*Statistics Faroe Islands*

# Examining the Export-led Growth Hypothesis (ELGH) using Granger Causality test: The Faroe Islands Experience

## Abstract

This paper tries to examine validity of ELG hypothesis utilising the Faroese macro-data. We rely on the most recent statistical procedure, namely the cointegration and VARD in order to determine causality directions based on Granger causality test (1969). Our inconclusive results can point only to a one thing, mainly; the principal need to construct reliable *deflators* if meaningful future research is to be conducted.

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## 1. Introduction

Following the basic postulates of international trade founded on the comparative advantage theory, a strategy for economic development in the form of export-led growth – (ELG) can be envisaged. On another hand, as it usually is in economic science, opposite or contradicting points of view in the form of economic growth leading to export growth (GLE) can be expressed, especially for countries at the very early stages of economic development. It must be said from the outset, that both propositions can be found to be plausible if argued coherently and presented to both the economist and the non-economist audience.

However, in a case of middle ground, a combination of previous arguments can emerge presenting us with a most likely outcome where economic growth and export are interdependent. That is to say, that for some countries at the lower level of development, the GLE hypothesis might be more applicable upon which ELG might follow.

The essential purpose of this paper is exactly to examine such a hypothesis looking at the Faroese data and to gather evidence for or against such support. We start our paper by initially looking at theoretical links between trade and development in its broadest sense, as well as looking at some arguments for and against free trade, liberalisation, openness and economic performance. The empirical literature main results and various approaches applied over time will follow where we will try to give some main characteristics of methodological trends and its associated findings over time.

Our main consideration of the issue based on latest methodological technique will be explained in the details as our principal working tool. We rely on the most recent statistical procedure, namely the cointegration and VARD in order to determine causality directions based on Granger causality test (1969). We will present our results in tabular fashion including the most important statistics upon which we elaborate in order to deliver our conclusions.

## 2. Theoretical Review

In the first part of the nineteenth century economists like Ricardo and Mill expanded the classical school of economic thought established by Adam Smith, by expressing the theoretical links between economic growth and trade. While Adam Smith based trade argument on absolute advantage, Ricardo has shown, using an example of England and Portugal in production of wine and cloth, that it was comparative advantage based cross-frontier trade that mattered. Following such an argument, gains from trade in the form of increased welfare will follow by opening up countries' borders. In such a framework, it is usually assumed that factor endowments stay fixed, that is to say, comparative advantage will not change over time, which might not always be the case as government intervention may, in the long run, contribute to a structural change (resources re-employment from primary production to a high-tech goods). Other factors that can contribute to changes in comparative advantage, observed in the last fifty years or so, are activities by multinational companies (Grimwade, 1989) and its relocation of production along the increased capital movements and transfers of technology.

As mentioned above, production and consumption gains can be achieved by international trade either by access to previously unavailable goods and services or by reduction in prices due to cheap imports. However, such gains are to be achieved only if we rely on conditions of free trade, that is to say, trade with minimum restrictions like tariffs and quotas. GATT would be one of the examples where the international community has tried to regulate such free trade flow. Any considerations of such a proposition must be analysed in context of the benefits of international trade and its unequal distribution among countries. Such unequal distribution of gains and benefits tend to produce various responses in forms of protections. The argument for free trade is further questioned by looking at the developing countries whose specialisation is based on primary products, given that world demand for such commodities increased very slowly over time. Nevertheless, justification for free trade and verification of proposition that open economies perform better in contrast to closed ones, as well as why protectionism takes place is widely discussed within the literature.

Edwards (1992), develops a simple endogenous growth model and by using a cross-country data finds "existence of a strong and robust relationship between trade orientation and economic performance … countries with more open and less distortive trade policies have tended to grow faster than those countries with more restrictive commercial policies."[1]

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[1] Edwards Sebastian, "Trade Orientation, distortions and growth in developing countries", Journal of Development Economics, Elsevier Science Publishers, Vol. 39, 1992,p. 54

Further on, the issue of measuring trade orientation led to the construction of subjective indexes, and the analysis of two stages effects of liberalisation to economic performance; 1) export encouraged by liberalisation and 2) testing association of economic growth and higher exports rates, left us with contradictory results. For example, according to the World Bank (1987), Korea's experience is seen as pro-trade liberalisation whilst for others (Sachs, 1987), the same country is the best example of how to avoid such a policy.

As far as growth in South East Asia is concerned, "The East Asian Miracle" by the World Bank (1993) advocated that Export led growth hypothesis for so called "Four Tigers", was the main engine of growth along the openness to foreign technology transfers and industry specific promotion. Prevailing "conventional wisdom" in favour of export-led orientation was further reinforced by the poor economic performance of the countries that followed opposite spectrum of policies, mainly inward oriented policies usually called import substitution strategy. Further empirical findings by Barro and Sala-I-Martin (1995) show four slow Latin America growing economies in period of 1965-85 as compared to 4 Asian countries.

Table 1. Details of high & low growth countries[2]

| Country | Growth rate 1965-85 | Country | Growth rate 1965-85 |
|---|---|---|---|
| Nicaraqua | -0.013 | Singapore | 0.073 |
| Guyana | -0.011 | Taiwan | 0.059 |
| Venezuela | -0.01 | Korea | 0.071 |
| Chile | 0.00 | Honk Kong | 0.056 |

Such findings are not to be translated as universal support for ELG. On the contrary, critics point out several issues where export-led growth hypothesis may not be so sound. Singer and Gray (1988), exploring some new data conclude that "outward orientation cannot be considered as a universal recommendation for all conditions and for all types of countries."[3] Their conclusion is based on observation that only when favourable market conditions are present will export orientation lead to higher growth followed by weaker correlation for low-income countries for all time periods.

[2] Barro J. Robert, Sala-I-Martin Xavier, " Economic Growth", McGraw-Hill, USA, 1995, tables 12.1, 12.2, p.416 & 418

[3] Singer Hans W., Gray Patricia, "Trade Policy and Growth of Developing Countries: Some new Data", World Development, Pergamon Press plc., UK, Vol. 16, No. 3, p.403

Nevertheless, one can find wide rejections of an inward-oriented approach within economic literature in the 1980's, followed by acceptances of export-led growth as scheme that both policy makers in less developed countries and most of the economic researches have adopted.

## 3. The empirical literature

Following Giles and Williams the empirical literature on ELG can be separated in three lines of inquiries. The initial research of the subject relied on cross-country correlation coefficients in order to test for such hypothesis. The second notion utilised regression analysis-mainly OLS in cross-sectional framework, while most recent ones follow advanced time-series technique. Along the cross-sectional investigations, individual country analyses have taken place and generally former one supported ELG hypothesis while later provided less support.

The research of cross-section data presents rank correlation coefficient along the significance of OLS regressions between exports and output. The ELG is to be found when positive and significant correlation is present and the general conclusion from these studies is that the high levels exports are highly associated with the growth in output. Shortcoming of such an approach comes in the form of results that rely on only one independent variable - export, ignoring the possibility of some other variables influencing such a relationship. Remedies in the form of variables like capital, labour and investment were included as control for other factors. In such cases, ELG was supported upon positive and significant values of coefficient on the export in linear regression model.

Further on, endogoneity issues were dealt with by introducing a simultaneous equation framework, while probably the most important issue was relying on positive correlation and interpreting it as evidence of causation. However, positive correlation, if found, can easily be compatible with both the ELG and GLE hypothesis, in which case no certain conclusion of direction of causation can be made. Along these shortcomings, regression parameters like production function and factor productivity’s, were assumed to be fixed or the same across the countries so that the different reaction to external shocks due to different political or financial countries' conditions was not allowed. Recognising difficulties in the estimation procedure within cross-sectional research in order to estimate ELG hypothesis has led to a new approach of finding direction of causality.

Granger (1969) work established causality approach where the intuitive idea behind it is the notion of predictability, that is to say, a cause precedes an effect. Such an approach is not a theoretical one as we simple regress Y on its own past values and other variables, and if we find out that the included lagged X values significantly improved the prediction of Y, then we state that X Granger causes Y.[4] Throughout the literature there are a few various methods applied while examining ELG using Granger test; vector autoregressive model in levels VARL, in the first differences data VARD or relying on a vector error correction model VECM.[5]

Looking at the different studies it is clear that results obtained are not unanimous and they depend very much on the econometric methodology applied. Generally, support for ELG is found within cross-sectional studies, but with the cost of concealing specific characteristics of low-income developing countries as well as petroleum-exporting countries. For that reason, the literature seems to start adopting a case study of a particular country applying most advanced time series analysis.[6]

## 4. Methodology and Data

As mentioned above, early literature on ELG relied on rank correlation coefficient or simple OLS regressions, where a positive correlation or positive and significant coefficient of the export variable was used to confirm the ELG hypothesis. Such findings, however did not provide us with direction of causality, "if X, Y are correlated random variables, then Y can be used to explain X but Y can be used to explain X"[7] Usage of dynamic time series followed where utilising the Granger causality test as principal researching tool took place.

This paper will use the most recent statistical procedure if appropriate - the cointegration and error-correction model (ECM) in bivariate context, which will provide us with a very elegant way to ensure for stationarity, which is required pre-condition if causality test is to be applied. Namely, Granger (1969) developed the Granger causality test where he defined the "arrow of time" to help us identify between cause and effect. Intuitively, his test provide us with opportunity to check if by including past values of variable X we predict better present values of Y. If this is true, we say that X Granger-cause Y, or if the opposite is true, we say that Y Granger-cause X. Finally, if we are about to discover that both propositions are true; then we say that a feedback occurs. More formally,

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[4] Gujurati Damodar N. "Basic Econometrics", McGraw-Hill, Inc. Singapore, International Editions 1995, p. 620

[5] Giles Judith A., Williams Cara L. "Export-led Growth, A survey of the Empirical Literature and Some Noncausality Results Part 2", Econometrics Working Paper EWP0001, University of Victoria,Canada, January 2000, p.2

[6] Medina Smith Emilio J., "Is the Export-Led Growth Hypothesis valid for developing countries? A case study of Costa Rica", United Nations Conference on Trade and Development, Policy Issues in International Trade and Commodities, Study Series No. 7, p.12-4

[7] Granger C.W.J., "Some Recent Developments in a Concept of Causality", Journal of Econometrics, Elsevier Science Publishers, No. 39, 1998, p. 204

$$X_t = \sum_{j=1}^{m} a_j X_{t-j} + \sum_{j=1}^{m} b_j Y_{t-j} + e_t,$$
$$Y_t = \sum_{j=1}^{m} c_j X_{t-j} + \sum_{j=1}^{m} d_j Y_{t-y} + h_t \qquad (1)$$

Where $e_t, h_t$ are non-correlated white-noise series.

$$E[e_t e_s] = 0 = E[h_t h_d], s \neq t$$

Granger argues that number of lags **m** can equal infinity but limitation is visible in practice, as our sample data is usually finite, in which case, **m** will be shorter than our time span. In the equation above, when b is zero Y does not cause X and when c is zero, the opposite is true.

According to Engle & Granger (1987) we can use standard causality tests only if cointegration exists, that is to say, while the individual time-series variable can deviate extensively, a pair of such series may move towards the long-term equilibrium relationship "where equilibrium is a stationary point characterised by forces which tend to push the economy back towards equilibrium whenever it moves away"[8] Denoting $x_t$ as a vector of economic variables, equilibrium is said to exist when

$a' x_t = 0$ however, we may not always expect such equilibrium to exist and the equilibrium error will be shown as

$$z_t = a' x_t \qquad (2)$$

What this means is that if the long-term relationship exists, then we will expect this disequilibrium error $z_t$ not too often to "drift far from zero" and "often cross the zero line", it should form a stationary time series and have a zero mean, $z_t$ should be I (0) with $E(z_t) = 0$.[9]

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[8] Engle Robert F. Granger C.W.J. " Co-Integration and Error Correction: Representation, Estimation, and Testing", Econometrica, Vol. 55, No.2 (March, 1987) , p. 251

[9] Thomas R.L. "Modern Econometrics-an introduction", Addison-Wesley, Essex, UK, 1997,p.425

Before introducing an error-correction model that helps us face the non-stationary series, we will briefly touch upon issues of stationary and non-stationary time series. If we refer to a stochastic process of a time-series variable as

$$X_t = (t = 1, 2, 3......)$$

Then each of $X_t$ will have its own mean, variance and also perhaps non-zero covariance between different $X_t$ then we define such time series as stationary if over time, its mean, variance and covariance remains the same.

$$E(X_t) = constant \quad \text{for all t}$$

$$Var(X_t) = constant \quad \text{for all t}$$

$$Cov(X_t, X_{t+k}) = constant \quad \text{for all t and } k \neq 0 \qquad (3)$$[10]

If we are to use OLS where at least one of independent variables is non-stationary and exhibit a clear trend, it is most likely that the dependent variable will have the same properties. If so, we are very likely to get a "significant" estimator with high explanation power, the Rsq will be very high. Hendry (1980) showed that there was a strong relationship between the UK inflation rate and rainfall in that country, which was a result of chance and of course meaningless. Therefore, we need to check for stationary conditions of variables in order to avoid spurious causality.

In our paper, two macroeconomic variable time-series, total export, and GDP are to be examined for their unit roots. If our variables are indeed non-stationary then we need to establish orders of integration. We first adopt the graphical inspection of variables in levels and if we find non-stationary we inspect the plots of variables in their first differences. Such graphical inspections serve us a first approximation, after which we will use the more formal test of unit roots mainly Dickey-Fuller (DF), augmented Dickey-Fuller (ADF) and Phillips-Perron method. Such a test will enable us to conclude if our variables are stationary of the order 0 written as I (0), or they follow a non-stationary trend of 1 denoted I (1) or higher.

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[10] Thomas R.L. "Modern Econometrics-an introduction", Addison-Wesley, Essex, UK, 1997

Defining the Dickey-Fuller regression as;

$y_t = b_0 + ry_{t-1} + e_t$ or

$y_t = b_0 + gt + ry_{t-1} + e_t$ where $gt$ is a time trend

while the augmented DF utilises differenced time series $\Delta y_t = y_t - y_{t-1}$

$$\Delta y_t = b_0 + ry_{t-1} + \sum_{j=1}^{k} b_j \Delta y_{t-j} + e_t$$

$$\Delta y_t = b_0 + gt + ry_{t-1} + \sum_{j=1}^{k} b_j \Delta y_{t-j} + e_t \qquad (4)$$

where in both regressions we may exclude constant $b_0$[11]

DF test assumes AR (1) data generating process (d.g.p.) where we rely on the critical DF values since a standard t-distribution is invalid under non-stationary. If d.g.p is however, AR (p), errors term from DF regression will be autocorrelated and assumption of $e$ being a "white noise" is violated. To accommodate for such misspecification ADF allows inclusion of additional higher-order lagged terms that ensure a white noise error. Extension using a "non-parametric" correction as in Phillips-Perron test along with other tests like the KPSS test, Sargan-Barghava DW test, Cochrane Variance Ratio test has taken place in applied work in addition to DF & ADF tests, mainly reflecting the fact of their low power and "search" for most powerful one. For our purposes, we limit ourselves by using DF, ADF, PP tests along the graphical inspection of data sets.

As mentioned above, if we find that our series is I (1), by using OLS technique and relying on high **Rsq, t** and **F** test, it might tempt us to accept the spurious relationship as a valid one, in which case our results become meaningless. Secondly, the traditional suggestion to solve for non-stationary conditions by using first differences is applied, having in mind that we may lose some valuable long-run relationship information, which we are trying to estimate. Of course, in case that we find variables to be stationary I (0), we do not need to test for cointegration and OLS can be applied to those stationary variables in levels.

[11] STATA Time Series Reference Manual, Release 8, A STATA press publication, Texas, USA, 2003,p.74-75

Our paper follows the cointegration test as proposed by Engle & Granger (1987), which is basically a two-step test that might be flawed by transferring errors from the first-step into the second one. Basically we are about to show if export and growth are cointegrated in Granger sense, by first estimating the long-run direct and reverse cointegrating regression of form;

$$Y_t = a_0 + a_1 X_t + e_t$$
$$X_t = b_0 + b_1 Y_t + h_t \qquad (5)$$

In step two we move on to test for stationarity of OLS residuals $e_t$ and $h_t$ from (5), using first difference of the error term on both its lagged value and a time trend.

$$\Delta e_t = e_t - e_{t-1} = b_0 + r e_{t-1} + \sum_{j=1}^{k} b_j \Delta e_{t-j} + z_t$$

$$\Delta h_t = h_t - h_{t-1} = f_t + r h_{t-1} + \sum_{j=1}^{k} f_j \Delta h_{t-j} + z_t \qquad (6)$$

The last stage of our estimation depends on the outcome of the co-integration test. If we find that our variable is not co-integrated the standard Granger causality test is applied. The model then cannot be estimated in levels, but we can use a first-difference form from below

$$\Delta Y_t = l_1 + \sum_{i=1}^{p} a_{i1} \Delta Y_{t-i} + \sum_{i=1}^{q} b_{i1} \Delta X_{t-i} + e_t \qquad (7)$$

$$\Delta X_t = l_2 + \sum_{i=1}^{l} a_{i2} \Delta Y_{t-i} + \sum_{i=1}^{m} b_{i2} \Delta X_{t-i} + h_t \qquad (8)$$

$\Delta$, is the first-difference operator, $a, b$, are parameters to be estimated and $l$ is a constant term. If we find all $b$ in equation (7) significant we say that X Granger causes Y, and same is true in equation (8) for $a$ , Y Granger causes X.

However, if we detect cointegration, a causality test can be performed by using ECM by constructing augmented Granger causality equation adding lagged error correction term.

$$\Delta Y_t = l + \sum_{i=1}^{p} b_i \Delta Y_{t-i} + \sum_{j=1}^{q} d \Delta X_{t-j} + J\,ECT_{t-1} + u_t \qquad (9)$$

$$\Delta X_t = l + \sum_{i=1}^{l} j_i X_{t-i} + \sum_{j=1}^{m} q_i \Delta Y_{t-j} + z\,ECT_{t-1} + v_t \qquad (10)$$

$u_t$ and $v_t$ are not correlated, zero mean random error terms, the Granger causality is present upon significance of the $d's$ and $q's$ from (9) & (10), conditional on the chosen lag lengths, $p, q, l \,\&\, m$ [12], that are usually chosen arbitrarily or based on optimum lag-selection statistics criteria like Akaika's information criterion (AIC). Further on, the ECM model includes short-run dynamics between the variables combined with the long run cointegrating relationship in which speed is given by $J, z < 0$. Consequently, if GDP is above its long run equilibrium in previous period $(GDP_{t-1})$, then we will expect that negative $(J < 0)$ amount will correct such disequilibrium in the next period $GDP_t$.

## 5. Data and Empirical findings

*"It is a capital mistake to theorise before you have all the evidence. It biases the judgement" – Sherlock Holmes, A study in Scarlet*

### 5.1 Data and variable definitions

We have yearly observations (1962-2001) and we utilise two variables GDP and Total Export of goods given in nominal prices expressed in Dkk[13]. We also utilise GDP deflator as kindly provided by the Faroese Governmental Bank, as well as Danish GDP deflator[14] as available at the WDI-2004 CD-ROM published by The World Bank. We define our variables as: lnGDP is the natural logarithm of GDP and lnEXP is natural logarithm of Total Exports. In the next section we will briefly touch upon the methodological procedure followed by the main results and their analysis.

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[12] Oxley Les, "Cointegration, causality and export-led growth in Portugal, 1865 –1985", Economic Letters Elsevier Science Publishers, No. 43, 1993, p.164

[13] We acknowledge that our study needs real values but since no reliable deflators exist we include in our analysis a nominal one, and we do not apologise for that. However, we are aware that our findings might be questionable on such grounds.

[14] Reference to such DK deflator is "justified" on the grounds of the export/import price indexation, however, as with the nominal data, our results might be seriously flawed.

## 5.2 Unit roots test

Table 2 presents the unit roots test. We initially test variables in their levels using DF, ADF and PP tests and depending on outcome we will test further first differences, if required. Based on the test results from the upper part of the table's unit roots are present in all the series in levels. However taking first differences of both variables lead to a stationary – time series, as it is a usual case for the macroeconomic time series. Given our annual data, the number of lags was very small, one or two, however, we have also relied on lag-order selection statistics obtained from STATA in order to check our arbitrary determined numbers of lags. We have found that the optimum lag level as proposed by Akaike's information

Table 2. Unit Root Tests

| **Variable in levels (natural logarithms)** | | | | | | |
|---|---|---|---|---|---|---|
| Data | lnGDP | | | ln EXP | | |
| | DF | ADF | PP | DF | ADF | PP |
| Nominal | -2.459 (0.1259) | -1.851 (0.6797) | -1.516 (0.2752) | -1.659 (0.4526) | -1.796 (0.7061) | -1.304 (0.3922) |
| GB deflator | -1.870 (0.3464) | -1.650 (0.7713) | -4.033 (0.3530) | -1.025 (0.7447) | -1.938 (0.6349) | -2.396 (0.7507 |
| WDI - DK deflator | -0.795 (0.8220) | -1.311 (0.8842) | -2.771 (0.7162) | -1.133 (0.7018) | -2.321 (0.4238) | -2.473 (0.7433) |
| **Variable in first difference (natural logarithms)** | | | | | | |
| Data | lnGDP | | | ln EXP | | |
| | DF | ADF | PP | DF | ADF | PP |
| Nominal | -3.101** (0.0265) | -3.376* (0.0547) | -14.731** (0.0324) | -5.387*** (0.0000) | -5.882** (0.0000) | -31.008*** (0.0000) |
| GB deflator | -5.745*** (0.000) | -5.860*** (0.000) | -33.101*** (0.000) | -5.940*** (0.0000) | -5.842** (0.0000) | -35.114*** (0.0000) |
| WDI - DK deflator | -3.101** (0.0265) | -3.376* (0.0547) | -14.731** (0.0324) | -5.387*** (0.0000) | -5.882** (0.0000) | -31.008*** (0.0000) |

Notes: DF denotes Dickey-Fuller test, ADF denotes Augmented Dickey-Fuller with trend. * , ** , *** indicates 10% , 5% and 1% levels of statistical significance respectively. Values in parantheses are MacKinnon approximate p values as obtained by STATA, PP=Philips Perron method

criterion (AIC) was not greater than two.

## 5.3 Test results for cointegration – EG two step test

Following our discussion from above, OLS methods are valid only if the time-series data is stationary. In our case, stationarity is achieved by first difference, that is to say our data is "homogenous non-stationary"[15] Following Engle and Granger (1987) we estimate a cointegration regression equation of the form:

$$\ln GDP_t = b_0 + b_1 \ln EXP_t + u_t$$

(11)

$$\ln EXP_t = b_0 + b_1 \ln GDP_t + u_t$$

Having saved our residuals $\{u_t\}$ from each equation we proceed with the unit root tests to test for stationarity of these residual series. Conditional on the outcome, we would be able to conclude if our time-series is cointegrated or not, and apply the next step towards causality tests.

Basically our residual test for cointegration relies on previously tested variables used by OLS in (11), and as our Tables 2 showed they were all I *(*1), which ultimately leads to testing of $\{u\} \rightarrow I(1)$ against alternative hypothesis of $\{u\} \rightarrow I(0)$. It has been shown by Granger (1981) that "the two series may be unequal in the short term, they are tied together in the long run."[16] There is a certain implication of such findings for our series as there might be a linear combination of I(1) that is I(0) and if we prove that such a relationship exists, then it is unique. In another words, if our $I(1)$ are cointegrated based on "unit roots" tests on residuals, then even when they move apart over the time (shocks), there still exists a common force that brings them back together. Further on, which is an essence of Granger causality test, we will be able to detect some evidence of causality (in one or both directions) if cointegration between GDP and exports is established. However, a word of caution regarding the finite sample series where such cointegration might not be detected. Looking at our results from Table 3 we can observe that all pairs of variables are not cointegrated. That is to say, all variables are non-stationary in their levels, integrated of order one, but not cointegrated.

Further on, since our variables are I(1), the OLS results from the Table 3 that show relatively high **Rsq** (B. excluded) **, t** and **F** test values, would lead us to accept the spurious

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[15] Giles David E.A., Giles Judith A, McCan Ewen, "Causality, unit roots and export-led growth: the New Zealand experience", The Journal of International Trade & Economic Development, 1993, No 1, p. 199

[16] Grange C.W.J., " Some properties of Time Series Data and their Use in Econometric Model Specification", Journal of Econometrics, Annals of applied Econometrics, 16, 1981

relationship as a valid one, however unit-root tests confirm such results as meaningless. For such a reason we proceed with a standard causality test utilising VARD.

Table 3 Results of Engle-Granger 2 step Cointegration Test

| Cointegration Equation | Slope | Adjusted Rsq | ADF for Residuals | PP |
|---|---|---|---|---|
| A. lnGDP = f (lnEXP) | 0.92 (43.03) | 0.9820 | -1.386 (0.8641) | -1.304 (0.3922) |
| A. lnEXP = f (lnGDP) | 1.06 (43.03) | 0.9825 | -1.172 (0.9155) | -1.516 (0.2752) |
| B. lnGDP = f (lnEXP) | 0.029 (5.86) | 0.4951 | -2.066 (0.5656) | -9.605 (0.1700) |
| B. lnEXP = f (lnGDP) | 17.17 (5.86) | 0.4951 | -2.237 (0.4706) | -8.430 (0.3368) |
| C. lnGDP = f (lnEXP) | 0.92 (13.95) | 0.8550 | -2.566 (0.2963) | -11.552 (0.1007) |
| C. lnEXP = f (lnGDP) | 0.92 (13.95) | 0.8550 | -1.172 (0.9155) | -3.081 (0.1107) |

Notes: We report slope coefficient of regressions & t values in parantheses, ADF as previously. * , ** , *** indicates 10% , 5% and 1% levels of statistical significance respectively. Values in paranheses (ADF clmn.) are MacKinnon approximate p values as obtained by STATA, **A**. Nominal **B**. GB deflator **C**.WDI DK deflator

5.4 Causality test – Standard Granger Causality Test (VARD)

Conditional on such outcome, the Granger Representation theorem explained above suggests how to form the VARD model. Consequently, we utilise the relationship in first-difference and perform Standard Granger Causality test for ELG and GLE hypothesis using next system of regression equations:

$$\Delta GDP_t = l_1 + \sum_{i=1}^{p} a_{i1}\Delta GDP_{t-1} + \sum_{i=1}^{q} b_{i1} a \Delta EXP_{t-1} + m_t$$
$$\Delta EXP_t = l_2 + \sum_{i=1}^{l} a_{i2}\Delta GDP_{t-1} + \sum_{i=1}^{m} b_{i2} a \Delta EXP_{t-1} + v_t \qquad (12)$$

We used the AIC criteria to determine optimal level of lags and we report our findings in Table 4 where the Wald based, small sample test was used to test the above Granger Causality test. Our results confirm ELG strongly at the 1% significance (0.0081), while GLE is similarly strong at 2% significant level (0.0277) in case of nominal data. Our other regressions confirm only GLE hypothesis when we utilised WDI-DK deflator.

Table 4. Causality analysis - Standar Granger Causality test (SGC)

| Data | Hypothesis | p-value | Decision at 5% |
|---|---|---|---|
| Nominal | $H_0$ Export does not Granger causes Growht | 0,0081 | Reject $H_0$ |
| | $H_0$ Growth does not Granger causes Export | 0,0277 | Reject $H_0$ |
| GB deflator | $H_0$ Export does not Granger causes Growht | 0,7228 | Do not reject $H_0$ |
| | $H_0$ Growth does not Granger causes Export | 0,3316 | Do not reject $H_0$ |
| WDI -DK deflator | $H_0$ Export does not Granger causes Growht | 0,4056 | Do not reject $H_0$ |
| | $H_0$ Growth does not Granger causes Export | 0,0513 | Reject $H_0$ |

Notes: Reported p values as obtained by Granger causality Wald test. We interpret p-values as probability of observing a calculated F value , obtaining a small p value leads to a rejection of $H_0$.

Table 4 reports results from equation (12) that specifically analyses the ELG/GLE hypothesis. The later hypothesis' theoretical foundations are found by assuming that economic growth contributes to improvement in labour skills fused with more advanced capital (technology) which leads to a higher efficiency. Such dynamic outcomes have further spillover towards creation of comparative advantages that lead to the export growth. Since we have found the GLE hypothesis to be statistically valid for the Faroe Islands in two cases, we are tempted to accept such findings, as growth processes leading to export growth are long-run phenomena, and for this reason it takes time for such a process to become statistically significant, as our findings have supported. To conclude, following our theoretical discussion from above and presenting empirical findings we are tempted to express our support (ignoring data issue) towards the proposition of GLE.

## 6. Conclusion

Our paper has followed the Granger Representation Theorem in order to avoid spurious regressions, where we have applied the SGC test using VARD. A look at our tables suggests inconclusive results for both hypothesis and very much reflects the state of the literature as mentioned above. It may be very difficult to account accurately for such outcomes but some reasons can be mentioned such as i) different time periods, ii) verification of unit roots, iii) inappropriate data set iv) inappropriate diagnostic tests v) unapropriate deflators and so on. However, our sound theoretical support for the growth-led export may be applied to the Faroe Islands' economy. Indeed, improvements in human capital, labour skills and capital accumulation fused with technological improvements will generally enable every country to achieve a threshold level upon which the comparative advantage argument can kick-in and lead to export expansion. Equally plausible and theoretically conceivable is the proposition of co-movements in export and growth in the long run.

Relying on our findings and having in mind the low power of unit root tests we have expressed the strongest support for GLE hypothesis in the case of Faroese economy. We strongly believe that our findings are very much affected by our small and finite sample as well as data quality, which we cannot improve. On the other hand, we realise the limited power of unit-root tests especially after visual inspections. Mostly, the unit root tests exhibit a problem of "the near equivalence on non-stationary and stationary processes in finite samples which makes it difficult to distinguish between trend-stationary and difference-stationary processes … it is not really possible to make such definitive statements …. (only indicate) whether finite sample exhibits stationary or non-stationary attributes."[17]

We are also aware that adding additional tests perhaps might be the way of expanding our findings. Further on, we agree with Rodney L. Jacobs et al. (1979) where only more complex models can capture exact the relationship between the variables as well as rejection of no-causality null hypothesis in the Granger sense does not necessarily imply the power of causality between the two variables, "test for causality is actually a test of the informativeness hypothesis and is not a test for exogeneity or causality as is generally believed."[18] Finally, we are of the opinion that both ELG & GLE hypothesis can be equally validated only by relying on economic specific context avoiding any generalisations, as well as relying on proper "deflator" that at the present time as far as the Faroese data set is concerned *do not exist*.

[17] Harris Richard, "Using Cointegration Analysis in Econometric Modelling", Prentice Hall Harvester Wheatsheaf, UK, 1995, p.47

[18]Jacobs Rodney L., Leamer Edward E., Ward Michael P. "Difficulties with Testing for Causation", Economic Inquiry – Journal of the Western Economic Association", Vol. XVII, No. 3, p.409

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