] economic growth. Panel cointegration methodology is used to test for the existence of a long relationship between the variable. Two tests, Kao (1999) and Johansen cointegration tests are applied to check for cointegration. The results of the two tests reveal that there exists a long run co-integrating relationship between export and infrastructure proxies and economic growth in GCC countries. Additionally, fully modified least square (FMOLS) and dynamic ordinary least square (DOLS) were used to test the magnitude of the long relationship among variables. The results show that export and infrastructure variables are positive and have significant impact on the long run growth of the GCC economy. Further, fixed –effects method is selected as random effect model is rejected based on Hausman test result. The results of fixed effect show that export and infrastructure variables ate positive and statistically significant. With regard to policy, variable mixed results were obtained. As a policy recommendation the study, suggest that proper absorptive capacity such as deep financial institution, good infrastructure quality and supplementing public expenditures should be met in order to maximize the benefits of exports.

JEL: C33; O11; F10; O19; O47

Keywords: exports; infrastructure; VARs, causality, cointegration, GCC

1. Introduction

The export sector plays an important role in the economic growth of a country. From the perspective of international trade, exports are generators of foreign exchange, which is necessary for financing imports and other developmental projects. Infrastructure on the other hand, whether soft or hard infrastructure paly a fundamental role for accelerating the process of development and growth. Since 1990s, the GCC country invest heavily in

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[ii] GCC includes, Saudi Arabia, U.A.E, Qatar, Oman, Kuwait and Bahrain

the infrastructure sector because they believe that this sector will boost their economic growth and help them to be competitive in the international markets. This believe is supported by many empirical studies that demonstrates the positive impact of infrastructure on economic growth and unveil that transport plays a vital role in economic activity either directly or as a complement to other factors of production.

The main objectives of this paper are to study the effect of export and infrastructure on economic growth of a panel of six gulf countries during the period 1990–2019 and to produce new evidence on the economic growth and these variables. Therefore, a test of the relationship between economic growth and export, infrastructure for these countries could reveal important information on this issue. Secondly, very few studies were conducted to test the impact of export and infrastructure on economic growth of GGC. Overall, this paper examines the dynamic relationship between export, infrastructure on economic growth of GGC.

The paper is organized into five sections. A brief literature review is discussed section 2. Section 3 describes the model specification and data Section 4 presents the analysis and discussion. Section 5 concludes the paper and provides some recommendations based on the empirical findings

2. Literature Review

In this section we shall shed some light on previous studies that dealt with exports and infrastructure and how they affect the economic growth of a country. As for exports, massive literature shows that there are numerous studies that explore the evidence of the positive impact of export expansion on economic growth (Heitger, 1987; Lussier, 1993; Gylfason, 1999; Ramos, 2001). More recently, Hagemejer and Muck (2019) in their study of export-led growth and its determinants in CEEC countries, they reveal that exports have played a major role in determining GDP growth of these countries. Moreover, Taghavi, et.al (2012) investigated VAR method between import, export and economic growth in Iran during the period 1962- 2011. The findings show a long run relationship between the variables considered. Based on the results, export had direct and positive impact on economic growth in the long run. Also import had a significant and negative impact on economic growth, then import had a negative relationship with economic growth in the long term.

On the other hand, the impact of infrastructure on economic growth has been extensively studied over the years. The basic theoretical framework of the impact of public capital on economic growth was developed first by Arrow and Kurz (1970). Subsequently, many empirical studies were conducted to test the relationship between infrastructure and economic growth. Calderon and Serven (2008) analyze the impact of infrastructure on economic performance of African countries. Using panel data for a large sample of countries for the period 1960-2005, they employ growth regressions estimated through a Generalized Method of Moments estimator and evaluate the impact of several types of infrastructure assets, as well as measures of quality of their services. Their findings suggest that both infrastructure stock and quality are positively and significantly

related to real GDP per capita growth. In their study of "Trade Can Be Good for Growth: The Role of Policy Complementarities" Chang, Kaltani, and Loayza (2009), show that, the quality of infrastructure (proxies by the number of main telephone lines per capita in their paper) is an important determinant of the impact of trade reforms on economic growth. Yet the number of telephone lines is only a partial indicator of infrastructure. Other literature has been examining how many other dimensions of hard infrastructure (e.g., telephone lines and other information and communications technology infrastructure, ports, and roads) and soft infrastructure (e.g., border and transport efficiency, and the business and regulatory environment) affect international trade flows. Most of this literature has used the empirical workhorse of studies in international trade—the gravity equation[iii].

However, the complementary role between infrastructure and export to boost economic growth has been ignored in previous literature. Only few studies have indirectly referred to it. Some studies have concluded that infrastructure development has a positive effect on trade through lower transport costs. Using a panel of bilateral trade-flow data for 1988-2002, Francois and Manchin (2013) concluded that transport infrastructure not only increases trade volumes, but also increases the probability of trade occurring. Lederman, Maloney, and Servén (2005) have found that the efficient provision of infrastructure is crucial for the success of trade-liberalization strategies aimed at optimal resource allocation and export growth. Conversely, some studies suggested that growth in international trade stimulates public infrastructure development. Since trade is a demand determinant for transport and logistics, growth in international trade will affect their growth (Lee and Rodrigues 2006).

3. Model Specification and Data

Following the empirical literature, we construct a model to test the relationship between exports, infrastructure, and economic growth in the GCC over the period, 1990-2019,

$GDPGRit = f(EXPTt, FXTELt,$ ELECTt, $INFt, GFCEXt, DCBt),$

Alternatively, the Regression model will look as fellow:

$$GPGDP_{it} = \beta_{0i} + \beta_1 EXPTt + \beta_2 FXTELt + \beta_3 ELECTt + \beta_4 (EXPTt * FXTELt + \beta_5 EXPTt * ELECTt + \beta_6 EXPT * DCBt + \beta_7 DCBt + GFCEXt + INFt + \varepsilon_{it}$$

Where real Real GDP at constant 2011 national prices (in mil. 2011US$) denoted as GDPGRit, is a dependent variable. EXPTt, is a measure real exports of goods and services (BoP, current US$), FXTELt, is fixed telephone subscriptions (total) is used as a proxy for infrastructure, ELECTt is electric power consumption (kWh per capita) is also used as a

[iii] Olarreaga, M. 2016. Trade, Infrastructure, and Development. ADBI Working Paper 626. Tokyo: Asian Development Bank Institute. Available: https://www.adb.org/publications/tradeinfrastructure-and-development

proxy for infrastructure. GFCEXt is General government final consumption expenditure (% of GDP), INFt is a measure of inflation rate and DCBt is domestic credit to private sector by banks (% of GDP). The study used annual data over the period of 1990-2019. The world Development Indicators prepared by World Bank are the source of data to this study. All variables have been transformed into natural logarithms (ln) to help mobilize stationarity.

Table 1: Variables Codes and Expected Signs

Variable	Definition	Codes of Variable	Expected sign	Source
Dependent Variable	Real GDP at constant 2011 national prices (in mil. 2011US$)	GDPGR		Penn Table 9.1*
Independent Variable	Real Exports of Goods and Services (BoP, current US$)	EXPT	+	WDI, 2018
	Fixed Telephone Subscriptions (total)	FXTEL	+	WDI, 2018
	Electric power consumption (kWh per capita	**ELECT**	+	WDI, 2018
Control Variables	Inflation, GDP deflator (annual %)	INF	-	WDI, 2018
	General government final consumption expenditure (% of GDP)	GFCEX	-	WDI, 2018
	Domestic credit to private sector by banks (% of GDP).	DCB	+	WDI, 2018

*Source: The data are extracted from Penn World Table, version 9.1. Description is at the reference: Feenstra, Robert C., Robert Inklaar and Marcel P. Timmer (2015), "The Next Generation of the Penn World Table" American Economic Review, 105(10), 3150-3182, available for download at www.ggdc.net/pwt.

3. Empirical Results

3.1 Descriptive Analysis

The descriptive statistics, minimum, maximum, mean, and standard deviation (Std. Dev.) of these variables is recorded below in Table 2. Over the period 1990–2019, EXPT-DCB has a maximum value (1134.925) and high standard deviation (225.0717)

Table 2: Summary Statistics for the Model Variables

Variable	Mean	Median	Maximum	Minimum	Std. Dev.
LNGDPGR	4.478031	4.350563	4.843102	4.173278	0.218917
LNEXPT	10.56865	10.59197	11.60354	9.269727	0.570124
LNELECT	3.990834	4.07439	4.365718	3.188695	0.279987
LN_FXTEL	5.731876	5.640981	6.73138	4.973105	0.459878
INF	4.83201	3.246227	144.6836	-25.95839	15.09032
GFCEX	19.48676	19.3895	76.22213	3.513854	8.538737
EXPT_FXTEL	60.79314	59.15848	77.56952	47.7228	7.847697
EXPT_ELET	42.20078	42.80935	47.49944	31.94134	3.887832
EXPT_DCB	493.5224	432.1106	1134.925	135.7661	225.0717
DCB	46.33048	41.57453	105.1868	14.16827	20.14864

Table 3 shows the correlation matrix. The correlation indicates a positive correlation between the LNEXPT, and LNELECT with. LNGDPGR.

Table 3: Correlation matrix

Variable	LNGDPGR	LNEXPT	LNELECT	LN_FXTEL	INF	GFCEX	EXPT_FXTEL	EXPT_ELET	EXPT_DCB	DCB
LNGDPGR	1									
LNEXPT	0.237422	1								
LNELECT	0.434286	0.145334	1							
LN_FXTEL	-0.00049	0.824926	-0.11687	1						
INF	0.071363	-0.00786	0.053772	-0.07962	1					
GFCEX	-0.38675	-0.36423	-0.44982	-0.04333	-0.11181	1				
EXPT_FXTEL	0.084681	0.930991	-0.01674	0.973579	-0.05202	-0.17484	1			
EXPT_ELET	0.468428	0.69002	0.815607	0.387825	0.033094	-0.54463	0.525931	1		
EXPT_DCB	0.159236	0.435213	0.552574	0.126892	-0.17054	-0.27823	0.256673	0.66965	1	
DCB	0.133546	0.339137	0.574355	0.038548	-0.17778	-0.25537	0.160911	0.629277	0.993614	1

3.2 Panel Unit Root Test

To determine the order of integration, the study uses four sets of unit root tests; as reported in Table 3. The results which reported in Table 4 show that all the variables except INF are non-stationary at levels. After taking the first difference the variables to perform stationarity all the variables were confirmed to be stationary. Therefore, the study moves to check for co-integration by using two different tests as we shall see later.

Table 4: Panel unit root test

Variables	**Levin, Lin & Chu t**		**Im, Pesaran and Shin W-stat**		**ADF - Fisher Chi-square**		**PP - Fisher Chi-square**	
	Level *p*-value	First Difference *p*-value	Level *p*-value	First Difference *p*-value	Level *p*-value	First Difference *p*-value	Level *p*-value	First Difference *p*-value
LNGDPGR	0.2768	0.0056	0.1140	0.0002	0.1559	0.0000	0.0235	0.0000
LNEXPT	0.0664	0.0000	0.8040	0.0000	0.7071	0.0000	0.9990	0.0000
LNELECT	0.3372	0.0000	0.0823	0.0000	0.0022	0.0000	0.8457	0.0000
LN_FXTEL	0.4010	0.0021	0.3503	0.0000	0.1241	0.0000	0.0890	0.0000
INF	0.0456	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
DCB	0.3458	0.0000	0.9020	0.0000	0.9047	0.0000	0.9990	0.0000
EXPT_FXTEL	0.2234	0.0000	0.8314	0.0000	0.5126	0.0000	0.9933	0.0000
EXPT_ELET	0.1143	0.0000	0.6170	0.0000	0.3838	0.0000	0.9988	0.0000
EXPT_DCB	0.5191	0.0000	0.9693	0.0000	0.9649	0.0000	0.9997	0.0000

Lag order selection criterion is provided in Table 5. With the exception of SC that called for two lags, all the other criteria including AIC, HQ, final prediction error (FPE) and Sequential likelihood ratio (LR) called for three lags. Hence, lag three is considered as optimum lag in our model.

Table 5: VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-719.0785	NA	2.29e-05	12.01783	12.20267	12.09290
1	855.2277	2914.418	3.30e-16	-12.94591	-11.28230*	-12.27026
2	902.5206	81.29679	4.41e-16*	-12.66976*	-9.527385	-11.39352*
3	941.4197	61.72419	6.90e-16	-12.25487	-7.633729	-10.37805
4	982.6855	60.02297	1.07e-15	-11.87910	-5.779192	-9.401694
5	1038.109	73.28788	1.38e-15	-11.73735	-4.158674	-8.659358
6	1107.460	82.53330	1.50e-15	-11.82579	-2.768353	-8.147220
7	1175.347	71.81426	1.81e-15	-11.89004	-1.353835	-7.610884
8	1267.020	84.85449*	1.64e-15	-12.34744	-0.332477	-7.467708

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

4.3 Panel Cointegration Test

After determining the order of integration, the next step is to check the possibility of long-run relationship between variables. So, Kao (1999), and Johansen cointegration tests are applied to check for cointegration. The null hypothesis for the two tests is that there is no cointegration in the series, and the alternative hypothesis is that there is cointegration in the series. The results of the panel cointegration tests are presented in Table 6, and 7.

The result of Kao (1999) as presented in Table 6 showed that the p-values is less than 5% therefore we can reject the null hypothesis of no cointegration, and accept the alternative hypothesis of cointegration.

Table 6: Results of Kao's Residual Cointegration Test

	t-Statistic	Prob.
ADF	-3.152302	0.0008
Residual variance	0.000297	
HAC variance	0.000439	

Table 7 below show the results of Johansen cointegration test. The trace test indicates seven cointegrating equations while max-eigen test have nine cointegrating equations at the 0.05 level.

Table 7: Johansen Cointegration Test

Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
None	6.931	0.7319	6.931	0.7319
At most 1	4.159	0.9399	41.00	0.0000
At most 2	1.386	0.9992	75.07	0.0000
At most 3	75.07	0.0000	75.07	0.0000
At most 4	231.1	0.0000	118.4	0.0000
At most 5	169.7	0.0000	112.5	0.0000
At most 6	126.0	0.0000	72.84	0.0000
At most 7	76.72	0.0000	59.24	0.0000
At most 8	30.99	0.0006	26.77	0.0028
At most 9	18.43	0.0482	18.43	0.0482

To conclude the results of the tests of Johansen's test and Kao's test agree. Thus, it can be concluded that the all variables have robust long-run association in GCC countries.

4.4. FMOLS and DOLS results

Based on the results of cointegration obtained from the two tests above and the confirmation of the long-run association between variables we can proceed further to estimate the magnitude of the long run relationship between the variables by applying panel Fully Modified Ordinary Least Squares (FMOLS) and panel Dynamic Ordinary Least Squares (DOLS) estimators. Table 8 and 9.

Table 8: Results Panel Fully Modified Least Squares (FMOLS)
Dependent Variable: LNGDPGR

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNEXPT	0.629261	0.246296	2.554901	0.0117
LNELECT	2.179696	0.562227	3.876898	0.0002
LN_FXTEL	0.041938	0.323750	0.129537	0.8971
INF	-0.000355	0.000329	-1.078187	0.2828
GFCEX	0.002275	0.001259	1.806260	0.0730
EXPT_FXTEL	-0.014524	0.027159	-0.534794	0.5936
EXPT_ELET	0.231671	0.056861	4.074301	0.0001
EXPT_DCB	-0.003838	0.000889	-4.317059	0.0000
DCB	0.038734	0.009592	4.038269	0.0001

R-squared	0.971113	Mean dependent var	4.480749
Adjusted R-squared	0.968265	S.D. dependent var	0.217911

S.E. of regression	0.038819	Sum squared resid	0.213986
Durbin-Watson stat	0.503224	Long-run variance	0.002936

Table 9: Results of Panel Dynamic Least Squares (DOLS)
Dependent Variable: LNGDPGR

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNEXPT	0.174225	0.052519	3.317396	0.0011
LNELECT	-4.547002	0.649978	-6.995627	0.0000
LN_FXTEL	4.027202	0.500580	8.045071	0.0000
INF	0.001174	0.000854	1.374922	0.1711
GFCEX	-0.004188	0.001905	-2.198844	0.0294
EXPT_FXTEL	-0.366255	0.043413	-8.436551	0.0000
EXPT_ELET	0.474903	0.064718	7.337987	0.0000

R-squared	0.480314	Mean dependent var	4.478031
Adjusted R-squared	0.460326	S.D. dependent var	0.218917

The results of both FMOLS and DOLS are reported in Table 8 and 9. The results of FMOS method show that LNEXPT and LNELECT have positive and long run significant effect on growth of GCC countries. With regard to policy, variable mixed results were obtained. Gross capital formation as percent of GDP is found to have negative and significant impact on the long run growth of the economy in DOLS model but positive and insignificant in FMOLS. Inflations as an indicator for economic stability is found to have positive and insignificant impact on the long run growth of the economy.

4.5 Fixed Effect VS Random Effects Model

In the following section we employ the panel fixed effect or random effect model. The choice of the method is based on the result of **Hausman test** where the null hypothesis is that the random effect model is more appropriate vs. the alternative hypothesis the fixed effect model is more appropriate.

After conducing Hausman test the result of test show that the p-value < 0.05 then Ho is rejected, as a result we select the fixed effect model (FEM).

Table 10: Hausman Test Result

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	2235.064982	5	0.0000

Since the results of Hausman test came in favor of fixed effect model, we run regression for panel fixed effect and the results are given in Table 11. The results show significant and positive effect of LNEXPT and LNELECT variables on economic growth of GCC countries. For policy variables, inflation and GFCEX are both insignificant.

Table 11: Fixed Effect Results

Dependent Variable: LNGDPGR

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNEXPT	0.403488	0.158743	2.541760	0.0121
LNELECT	1.764805	0.365697	4.825871	0.0000
LN_FXTEL	0.272031	0.210304	1.293513	0.1978
INF	-0.000248	0.000218	-1.139424	0.2564
GFCEX	0.001098	0.000808	1.359364	0.1761
EXPT_FXTEL	-0.032320	0.017819	-1.813835	0.0717
EXPT_ELET	0.186306	0.036982	5.037758	0.0000
EXPT_DCB	-0.003127	0.000586	-5.336724	0.0000
DCB	0.031690	0.006317	5.016440	0.0000
C	8.383469	1.664392	5.036957	0.0000

R-squared	0.972436	Mean dependent var	4.478031
Adjusted R-squared	0.969828	S.D. dependent var	0.218917
S.E. of regression	0.038026	Akaike info criterion	-3.613582
Sum squared resid	0.214004	Schwarz criterion	-3.328882
Log likelihood	309.5070	Hannan-Quinn criter.	-3.497997
F-statistic	372.9469	Durbin-Watson stat	0.385024
Prob(F-statistic)	0.000000		

4.6 Results of Granger-Causality Tests

Table 12 reveals the causality effect of the variables of interests adopted in this paper. The analysis shows that there is unidirectional causality running from the interaction term of export to real growth rate.

Table 12: Granger Causality Tests

Variables	F-Stat.	p-value	Causality
LNEXPT → LNGDPGR	0.79220	0.4548	No
EXPT_FXTEL → LNGDPGR	2.70503	0.0702	Yes
EXPT_ELET → LNGDPGR	4.403	0.043	Yes
LNELECT → LNGDPGR	0.867	0.358	No
DCB → LNGDPGR	3.52613	0.0234	Yes
EXPT_DCB → LNGDPGR	3.90131	0.0222	Yes

5. Conclusion and Policy Implications

The paper is concerned with the growth impact of Export and infrastructure in GCC countries. By employing a panel data methodology for the period of 1990–2019 the study investigates whether the export and infrastructure have a positive effect on GCC countries. For initial check of the series, the study employs four panel unit root test and the results show that all series are integrated of order one after the first difference.

Panel cointegration methodology is used to test for the existence of a long relationship between the variable. Two tests, Kao (1999) and Johansen cointegration tests are applied to check for cointegration. The results of the two tests reveal that there exists a long run co-integrating relationship between export and infrastructure proxies and economic growth in GCC countries. To test the magnitude of the long relationship among variables fully modified least square (FMOLS) and dynamic ordinary least square (DOLS) were used. The results show that export and infrastructure variables are positive and have significant impact on the long run growth of the economy.

Further, fixed –effects method is selected as random effect model is rejected based on Hausman test result. The results of fixed effect show that export and infrastructure variables ate positive and statistically significant. With regard to policy, variable mixed results were obtained.

As a policy recommendation the study, suggest that proper absorptive capacity such as deep financial institution, good infrastructure quality and supplementing public expenditures should be met in order to maximize the benefits of exports.

Conflict of Interest Statement
The author declares no conflicts of interests.

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