

Kalaitzi, Athanasia Stylianou; Chamberlain, Trevor W.

Article

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Provided in Cooperation with:

International Journal of Energy Economics and Policy (IJEPP)

Reference: Kalaitzi, Athanasia Stylianou/Chamberlain, Trevor W. (2020). Fuel-mining exports and growth in a developing state : the case of the UAE. In: International Journal of Energy Economics and Policy 10 (4), S. 300 - 308.

<https://www.econjournals.com/index.php/ijeep/article/download/9183/5135>.

doi:10.32479/ijeep.9183.

This Version is available at:

<http://hdl.handle.net/11159/8422>

Kontakt/Contact

ZBW – Leibniz-Informationszentrum Wirtschaft/Leibniz Information Centre for Economics

Düsternbrooker Weg 120

24105 Kiel (Germany)

E-Mail: [rights\[at\]zbw.eu](mailto:rights[at]zbw.eu)

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Fuel-mining Exports and Growth in a Developing State: The Case of the UAE

Athanasia Stylianou Kalaitzi^{1*}, Trevor William Chamberlain²

¹Middle East Centre, London School of Economics and Political Science, London, United Kingdom, ²DeGroote School of Business, McMaster University, Hamilton, Canada. *Email: a.kalaitzi@lse.ac.uk

Received: 06 January 2020

Accepted: 24 April 2020

DOI: <https://doi.org/10.32479/ijeeep.9183>

ABSTRACT

This study examines the causal effects of traditional UAE exports on economic growth over the period 1981-2012, using a neoclassical production function augmented with fuel-mining exports and imports of goods and services. To investigate the existence of a long-run relationship between fuel-mining exports and economic growth, the study applies the Johansen cointegration test, while the direction of the short-run causality is examined by applying the Granger causality test in a vector error correction model framework. In addition, a modified Wald test in an augmented vector autoregressive model, developed by Toda and Yamamoto (1995), is used to investigate the existence of a long-run causality between the variables. The cointegration analysis confirms the existence of a long-run relationship between the variables, while fuel-mining exports are found to have a negative impact on economic growth. Moreover, the study finds that fuel-mining exports do not cause economic growth in the short-run or the long-run.

Keywords: Exports, Economic Growth, Causality, UAE

JEL Classifications: O47, F43, C32

1. INTRODUCTION

Many studies have investigated the relationship between exports and economic growth, noting the positive effect of exports on growth. However, some studies have shown that aggregate measures may mask the different causal effects of subcategories of exports. Total exports may have a positive effect on economic growth, while disaggregated exports have an inverse effect, or vice-versa. This inverse effect often arises in countries in which primary exports comprise a large proportion of total exports.

The UAE is a country that relies heavily on oil exports and has experienced a high rate of economic growth, but are primary exports the cause of this growth? There is no published evidence on the causal relationship between fuel-mining exports and economic growth for the UAE. This study, in investigating this relationship, is intended to contribute to the discourse on future

policies for sustaining economic growth in the UAE and other oil-producing countries.

This study also addresses some methodological issues that have been overlooked in the previous empirical literature. In particular, conventional unit root tests applied in most of the previous studies are biased towards the non-rejection of a unit root in the presence of a structural break. Based on the fact that oil-producing economies like that of the UAE are subject to oil price shocks, this study also applies the Saikkonen and Lutkepohl test with a structural break. Another issue that has been ignored by previous studies is that Johansen's cointegration test may be biased towards rejection of the null hypothesis of no cointegration for small samples. To remedy this issue, the Reinsel-Ahn adjustment for small samples is used (Reinsel and Ahn, 1992).

Most empirical work has investigated the causality between exports and economic growth using bivariate or trivariate models.

This may lead to biased conclusions, as causality tests are considered to be sensitive to omitted variables. Moreover, most recent studies have examined the existence of a long-run causality between exports and economic growth based on error correction models (ECMs), but in the case of multivariate ECMs, the long-run causal effect of each variable on the dependent variable cannot be identified. To overcome these issues, this study uses an augmented production function, including variables omitted in previous studies, and performs the Toda-Yamamoto long-run causality test.

The empirical analysis confirms the existence of a long-run relationship between the variables, while fuel-mining exports are found to have a negative impact on economic growth. Moreover, the study finds that fuel-mining exports do not cause economic growth in the short-run or the long-run.

The remaining sections of this paper are organized as follows: Section 2 presents the literature on the relationship between exports and economic growth, while the chosen methodology and data sources are presented in Section 3. Section 4 reports and interprets the empirical results, while Section 5 presents the conclusions and policy implications of this research.

2. LITERATURE REVIEW

A number of studies have described the positive impact of export expansion on economic growth, through enhanced economies of scale, adoption of advanced technology and greater capacity utilization (Feder, 1982; Lucas, 1988; Al-Yousif, 1997; Vohra, 2001; Abou-Stait, 2005). In particular, export growth increases investment in those sectors in which a country has a comparative advantage, fostering the adoption of advanced technologies, increasing national production and raising the rate of economic growth. Moreover, an increase in exports increases the inflow of foreign exchange, allowing the expansion of imports of services and capital goods, which are essential to improving productivity and economic growth (McKinnon, 1964; Chenery and Strout, 1966; Gylfason, 1998; Shirazi and Manap, 2004). This is referred to as the export-led growth (ELG) hypothesis. In contrast, some studies provide evidence that the causality runs from growth to exports, referred to as the growth-led exports (GLE) hypothesis, or conclude that there is a bi-directional causal relationship (ELG-GLE) between exports and economic growth (Panas and Vamvoukas, 2002; Love and Chandra, 2005; Elbeydi et al., 2010; Kalaitzi and Cleeve, 2017).

At the same time, other studies have found that exports have a negative effect on economic growth (Myrdal, 1957; Meier, 1970; and Lee and Huang, 2002; Kim and Lin, 2009). This negative effect may arise from the fact that in some countries primary exports constitute a large share of total exports. Primary exports may be subject to large price fluctuations (Myrdal, 1957), and seldom offer the knowledge spillovers and other externalities of manufactured good exports (Herzer et al., 2006). In general, as Sachs and Warner (1995) note, primary exports comprising a large share of total exports are associated with lower economic growth.

These findings have led a number of economists to investigate the impact of export categories on economic growth, as aggregate

measures may mask the different causal effects of subcategories of exports. In particular, studies by Fosu (1990), Ghatak et al. (1997), Siliverstovs and Herzer (2007), Hosseini and Tang (2014) and Kalaitzi and Cleeve (2017) examine the effect of export composition on economic growth, and find that not all exports affect economic growth equally.

In particular, the study by Fosu (1990) argues that the heterogeneity of exports plays an important role in explaining the economic growth differentials among countries. The study uses cross-sectional data for sixty-four developing countries over the period 1960-1980, to examine the effect of manufacturing and primary exports. Fosu (1990) uses ordinary least squares based on a production function augmented with non-manufacturing and manufacturing exports growth. The results indicate that non-manufacturing exports have a negligible impact on economic growth; in contrast, the manufacturing export sector has a positive and significant effect.

Ghatak et al. (1997) examine the ELG hypothesis for Malaysia over the period 1955-1990. Their study focuses on the effects of aggregate and disaggregated exports on real GDP and non-export real GDP, using cointegration and causality testing. Two production functions are used, where, in addition to human and physical capital, manufactured exports, fuel primary exports and non-fuel primary exports are included as inputs. Real gross domestic investment as a percentage of real GDP is used as a proxy for physical capital, while the enrolment ratio in primary and secondary school is used as a proxy for human capital. This study provides evidence that non-fuel primary exports have a significant negative causal effect on economic growth.

Siliverstovs and Herzer (2007) examine the ELG hypothesis using annual time series data for Chile, over the period 1960-2001. This study uses Johansen's cointegration methodology to investigate the impact of manufactured and mining exports. Siliverstovs and Herzer (2007) estimate an augmented neoclassical production function, including manufactured exports, mining exports and imports of capital goods. As for the human capital and physical capital variables, the study uses total working population and accumulated capital expenditure. The results indicate that there is a uni-directional Granger causality from manufactured exports to economic growth, while a bi-directional causality exists between mining exports and real non-export GDP.

Hosseini and Tang (2014) examine the causal effects of oil and non-oil exports in Iran, over the period 1970-2008, using a production function augmented with oil exports, non-oil exports and imports of goods and services. This study applies Johansen's cointegration test and the Granger causality test to examine the existence of a long-run relationship and the direction of the short-run causality respectively. The cointegration results indicate that a long-run relationship exists between the variables, while oil exports and imports are found to have a negative effect on economic growth. The Granger causality results show evidence of a uni-directional short-run causality from oil exports and non-oil exports to economic growth, indicating that the ELG hypothesis is valid in the case of Iran.

Kalaitzi and Cleeve (2017) investigate the causality between primary exports, manufactured exports and economic growth in the UAE over the period 1981-2012, using a Cobb-Douglas production function augmented with primary exports, manufactured exports and imports of goods and services. This study employs the Johansen cointegration test, while the Granger causality test in a VECM framework and the Toda-Yamamoto causality test are performed to find the short-run and long-run causality respectively. The cointegration results show that there is a long-run relationship between the variables, while manufactured exports contribute more to economic growth than primary exports. This study also provides evidence to support a bi-directional short-run causality between manufactured exports and economic growth, while no causality exists between primary exports and economic growth. In the long-run, economic growth causes manufactured exports in the case of UAE.

The present study extends the work of Kalaitzi and Cleeve (2017), by testing the validity of the ELG hypothesis, focusing on the causality between fuel-mining exports and economic growth in the UAE for the same period.

3. RESEARCH METHODOLOGY

The relationship between fuel-mining exports and economic growth, assuming that aggregate production can be expressed as a function of physical capital, human capital, fuel-mining exports and imports of goods and services, is as follows:

$$Y_t = A_t K_t^\alpha HC_t^\beta \quad (1)$$

Where Y_t denotes the aggregate production of the UAE economy at time t , A_t is total factor productivity, and K_t and HC_t represent physical capital and human capital respectively. The constants α and β are between zero and one, measuring the impact of physical capital and human capital on national income. As mentioned above, in order to test the relationship between fuel-mining exports and economic growth, it is assumed that total factor productivity can be expressed as a function of fuel-mining exports, FX_t , imports of goods and services, IMP_t , and other exogenous factors C_t :

$$A_t = f(FX_t, IMP_t, C_t) = FX_t^\gamma IMP_t^\delta C_t \quad (2)$$

Combining equations (1) and (2), the following equation is obtained:

$$Y_t = C_t K_t^\alpha HC_t^\beta FX_t^\gamma IMP_t^\delta \quad (3)$$

α , β , γ and δ represent the elasticities of production with respect to the inputs of production: K_t , HC_t , FX_t , and IMP_t . After taking the natural logs of both sides of equation (3), we obtain the following:

$$LY_t = c + \alpha LK_t + \beta LHC_t + \gamma LFX_t + \delta LIMP_t + \varepsilon_t \quad (4)$$

where c is the intercept, the coefficients α , β , γ and δ are constant elasticities and ε_t is the error term, which reflects the influence of other factors not included in the model.

Table 1: Descriptive statistics

Statistics	LY	LK	LHC	LFX	LIMP
Mean	25.73	24.02	14.83	24.38	24.79
Median	25.72	23.90	14.74	24.28	24.73
Maximum	26.36	24.88	16.04	25.27	26.06
Minimum	25.14	23.29	13.89	23.55	23.74
Std. Dev.	0.40	0.52	0.65	0.50	0.78
Jarque-Bera	2.61	2.63	2.16	1.71	2.24
Probability	0.27	0.27	0.34	0.42	0.33
Observations	32	32	32	32	32

Source: Authors' calculation

The study uses annual time series for the UAE over the period 1981-2012, obtained from national and international sources. Specifically, gross domestic product (Y) is obtained from the World Bank, population (HC) is taken from the National Bureau of Statistics of the UAE, while fuel-mining exports (FX) come from the World Trade Organization. The data series for imports of goods and services (IMP) and gross fixed capital formation (K) are taken from the *IMF*, the UAE National Bureau of Statistics and the World Bank. All the variables are expressed in logarithmic form and real terms, using the GDP deflator obtained from the World Bank. Table 1 provides a brief summary of the descriptive statistics for all variables used in this study.

In order to investigate the existence of a causal relationship between fuel-mining exports and economic growth, the study applies the following tests: (a) unit root tests, in order to assess the stationary properties of the variables; (b) a cointegration test to confirm the existence of a long-run relationship between the variables; (c) the multivariate Granger causality test to find the direction of any short-run causality; and (d) a modified Wald test (MWALD) in an augmented vector autoregressive model, to investigate the existence of long-run causality between exports and economic growth.

3.1. Unit Root Tests

This study uses the augmented Dickey-Fuller (ADF) test (1979), the Phillips-Perron (PP) test (1988) and the unit root test with a structural break proposed by Saikkonen and Lutkepohl (SL) (2002). In each test, the null hypothesis, H_0 , is that a unit root exists, while the alternative hypothesis, H_A , is that the time series is stationary. In the case where the series is found to be non-stationary, the first difference is used. In particular, the ADF test is based on the following equations:

$$\Delta Y_t = \alpha_0 + \gamma Y_{t-1} + \alpha_2 t + \sum_{i=1}^p \beta_i \Delta Y_{t-i} + \varepsilon_t \quad (5)$$

$$\Delta Y_t = \alpha_0 + \gamma Y_{t-1} + \sum_{i=1}^p \beta_i \Delta Y_{t-i} + \varepsilon_t \quad (6)$$

$$\Delta Y_t = \gamma Y_{t-1} + \sum_{i=1}^p \beta_i \Delta Y_{t-i} + \varepsilon_t \quad (7)$$

α_0 and α_2 represent the deterministic elements, equation (5) is a random walk with intercept and time trend; equation (6) is a random walk with intercept only; while equation (7) is a random walk (Gujarati, 2003). The random errors, ε_t , are assumed to be identically distributed, with zero mean and variance σ^2 $\{\varepsilon_t \sim \text{ii}(0, \sigma^2)$ for $t = 1, 2, \dots\}$, and not correlated.

The PP unit root test, which proposes a semi-parametric correction of serial correlation and time-dependent heteroskedasticity (Enders, 1995), involves the following equations:

$$Y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 (t-T/2) + \mu_t \quad (8)$$

$$Y_t = \alpha_0 + \alpha_1 y_{t-1} + \mu_t \quad (9)$$

T is the number of observations and the error term μ_t is such that $E(\mu_t) = 0$, but is not necessarily serially uncorrelated. If there are structural breaks in the data, the ADF and PP test statistics are biased toward the non-rejection of a unit root. The SL test is based on the following equations, allowing the inclusion of a shift dummy variable.

$$Y_t = \mu_0 + \mu_1 t + \delta d_{1t} + u_t \quad (10)$$

$$Y_t = \mu_0 + \delta d_{1t} + u_t \quad (11)$$

μ_0 is the constant term, μ_1 and δ are the coefficients of the trend term and the shift dummy variable respectively, while u_t is the error term. d_{1t} is a shift dummy variable with break date T_{break} : $d_{1t} = 0$, for $t < T_{break}$ and $d_{1t} = 1$, for $t > T_{break}$.

3.2. Cointegration Test

To test the existence of a long-run relationship between the variables, this study performs the Johansen cointegration test (Johansen, 1988), which is based on the following restricted vector autoregressive model (VECM):

$$\Delta X_t = \mu + \Pi X_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \Phi D_t + \varepsilon_t \quad (12)$$

where $\Gamma_i = -\sum_{j=i+1}^p A_j$, $\Pi = \sum_{i=1}^p A_i - I$

Δ is the difference operator, Γ_i , Π and Φ are the coefficient matrices, and D_t is a vector of the deterministic variables¹. If the coefficient matrix Π has rank $r < n$, but is not equal to zero, the variables are cointegrated and r is the number of cointegrating vectors. The number of cointegrating vectors can be determined by using the likelihood ratio (LR) trace test statistic suggested by Johansen (1988). The LR trace statistic, which is adjusted for small sample size, as proposed by Reinsel and Ahn (1992)², is given by

$$J_{trace} = -T \sum_{i=r+1}^n \ln(1 - \lambda_i), \quad (13)$$

where T is the sample size and λ is the eigenvalue. The trace test is a test of the null hypothesis of at most r cointegrating vectors against the alternative hypothesis of n cointegrating vectors.

3.3. Short-run Granger Causality Test

The Granger causality test is used to examine the direction of the causality between fuel-mining exports and economic growth.

If the variables are cointegrated, the causality can be tested by estimating the following VECM model:

$$\begin{aligned} \Delta LY_t = & \sum_{j=1}^p \beta_{1j} \Delta LY_{t-j} + \sum_{j=1}^p \gamma_{1j} \Delta LK_{t-j} \\ & + \sum_{j=1}^p \delta_{1j} \Delta LHC_{t-j} + \sum_{j=1}^p \zeta_{1j} \Delta LFX_{t-j} \\ & + \sum_{j=1}^p \theta_{1j} \Delta LIMP_{t-j} - \lambda_y ECT_{t-1} + \varepsilon_{1t} \end{aligned} \quad (14)$$

$$\begin{aligned} \Delta LK_t = & \sum_{j=1}^p \beta_{2j} \Delta LY_{t-j} + \sum_{j=1}^p \gamma_{2j} \Delta LK_{t-j} \\ & + \sum_{j=1}^p \delta_{2j} \Delta LHC_{t-j} + \sum_{j=1}^p \zeta_{2j} \Delta LFX_{t-j} \\ & + \sum_{j=1}^p \theta_{2j} \Delta LIMP_{t-j} - \lambda_k ECT_{t-1} + \varepsilon_{2t} \end{aligned} \quad (15)$$

$$\begin{aligned} \Delta LHC_t = & \sum_{j=1}^p \beta_{3j} \Delta LY_{t-j} + \sum_{j=1}^p \gamma_{3j} \Delta LK_{t-j} \\ & + \sum_{j=1}^p \delta_{3j} \Delta LHC_{t-j} + \sum_{j=1}^p \zeta_{3j} \Delta LFX_{t-j} \\ & + \sum_{j=1}^p \theta_{3j} \Delta LIMP_{t-j} - \lambda_{hc} ECT_{t-1} + \varepsilon_{3t} \end{aligned} \quad (16)$$

$$\begin{aligned} \Delta LFX_t = & \sum_{j=1}^p \beta_{4j} \Delta LY_{t-j} + \sum_{j=1}^p \gamma_{4j} \Delta LK_{t-j} \\ & + \sum_{j=1}^p \delta_{4j} \Delta LHC_{t-j} + \sum_{j=1}^p \zeta_{4j} \Delta LFX_{t-j} \\ & + \sum_{j=1}^p \theta_{4j} \Delta LIMP_{t-j} - \lambda_{fx} ECT_{t-1} + \varepsilon_{4t} \end{aligned} \quad (17)$$

$$\begin{aligned} \Delta LIMP_t = & \sum_{j=1}^p \beta_{5j} \Delta LY_{t-j} + \sum_{j=1}^p \gamma_{5j} \Delta LK_{t-j} \\ & + \sum_{j=1}^p \delta_{5j} \Delta LHC_{t-j} + \sum_{j=1}^p \zeta_{5j} \Delta LFX_{t-j} \\ & + \sum_{j=1}^p \theta_{5j} \Delta LIMP_{t-j} - \lambda_{imp} ECT_{t-1} + \varepsilon_{5t} \end{aligned} \quad (18)$$

LY_t represents economic growth, while LK_t , LHC_t , LFX_t and $LIMP_t$ represent the independent variables of equation (1). Δ is the difference operator, β_{ij} , γ_{ij} , δ_{ij} , ζ_{ij} , θ_{ij} , μ_{ij} and λ_{ij} are the regression coefficients and ECT_{t-1} is the error correction term derived from the cointegration equation.

Once the models have been estimated, the following diagnostic tests are conducted in order to determine whether the models are well-specified and stable: (a) the Jarque-Bera normality test; (b) the Portmanteau test; (c) the Breusch-Godfrey LM test; (d) the White heteroskedasticity test; (e) the multivariate ARCH test; and (f) the AR roots stability test. In addition, the parameter constancy of the ECM estimates are assessed by applying the cumulative sum of recursive residuals (CUSUM) and the CUSUM of squares (CUSUMQ) tests proposed by Brown et al. (1975). The CUSUM and CUSUMQ tests detect systematic and haphazard changes in the parameters respectively. In particular, the CUSUM test is based on the statistic:

$$W_t = \sum_{k=1}^t w_t / s, \quad t = k+1, \dots, T \quad (19)$$

s is the standard deviation of the recursive residuals (w_t), defined as:

$$w_t = (y_t - x_t' b_{t-1}) / (1 + x_t' (X_{t-1}' X_{t-1})^{-1} x_t)^{1/2}$$

1 The Pantula Principle (Pantula, 1989) is used to determine the appropriate specification of the deterministic term in the VECM.

2 Trace statistics are adjusted by using the correction factor $(T - n^*p)/T$ proposed by Reinsel and Ahn (1992), where T is the sample size, and n and p are the number of variables and the optimal lag length respectively.

The numerator $y_t - x_t' b_{t-1}$ is the forecast error, b_{t-1} is the estimated coefficient vector up to period $t-1$ and x_t' is the row vector of observations on the regressors in period t . The X_{t-1} denotes the $(t-1) \times k$ matrix of the regressors from period 1 to period $t-1$. If the b vector changes, W_t will tend to diverge from the zero mean value line; if the b vector remains constant, $E(W_t)=0$. The test shows parameter instability if the cumulative sum of the recursive residuals lies outside the area between the two 5% significance lines, the distance between which increases with t .

The CUSUM of squares test uses the square recursive residuals, w_t^2 , and is based on the plot of the statistic:

$$S_t = \sum_{k=1}^t w_k^2 / \sum_{k=1}^T w_k^2, \quad (20)$$

where $t=k+1, \dots, T$. The expected value of S_p under the null hypothesis of the b_t 's being constant, is $E(S_p) = (t-k)/(T-k)$, which changes from zero at $t=k$ to unity at $t=T$. In this test, the S_t are plotted together with the 5% significance lines. Movements outside the 5% significance lines indicate instability in the equation during the period examined. After assessing the stability of the model parameters, the causality from fuel-mining exports to economic growth can be examined by conducting a Chi-square test. The null hypothesis "fuel-mining exports do not Granger cause economic growth" ($H_0: \sum_{j=1}^p \zeta_{1j} = 0$) is tested against the alternative hypothesis "fuel-mining exports Granger cause economic growth" ($H_A: \sum_{j=1}^p \zeta_{1j} \neq 0$). To examine the causality from economic growth to fuel-mining exports, the null hypothesis "economic growth does not Granger cause fuel-mining exports" ($H_0: \sum_{j=1}^p \beta_{4j} = 0$) is tested against the alternative hypothesis "economic growth Granger causes fuel-mining exports" ($H_A: \sum_{j=1}^p \beta_{4j} \neq 0$).

3.4. Long-run Granger Causality Test

This paper applies the modified version of the Granger causality test (MWALD) proposed by Toda and Yamamoto (1995). This test is based on the following model:

$$\begin{aligned} LY_t = & \alpha_{10} + \sum_{j=1}^{p+d \max} \beta_{1j} LY_{t-j} + \sum_{j=1}^{p+d \max} \gamma_{1j} LK_{t-j} \\ & + \sum_{j=1}^{p+d \max} \delta_{1j} LHC_{t-j} + \sum_{j=1}^{p+d \max} \zeta_{1j} LFX_{t-j} \\ & + \sum_{j=1}^{p+d \max} \theta_{1j} LIMP_{t-j} + \varepsilon_{1t} \end{aligned} \quad (21)$$

$$\begin{aligned} LK_t = & \alpha_{20} + \sum_{j=1}^{p+d \max} \beta_{2j} LY_{t-j} + \sum_{j=1}^{p+d \max} \gamma_{2j} LK_{t-j} \\ & + \sum_{j=1}^{p+d \max} \delta_{2j} LHC_{t-j} + \sum_{j=1}^{p+d \max} \zeta_{2j} LFX_{t-j} \\ & + \sum_{j=1}^{p+d \max} \theta_{2j} LIMP_{t-j} + \varepsilon_{2t} \end{aligned} \quad (22)$$

$$\begin{aligned} LHC_t = & \alpha_{30} + \sum_{j=1}^{p+d \max} \beta_{3j} LY_{t-j} + \sum_{j=1}^{p+d \max} \gamma_{3j} LK_{t-j} \\ & + \sum_{j=1}^{p+d \max} \delta_{3j} LHC_{t-j} + \sum_{j=1}^{p+d \max} \zeta_{3j} LFX_{t-j} \\ & + \sum_{j=1}^{p+d \max} \theta_{3j} LIMP_{t-j} + \varepsilon_{3t} \end{aligned} \quad (23)$$

$$\begin{aligned} LFX_t = & \alpha_{40} + \sum_{j=1}^{p+d \max} \beta_{4j} LY_{t-j} + \sum_{j=1}^{p+d \max} \gamma_{4j} LK_{t-j} \\ & + \sum_{j=1}^{p+d \max} \delta_{4j} LHC_{t-j} + \sum_{j=1}^{p+d \max} \zeta_{4j} LFX_{t-j} \\ & + \sum_{j=1}^{p+d \max} \theta_{4j} LIMP_{t-j} + \varepsilon_{4t} \end{aligned} \quad (24)$$

$$\begin{aligned} LIMP_t = & \alpha_{50} + \sum_{j=1}^{p+d \max} \beta_{5j} LY_{t-j} + \sum_{j=1}^{p+d \max} \gamma_{5j} LK_{t-j} \\ & + \sum_{j=1}^{p+d \max} \delta_{5j} LHC_{t-j} + \sum_{j=1}^{p+d \max} \zeta_{5j} LFX_{t-j} \\ & + \sum_{j=1}^{p+d \max} \theta_{5j} LIMP_{t-j} + \varepsilon_{5t} \end{aligned} \quad (25)$$

p is the optimal lag length, selected by minimising the value of the Schwartz information criterion (SIC), while $dmax$ is the maximum order of integration of the variables in the model. The selected lag length (p) is augmented by the maximum order of integration ($dmax$) and the chi-square test is applied to the first p VAR coefficients.

4. EMPIRICAL RESULTS

4.1. Unit Root Tests

Before testing for the causality between fuel-mining exports and economic growth, the order of integration of the variables is examined. Tables 2 and 3 present the results of the ADF, PP and SL tests for the logarithmic level and first difference of the time series respectively. The results of the unit root tests at the log level indicate that the null hypothesis of non-stationarity cannot be rejected for any of the variables at the 5% significance level. In contrast, after taking the first difference of LY , LK , LFX and $LIMP$, the null hypothesis of the presence of a unit root can be rejected at the 1% level, while the first-differenced series of LHC is found to be stationary at 5%. Hence, the time series for the period 1981-2012 are integrated of order one $I(1)$.

4.2. Cointegration Test

The Johansen cointegration test is conducted in order to investigate the existence of a long-run relationship between LY , LK , LHC , LFX and $LIMP$. Table 4 shows that the null hypothesis of no cointegration is rejected at the 5% level, indicating the existence of one cointegrating vector. This suggests that real GDP, real gross fixed capital formation, population, real fuel-mining exports and real imports are cointegrated and follow a common long run path.

The cointegrating vector is estimated after normalizing on LY . The following long-run relationship is obtained, with the absolute t -statistics reported in the parentheses:

$$\begin{aligned} LY_t = & 0.499*** \quad LK_t - 0.137** \quad LHC_t - 0.109*** \quad LFX_t + 0.322*** \\ & (8.709) \quad (2.474) \quad (2.474) \quad (5.216) \\ LIMP_t = & 10.473*** \\ & (19.952) \end{aligned} \quad (26)$$

From the above equation, a one percent increase in real fuel-mining exports leads to a 0.109% decrease in real GDP, while a one percent increase in physical capital increases real GDP by 0.499%. In addition, real GDP decreases by 0.137% in response to a one percent increase in human capital. In contrast, a one

Table 2: ADF, PP and SL test results at logarithmic level

Variables	ADF	PP	SL			
			Without trend		With trend	
LY	-3.45*[0] ^(a)	-3.41*{3} ^(a)	0.77[0]	1990	-1.09[0]	1986
LK	-2.36[0] ^(a)	-2.36{6} ^(a)	0.11[0]	2001	-1.45[0]	2001
LHC	-2.02[1] ^(a)	5.84{1} ^(c)	0.05[1]	2008	-2.64[1]	2008
LFX	-3.02[0] ^(a)	-3.49*{11} ^(a)	-0.23[0]	1986	-1.86[0]	1986
LIMP	-2.91[0] ^(a)	-2.92{2} ^(a)	0.50[0]	2001	-1.24[0]	2001

Note: *Denote the rejection of the null hypothesis at 10%. Numbers in [] corresponding to the ADF and SL test statistics are the optimal lags, chosen based on the SIC. Bandwidth in { } (Newey-West automatic) using the Bartlett kernel estimation method. Critical values for SL test are tabulated in Lanne et al. (2002). The maximum lag length for the ADF test is found by rounding up $P_{\max} = [12 * (T/100)^{1/5}] = [12 * (32/100)^{1/5}] \approx 9$ (Schwert, 1989). For the ADF and PP tests, all time series are tested for the unit root including intercept and trend (a), intercept only (b) and no constant or trend (c). The letters in brackets indicate the selected model following Dolado et al. (1990). The years in the table refer to the shift dummy variable d_{it} with break date T_{break} : $d_{it}=0$, for $t < T_{\text{break}}$ and $d_{it}=1$, for $t > T_{\text{break}}$ in equations 10 and 11

Table 3: ADF, PP and SL test results at first difference

Variables	ADF	PP	SL			
			Without trend		With trend	
ΔLY	-4.32***[0] ^(b)	-4.30***{1} ^(b)	-5.14***[0]	1986	-4.50***[0]	1990
ΔLK	-4.84***[0] ^(c)	-4.88***{2} ^(c)	-4.85***[0]	2001	-4.95***[0]	2001
ΔLHC	-3.04**[0] ^(b)	-3.04**{3} ^(b)	-3.75***[1]	2008	-3.46**[1]	2008
ΔLFX	-4.92***[0] ^(c)	-4.91***{3} ^(c)	-5.54***[0]	1986	-5.28***[0]	1986
$\Delta LIMP$	-3.81***[0] ^(b)	-3.72***{2} ^(b)	-7.41***[7]	2001	-6.92***[7]	2001

Note: ***, **Denote the rejection of the null hypothesis of a unit root at 5% and 1% respectively. Numbers in [] corresponding to the ADF and SL test statistics are the optimal lags, chosen based on the SIC. Bandwidth in { } (Newey-West automatic) using the Bartlett kernel estimation method. Critical values for SL test are tabulated in Lanne et al. (2002). The maximum lag length for the ADF test is found by rounding up $P_{\max} = [12 * (T/100)^{1/5}] = [12 * (32/100)^{1/5}] \approx 9$ (Schwert, 1989). For the ADF and PP tests, all the time series are tested for the unit root including intercept and trend (a), intercept only (b) and no constant or trend (c). The letters in brackets indicate the selected model following Dolado et al. (1990). The years in the table refer to the shift dummy variable d_{it} with break date T_{break} : $d_{it}=0$, for $t < T_{\text{break}}$ and $d_{it}=1$, for $t > T_{\text{break}}$ in equations 10 and 11

Table 4: Johansen's cointegration test results

Hypothesized number of cointegrating equations	Adjusted trace statistic	Critical value		
		1%	5%	10%
$r=0$	80.46**	84.45	76.07	71.86
$r \leq 1$	48.19	60.16	53.12	49.65
$r \leq 2$	28.18	41.07	34.91	32.00
$r \leq 3$	14.68	24.6	19.96	17.85

Note: ** Indicate rejection at 5% significance level. Critical values are taken from Osterwald-Lenum (1992). The model includes a restricted constant (model selection based on the Pantula Principle) and is estimated using lag length³.

Table 5: Short-run Granger causality test

Dependent variable	Source of causality					
	ΔLY_t	ΔLK_t	ΔLHC_t	ΔLFX_t	$\Delta LIMP_t$	ALL
	$\chi^2 (2)$	$\chi^2 (2)$	$\chi^2 (2)$	$\chi^2 (2)$	$\chi^2 (2)$	$\chi^2 (8)$
ΔLY_t	-	3.263	1.184	5.686*	3.364	11.806
ΔLK_t	0.870	-	0.418	1.972	1.625	4.617
ΔLHC_t	1.131	6.815**	-	2.358	1.916	10.298
ΔLFX_t	0.658	7.397**	0.471	-	4.287	11.174
$\Delta LIMP_t$	6.288**	8.931**	0.989	11.666***	-	17.117**

Note: ***, ***, **Indicate significance at the 10%, 5% and 1% levels respectively (df in parentheses). The diagnostic tests for the VECM model show that serial correlation is not present, while the residuals are multivariate normal and homoscedastic. In addition the stability of the VECM is confirmed based on calculations of the inverse roots of the characteristic AR polynomial.

Table 6: Short-run Granger causality results

ΔLFX_t	→	ΔLY_t
ΔLK_t	→	ΔLHC_t
ΔLK_t	→	ΔLFX_t
ΔLY_t	→	$\Delta LIMP_t$
ΔLK_t	→	$\Delta LIMP_t$
ΔLFX_t	→	$\Delta LIMP_t$
$\Delta LY_t, \Delta LK_t, \Delta LHC_t, \Delta LFX_t$	→	$\Delta LIMP_t$

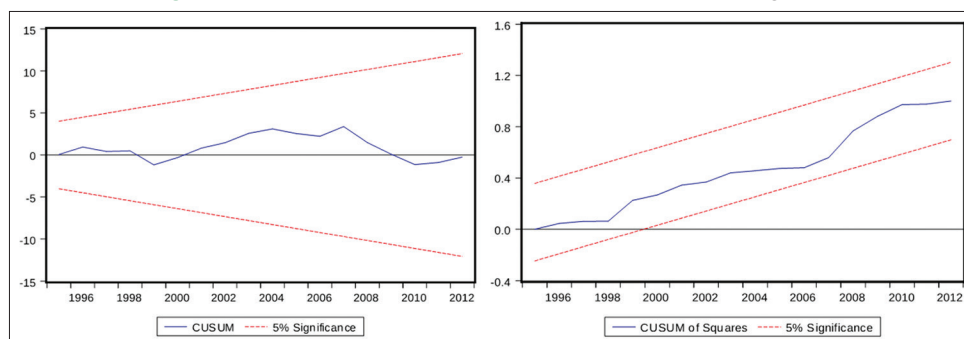
Note: Arrows indicate the direction of Granger causality between the variables

- 3 Although SIC and AIC criteria suggest the use of one lag in the VAR system, a lag length of two is used, as a lag of one introduces autocorrelation. The multivariate specification tests for the VAR(2) model indicate that there is no problem of serial correlation, while the residuals are multivariate normal and homoscedastic.

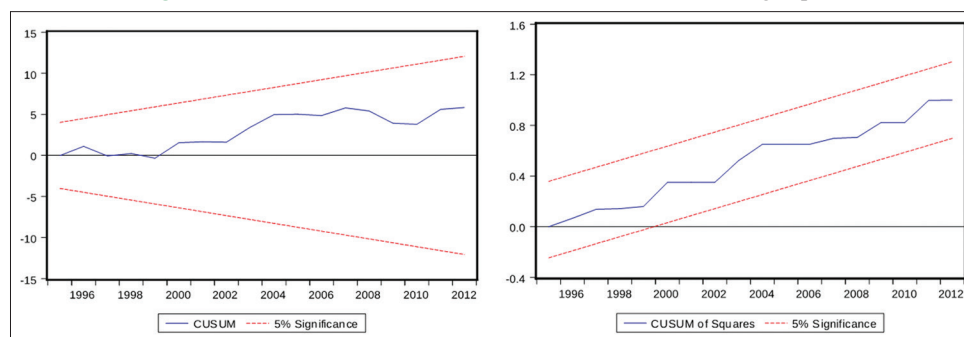
percent increase in imports can lead to an increase in real GDP of 0.322%. These results suggest that fuel-mining exports do not enhance economic growth in the long-run.

4.3. Granger Causality in VECM

The short-run causality results reported in Table 5 show that the null hypothesis of non-causality from fuel-mining exports to economic growth can be rejected at the 10% significance level, indicating some support for the ELG hypothesis in the short-run. However, the null hypothesis of non-causality from economic growth to fuel-mining exports cannot be rejected at any conventional significance level. In other words, the GLE is not valid in the case of fuel-mining exports. As for the other causal relationships, a uni-directional

Figure 1: Plot of CUSUM for the estimated ECM for economic growth

$$\begin{aligned} \Delta LY_t = & -0.097\Delta LY_{t-1} - 0.057\Delta LY_{t-2} + 0.290\Delta LK_{t-1} - 0.227\Delta LK_{t-2} - 0.079\Delta LHC_{t-1} + 0.234\Delta LHC_{t-2} + 0.341\Delta LFX_{t-1} + 0.067\Delta LFX_{t-2} \\ & - 0.173\Delta LIMP_{t-1} + 0.314\Delta LIMP_{t-2} - 0.532ECT_{t-1} \end{aligned}$$

Figure 2: Plot of CUSUM for the estimated ECM for fuel-mining exports

$$\begin{aligned} \Delta LFX_t = & -0.802\Delta LY_{t-1} - 0.010\Delta LY_{t-2} + 1.166\Delta LK_{t-1} - 1.021\Delta LK_{t-2} - 0.336\Delta LHC_{t-1} + 0.465\Delta LHC_{t-2} + 1.168\Delta LFX_{t-1} + 0.057\Delta LFX_{t-2} \\ & - 0.746\Delta LIMP_{t-1} + 0.884\Delta LIMP_{t-2} - 1.623ECT_{t-1} \end{aligned}$$

causality runs from physical capital to fuel and mining exports at a 5% level of significance, while fuel-mining exports Granger cause imports at 1%. These results show that investments cause the expansion of fuel-mining exports, allowing the expansion of imports of services and capital goods, which are essential to improving productivity and economic growth (Gylfason, 1998; McKinnon, 1964; Chenery and Strout, 1966).

In addition, a Chi-square test is performed to investigate the joint significance of the explanatory variables. The results indicate that the variables ΔLY_t , ΔLK_t , ΔLHC_t and ΔLFX_t jointly cause imports, $\Delta LIMP_t$, at the 5% significance level. Table 6 summarizes the short-run Granger causality results.

The structural stability of the parameters of equation (14) is tested by applying the cumulative sum of recursive residuals (CUSUM) and the CUSUM of squares (CUSUMQ). The CUSUM plots (Figure 1) show that there is no movement outside the 5% critical lines of parameter stability. Therefore, the model for economic growth is stable, even during the oil crises of 1986 and 2000. The CUSUM plots (Figure 2) for the estimated ECM for fuel-mining exports (equation 17) show that there is no movement outside the 5% critical lines. The model for fuel-mining exports is thus also stable and, again, even during the oil crises of 1986 and 2000.

4.4. Toda-Yamamoto Granger Causality Test

The maximum order of integration of the variables is $dmax = 1$, while the optimal lag length is two. Therefore the selected lag

length ($p = 2$) is augmented by the maximum order of integration ($dmax = 1$) and Wald tests are applied to the first p VAR coefficients. The results are presented in Table 7.

The results of the Wald tests show that there is no evidence to support the ELG hypothesis in the long-run, as the null hypothesis that LFX does not Granger cause LY cannot be rejected at any conventional significance level. According to Siliverstovs and Herzer (2007), such results show evidence of the productivity-limiting effects of fuel-mining exports. In addition, the absence of any direct long-run causality from economic growth to fuel-mining exports indicates that the GLE is not valid.

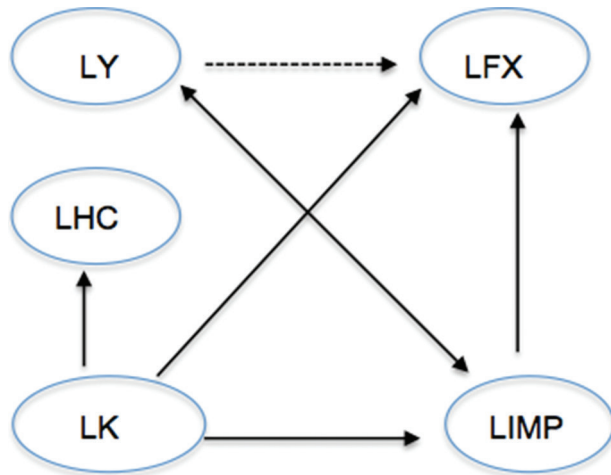
In contrast, a long-run bi-directional causality exists between imports and economic growth. In particular, the null hypothesis that $LIMP$ does not Granger cause LY can be rejected at the 10% level, while LY Granger causes $LIMP$ at the 1%. This suggests that economic growth can increase the country's capacity to import essential materials for domestic production, improving existing technology and leading to further economic growth. Moreover, imports are also affected directly by physical capital at the 1% level.

At the same time, a long-run causality runs from physical capital and imports to fuel-mining exports at 1% and 5% significance respectively, suggesting that investments in advanced technology and imports contribute to the expansion of fuel-mining exports.

Table 7: Granger causality based on the Toda-Yamamoto procedure

Dependent variable	Source of causality					
	LY_t	LK_t	LHC_t	LFX_t	$LIMP_t$	ALL
	$\chi^2 (2)$	$\chi^2 (2)$	$\chi^2 (2)$	$\chi^2 (2)$	$\chi^2 (2)$	$\chi^2 (8)$
LY_t	-	3.516	0.846	2.368	5.764*	11.223
LK_t	3.906	-	0.484	0.076	0.667	12.418
LHC_t	0.612	5.929*	-	1.609	2.837	11.112
LFX_t	3.500	10.105***	0.557	-	7.689**	20.675***
$LIMP_t$	12.328***	11.867***	1.138	4.169	-	20.834***

Note: ***, ** and * indicate significance at the 10%, 5% and 1% levels respectively. The diagnostic tests for the select VAR(p) model prior to the application of the Toda-Yamamoto procedure show that serial correlation is not present, while the residuals are multivariate normal and homoscedastic.

Figure 3: Long-run causal relationships (→: direct;---->: indirect)

Source: Created by the authors for the purpose of this study

An indirect long-run causal relationship also exists between economic growth and fuel-mining exports, through imports of goods and services. In particular, LY Granger causes $LIMP$ at the 1% significance level and $LIMP$ Granger causes LFX at 5%. Therefore, economic growth indirectly causes the expansion of fuel-mining exports. In addition, the results show that LY , LK , LHC and $LIMP$ jointly Granger cause LFX in the long-run at the 1% level, while all variables in the model jointly cause $LIMP$ at 1%. Figure 3 summarizes the long-run causal relationships among the variables in the model.

5. CONCLUSION

The cointegration analysis of the model confirms the existence of a long-run relationship between GDP, physical capital, human capital, fuel-mining exports and imports, while fuel-mining exports are found to have a negative impact on economic growth. These findings are consistent with previous studies, which argued that this category of exports does not enhance economic growth in the long-run (Myrdal, 1957; Sachs and Warner, 1995; Herzer et al., 2006; Hosseini and Tang, 2014; Kalaitzi and Cleeve, 2017). Moreover, the study finds that fuel-mining exports do not cause economic growth in the short-run or the long-run.

UAE fuel-mining exports have been decreasing steadily since 1981, with fuel mining exports as a proportion of total merchandise exports decreasing from 84% in 1981 to 31% in 2014. In other words, the UAE is moving away from fuel-mining as its primary

source of export revenue. Further reductions in the relative importance of fuel-mining exports should enhance the rate of economic growth, with greater emphasis on imports and physical capital accumulation, directly or indirectly increasing growth in the long-run.

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