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Export-Led Growth or Manufacturing-Led Growth? Evidence from a panel approach

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Abstract

The export-led growth and the manufacturing-led growth hypotheses are examined for 43 countries over the period 1980-2013, using panel data. First and second generation panel unit root and cointegration tests are applied in order to investigate the nature of the relationship between exports and growth. Moreover, a dynamic panel vector error correction model is conducted in order to examine the short-run and long-run dynamics. The present analysis focuses not only on total exports, but also on exports of manufactures. The dependent variable used in analysis consist of GDP net of exports instead of total GDP. The empirical results provide evidence on the long-run relationship between exports and non-export output, however, the long-run effect is negative on average. Finally, there are large differences in the long-run effect of exports on non-export GDP across countries.

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1 Introduction

Over the past few years, the macroeconomic relationship between export growth and economic growth has been a popular subject of debate among economists and analysts. The so-called export-led growth hypothesis (or ELG) postulates that exports are a key factor of promoting growth in developed and developing economies. The argument concerning that exports play a decisive role in economic development has its source in the 17th and 18th centuries, when classical economists support the view that international trade has a major impact on economic growth. Adam Smith (1776) and David Ricardo (1817) were of view that a country can increase exports of products in which they have comparative advantage and, thus, boost their development process.

There are several arguments supporting that exports play a major role in the growth process of an economy. First, export growth may increase the national income of a country and therefore demand for goods will be created, which in turn leads to the increase of the real output. Second, exports have an indirect growth effect through productivity. Exports can increase productivity through specialization, by concentrating investment in the most efficient sectors of an economy, those in which the country has a comparative advantage (Tyler, 1981 ; Kunst and Marin, 1989). Third, export promotion allows countries to receive the benefit of increasing returns to scale due to the fact that international market facilitates larger scale operations than does the domestic market alone (Helpman and Krugman, 1985). Fourth, the expansion of the exporting sector creates positive externalities to the rest of the economy. In particular, it has been argued that the expansion of exports will enhance the access to advanced technologies, it will improve management techniques and skills, it will enlarge entrepreneurial activity, increasing the rate of capital formation.

The causal link between exports and economic growth has long been at the center of development literature. The hypothesis of export promotion should be taken to be not only an assertion of correlation, but also an assertion of causation (Jung and Marshall, 1985). On the theoretical front, the causality relationship between growth and exports can be analyzed in four different ways. The causality could go from exports to growth as it was stated previously. Another view is that there is a possibility to exist causality from economic growth to export; the so-called growth-led export or GLE hypothesis. Lancaster (1980) and Krugman (1984) support the view that economic growth increase efficiency due to the enhancement of skills and technology, which result in a comparative advantage for the country that facilitates exports. Furthermore, another plausible hypothesis is that causality could hold both ways in a feedback relationship, or another hypothesis is that there is no relation and no causal effects among variables.

In this paper, we attempt to empirically investigate the export-led and the manufacturing export-led growth hypotheses for a wide range of developing and industrialized countries for the period 1980-2013. We examine the causal relationship between economic growth and exports both in short-run and in long-run, using panel data analysis. In our analysis, furthermore, we are focusing on whether manufacturing exports have become a new engine of export-led growth hypothesis replacing total exports. In order to analyze the nexus between exports and growth, we are trying to answer the following questions: (i) Does a long-run relationship between non-export GDP, capital, and exports exist? (ii) Is there a long-run relationship between these variables when considering manufacturing exports instead of total exports? (iii) If yes, how do export variable affect non-export GDP in the long-run, and how is non-export GDP affected by export variable in the short-run? (iv) Are there significant differences across countries, according to long-run effects between exports and GDP growth?

This study contributes to the existing literature in several ways. First of all, the present study applies more appropriate econometric techniques, than previous researches in order to improve the quality of the results, into a panel data framework for 43 countries. Our analysis is based on panel data approach because of its advantages over cross-section and time series in using all the information available, which are not detectable in pure cross-sections or in pure time series. Moreover, panel data estimation provides improved coefficient estimates by increasing the power of the tests if the data span is short, given the fact that here there are only in average 22 observations for each country. [1] In contrast to earlier studies, the present analysis focuses not only on total exports, but also on exports of manufactures. The dependent variable used in this analysis consist of gross domestic product net of exports instead of export-inclusive GDP in order to separate the influence of exports on output from that incorporated in the 'growth-accounting' relationship. (Sharma and Panagiotidis, 2005 ; Parida and Sahoo, 2007 ; Dreger and Herzer, 2013). [2] Since economic growth is an extremely complex process (Medina-Smith, 2001) which faces differences across countries, the present analysis takes into account the cross-sectional dependence using both first and second generation panel unit root and cointegration techniques. Country specific differences may have some important policy

[1] For more details regarding the data and the methodology that have been used, see Chapter 4 and 5, respectively.

[2] For more details regarding the econometric model that have been used, see Chapter 3.

implications. If the results for an economy indicate that exports are an engine of growth under specific assumptions and measures, then policy-makers would therefore need to pursue policies that promote export expansion.

The remainder of the paper is organized as follows: In section 2, we present a brief literature review of studies concerning export-led growth hypothesis and a more comprehensive literature review of studies focusing on manufacturing-led growth hypothesis. The economic model and the data are presented in Section 3 and 4, respectively. Section 5 includes econometric techniques and methodology. Empirical results are stated in section 6 and concluding remarks are discussed in final section.

2 Literature Review

2.1 Export-led growth hypothesis

The empirical literature, which tests the ELG hypothesis, has its source in the late 1970s and it has produced ambiguous and mixed results. The numerous studies that examine the applicability and the validity of the ELG hypothesis diverge regarding the methodology and the outcomes. [3]

Cross-country studies, such as Balassa (1978), Tyler (1981), Kavoussi (1984), Kohli and Singh (1989), Moschos (1989), Sheehey (1990), Dodaro (1991), Esfahani (1991) and Fosu (1996), investigated the relation between exports and economic growth, revealing strong and clear results. Although the results reveal a statistically significant positive ELG relationship, studies are subject to criticism based on methodological issues. These studies assume that export growth has a positive causal effect on GDP, ignoring that causality may run in both directions, increasing the fear of biased results.

In response to these criticisms, another group of studies investigate the causal relationship between export growth and output growth for individual countries using time series data analysis and Granger's (1969) or Sims' (1972) causality tests. Jung and Marshall (1985), Chow (1987), Ahmad and Kwan (1991), Bohmani-Oskooee et al. (1991), Sharma and Panagiotidis (2005), Kubo (2011) provided weak support of ELG hypothesis, while Serletis (1992), Henriques and Sadorsky (1996), Bahmani-Oskooee and Alse (1993), Ghatak et al (1995), Ramos (2001), Awokuse (2005) and Tsen (2007) confirm the strong association between exports and economic growth.

[3] For an extensive survey of this literature, see Giles and Williamson (2000).

However, an alternative approach is used by researchers in recent studies in order to investigate the ELG hypothesis by using panel cointegration methods which have more power due to the exploitation of both time-series and cross-sectional dimensions of the data. Bohmani-Oskoooe (2005), Reppas and Christopoulos (2005), Parida and Sahoo (2007), Jun (2007), Dreger and Herzer (2013) found mixed results in support of the export-led growth hypothesis, concluding that a consensus on export-led growth was difficult to find.

2.2 From export-led growth to manufacturing-led growth hypothesis

Are manufacturing exports a new engine of growth? A plethora of studies, in order to analyze the ELG hypothesis, focus on aggregate exports (e.g. Balassa, 1978, among others) while other concentrate on exports of manufactures (e.g. Marin, 1992, among others). Manufacturing-led growth (or MLG) hypothesis stimulates the determinant role of manufacturing exports, rather than total exports, on economic growth. The argument concerning the role of manufacturing exports as one of the key factors of economic growth is not new. Studies, such as Crespo-Cuaresma and Worz (2005), Berg et al. (2005), Hausman et al. (2007), Jarreau and Poncet (2012), support that countries that emphasize manufacturing exports will grow faster than those that focus on exports of primary products. As it was stated before, the ELG hypothesis has been examined extensively in the theoretical and empirical literature. In this section, a brief literature review of empirical studies concerning the validity of the manufacturing-led growth hypothesis is presented.

Fosu (1990) used African pooled cross-sectional two period data covering the period 1960-1970 and 1970-1980 and he found evidence to support both of export–led growth and manufacturing-led growth hypothesis, emphasizing that manufacturing export sector have stronger impact on growth than primary export sector. Ahmad and Kwan (1991) analyze the causality between exports and economic growth for 47 African developing countries over the period 1981-1987, concluding in the rejection of the ELG and MLG hypothesis. However, when countries were grouped by income, support of GLE and growth-led manufacturing (or GLM) hypothesis was found. Dodaro (1991) employs cross-section analysis for a wide range of developing countries, supporting that the level of development is an important determinant of the degree of manufacturing and processing in a country's export basket and suggesting that the composition of exports affects economic growth. Marin (1992) further investigates the validity of the export-led growth hypothesis for industrialized countries, finding that the disaggregated exports of manufacturing goods had significant causal effects on productivity growth. Khan and Saqib (1993) study the case of Pakistan over the period 1972-1988 in a simultaneous equation framework using 3SLS technique. Although they found evidence of ELG and MLG hypotheses, exports of primary materials was found to be more effective on growth than exports of manufactures. Hansen (1994) uses annual data covering the period 1968-1991 for New Zealand, he rejects the ELG and MLG hypotheses. Nonetheless, exports of manufactures and services appear to have had a greater effect on economic growth than exports of primary produce and raw materials. Ukpolo (1994) investigates the case of 8 low-income African countries over the period 1968-1989 using Feasible Generalized Least Squares technique. His findings support the hypothesis of a positive linkage between the growth of non-fuel primary exports and growth, but the results cast some doubt on the positive contribution of the manufactured exports sector to growth. Bodman (1996) uses cointegration and vector-error correction modeling to investigate whether the export-led growth hypothesis applies to Australian and Canadian exports. The results indicated the confirmation of ELG and MLG hypotheses for the period 1960-1995. Ghatak et al. (1997) test the ELG hypothesis for Malaysia for the period 1955-1990 using Granger causality and cointegration technique. The relationship between exports and growth is found to be driven by manufacturing exports rather than by traditional exports. Dhananjayan and Devi (1997) found statistically significant positive ELG and MLG relationship for 12 Asian and European countries over the period 1991-1994. Shan and Sun (1998) investigate the case of Australia for the period 1978-1996 using quarterly data and evidence of one way causality running from manufacturing growth to export growth was found. Greenaway et al. (1999) disaggregated exports into fuel, food, metals, other primary, machinery, textiles, and other manufactures. Their results asserted that the export variable still has a positive and statistically significant effect on economic growth. Calderon, Chong, and Zanforlin (2001) use a system GMM model to investigate the ELG hypothesis by considering high technology exports of manufactures. Using a panel of 62 countries during the period of 1960-1995, they find evidence of MLG hypothesis. Söderbom and Teal (2003) use both macro and micro evidence from nine African countries to investigate whether manufacturing exports are the key to success in Africa. The results indicate that only Botswana and Mauritius confirm the ELG and MLG hypotheses. Alam (2003) tests the relationship between the manufacturing exports and growth, using annual data from two Latin American countries, Mexico and Brazil, in a production function framework and the results indicate that the MLG hypothesis does not exist. Abu-Qarn and Abu-Bader (2004) examine the export-led growth hypothesis for nine Middle East and North Africa (MENA) countries in three-variable vector autoregressive and error correction models and they found mixed results depending on the measurement of exports. Herzer et al. (2006) applying panel cointegration techniques, find for Chilean economy that exports of manufactured products have been especially important for productivity and thus for long-run economic growth. Parida and Sahoo (2007) examine the export-led and manufacturing export-led growth hypotheses for four South Asian countries, using Pedroni's panel cointegration technique for the period 1980-2002. The study finds long-run equilibrium relationship between GDP and exports along with other variables supporting both ELG and MLG hypotheses. Sheridan (2014) uses a wide cross-section of countries over the period 1970–2009 and finds that although increasing manufacturing exports is important for sustained economic growth, this relationship only holds once a threshold level of development is reached.

2.3 Studies testing manufacturing-led growth hypothesis

The main features of studies reviewed above and other related work are provided in tables below and they are sorted by date of publishing. For every single article, we display the methodology that has been adopted, the variables and the data that have been used as well as the main conclusions and results that were drawn.

Table 1: Literature review of studies testing MLG hypothesis.

Authors	**Countries**	**Period**	**Method**	**Variables**	**Empirical Results**
Fosu (1990)	64 developing countries.	1960-1980 (annual data)	OLS (mean annual GDP growth on merchandise exports growth rate and on percent share of manufactured exports).	Growth of capital, growth of labor force, gross domestic investment.	Confirmation of ELG and MLG hypotheses. (manufacturing export sector has stronger impact in growth than primary export sector)
Ahmad and Kwan (1991)	47 African developing countries. (30 low-income and 17 middle/high -income countries).	1981-1987 (annual data)	Bivariate Granger, VAR with constant.	GDP per capita, annual growth of GDP, total exports, total manufactured exports, share of manufactured exports to total exports.	Rejection of ELG and MLG hypothesis. (Full sample) Support of GLE and GLM hypotheses when grouping countries by income.
Dodaro (1991)	41 developing countries.	1965-1970 and 1970-1981 (annual data)	OLS (averaged GDP growth on averaged manufacturing export as % of total merchandise exports or on export share defined by stage of processing).	GDP growth, manufacturing exports, export share define by stage processing.	Confirmation of ELG and MLG hypotheses. (The level of development and the composition of exports are important determinants)

Table 2: Literature review of studies testing MLG hypothesis.

Authors	Countries	Period	Method	Variables	Empirical Results
Khan and Saqib (1993)	Pakistan	1972-1988 (annual data)	OLS, 3SLS (GDP growth onexports, manufactured exports, primary exports).	World GDP index, capital stock series, employed labor force, ratio of domestic export prices to World export prices.	Confirmation of ELG and MLG hypotheses. (exports of primary materials are more effective on growth than exports of manufactures)
Hansen (1994)	New Zealand	1968-1991 (annual data)	OLS (multi-sector production model) Engle-Granger Cointegration technique. (between the share of exports in GDP and the share of government expenditure in GDP)	GDP, exports of manufactures and services, share of exports in GDP.	Rejection of ELG and MLG hypotheses. (exports of manufactures are more effective on growth than exports of primary materials)
Ukpolo (1994)	8 low-income African countries.	1968-1989 (annual data)	Feasible generalized least squares. (between set of variables)	Growth of GDP on fuel exports growth, non fuel primary exports growth, manufactured exports growth, private and government consumption, population growth, ratio of investment to GDP growth.	Confirmation of ELG hypotheses for non-fuel exports. Not significant for manufactured exports and for fuel exports.

Table 3: Literature review of studies testing MLG hypothesis.

Authors	Countries	Period	Method	Variables	Empirical Results
Bodman (1996)	Canada and Australia.	1960-1995 (quarterly data)	Bivariate Granger, VECM, Johansen's Cointegration technique. (between exports and labor productivity in manufacturing sector, total exports and total labor productivity, manufactured exports and total labor productivity).	Exports of manufactured goods, total exports, manufacturing output per employee, total output per employee.	Confirmation of ELG and MLG hypothesis for both countries. (except Canada - no bidirectional causality between manufacturing exports and manufacturing labor productivity).
Ghatak et al. (1997)	Malaysia	1955-1990 (annual data)	Bivariate Granger, VECM, Johansen's Cointegration technique. (between exports and GDP, exports and non-export GDP).	Exports of manufactured products, fuel and non-fuel primary products, gross domestic investment as % of GDP, enrollment ratio in primary and secondary schools.	Support of ELG hypothesis. Support of MLG hypothesis in disaggregated case (1966-1990).
Dhananjayan and Devi (1997)	12 Asian and European countries. (China, India, Indonesia, South Korea, Malaysia, Pakistan, Sweden, Spain, France, Germany, Italy, UK).	1981-1994 (annual data)	OLS (between sets of variables).	GNP growth, total exports manufactured commodity exports, manufactured commodity exports as % of total exports, Gross domestic investment.	Confirmation of ELG and MLG hypotheses.

Table 4: Literature review of studies testing MLG hypothesis.

Authors	Countries	Period	Method	Variables	Empirical Results
Shan and Sun (1998a)	Australia	1978(3)-1996(3) (quarterly data)	5-variable Granger, VAR with constant.	Manufacturing output, total exports, total employed persons, imports, gross fixed capital expenditure.	Evidence for one-way causality running from manufacturing growth to export growth.
Greenaway, Morgan and Wright (1999)	A panel of 69 countries.	1975-1993 (annual data)	GMM model estimation.	GDP per capita, school enrolment, trade index, population, domestic investment, total exports and manufacturing exports.	Support of ELG and MLG hypotheses.
Calderon, Chong, and Zanforlin (2001)	A panel of 96 countries	1960-1995 (annual data)	GMM model estimation.	GDP per capita rate, growth rate of labor, school enrollment. high technology manufacturing exports.	Support of MLG hypothesis.
Söderbom and Teal (2003)	9 African countries. (Mauritius, South Africa, Zimbabwe, Ghana, Kenya, Cameroon, Zambia, Tanzania, Nigeria)	1970-2000 (annual data)	Panel regression estimations with fixed effects and time trend.	Income per capita, total exports and manufacturing exports.	Support of ELG and MLG hypotheses in Mauritius and Botswana.

Table 5: Literature review of studies testing MLG hypothesis.

Authors	**Countries**	**Period**	**Method**	**Variables**	**Empirical Results**
Alam (2003)	Mexico and Brazil.	Mexico - (1959-1990) Brazil - (1955-1990). (annual data)	Fully Modified OLS.	GDP, capital stock, employed labor, manufacturing exports, capital goods imports.	Rejection of MLG hypothesis.
Abu-Qarn and Abu-Bader (2004)	9 MENA countries (Algeria, Egypt, Israel, Morocco, Iran, Jordan, Sudan, Tunisia, Turkey).	Algeria, Egypt, Israel, Morocco - (1963-1999), Iran - (1976-1999), Jordan - (1976-1998), Sudan - (1960-1991), Tunisia - (1963-1998), Turkey - (1966 - 1996). (annual data)	Trivariate Granger, ECM for cointegrated countries, 1st differenced VAR for non-cointegrated.	GDP, total exports, manufactured exports, imports.	Confirmation of ELG hypothesis in Iran. Support of GLE hypothesis for Israel, Sudan, Tunisia. (when considering total exports) Support of MLG in Israel, Tunisia, Morocco and Turkey. Support of GLM in Egypt.
Cuaresma and Wörz (2005)	45 developed and developing countries.	1981-1997 (annual data)	Generalized Least Squares estimation.	GDP growth rate, share of investment in GDP, growth rate of population, share of high-tech and low-tech manufacturing industry export in GDP, share of non-manufacturing industry export in GDP.	Confirmation of MLG hypothesis. (especcially for high-tech manufacturing)

Table 6: Literature review of studies testing MLG hypothesis.

Author	Countries	Period	Method	Variables	Empirical Results
Herzer, Lehmann and Siliverstovs (2006)	Chile	1960-2001 (annual data)	Engle-Granger cointegration test, Johansen's cointegration test and Dynamic OLS.	GDP, imports, exports of primary goods, exports of manufactured goods, non-export GDP, capital stock and labor force.	Confirmation of ELG and MLG hypotheses. (exports of manufactured products have been especially important for productivity and thus for long-run economic growth.)
Parida and Sahoo (2007)	4 South Asian countries (India, Pakistan, Bangladesh and Sri Lanka).	1980-2002 (annual data)	Panel Cointegration tests and Fully Modified OLS.	GDP, non-export GDP, total exports, total manufacturing exports, gross fixed capital formation, manufacturing imports, public expenditure on health and education.	Confirmation of ELG and MLG hypotheses.
Sheridan (2014)	A panel of 92 countries.	1970-2009 (annual data)	Regression tree analysis.	GDP per capita growth, total exports, manufacturing exports, primary exports, population growth school enrollment and investment to GDP ratio.	Confirmation of MLG hypotheses when a minimum level of human capital is reached.

3 The economic model

Before introducing the economic model which is used in our empirical analysis to investigate the ELG and MLG hypotheses, we focus on the relationship between gross domestic product and export variable. A major problem arises from the fact that exports are themselves a part of output, through the national income accounting identity. There has been criticism that some of the results may be spurious and suffer from a simultaneity bias since exports are a component of GDP. In order to handle this issue, some researchers use GDP net of exports as a measure of the growth variable. As it was stated by Gershon Feder (1982), the economy can be divided into two sectors, export and non-export. Following Feder, the model employed in this study has been derived within the neoclassical framework of an aggregate production function, so as to capture the impact of exports on output via the productivity channel.

More formally, consider the following AK-type production function:

$$Y_{it} = A_{it} K_{it}^{b_{1i}} \tag{1}$$

where:
Y_{it} is the output of country i at time t,
K_{it} is the capital of country i at time t, and
A_{it} is a productivity parameter.
Let exports denoted as X_{it} and assume that the productivity parameter A_{it} can be expressed as a function of exports.

$$A_{it} = f(X_{it}) = X_{it}^{b_{2i}} \tag{2}$$

Combining equation (1) and equation (2) and taking natural logarithms yields:

$$lnY_{it} = b_{1i} lnK_{it} + b_{2i} lnX_{it} \tag{3}$$

where:
b_{1i} coefficient is the cross-country average of the elasticity of output with respect to capital, and
b_{2i} coefficient is the cross-country average of the elasticity of output with respect to exports.

As already has been stated, exports are themselves a component of GDP, so a positive and significant relationship between exports and output is almost unavoidable, even if there are no productivity effects. Therefore, the coefficient b_{2i} can not be used, as it is a biased measure of average productivity effect of exports on output. To overcome this problem, we consider output net of exports as a proxy for growth. (eg. Greenaway and Sapsford, 1994 ; Sharma and Panagiotidis, 2005 ; Siliverstovs and Herzer, 2007) By replacing the logarithm of total output with the logarithm of output without exports, we obtain:

$$lnN_{it} = c_{1i}lnK_{it} + c_{2i}lnX_{it} \tag{4}$$

where:
N_{it} is the output without exports ($N = Y - X$) of country i at time t,
c_{1i} coefficient is the cross-country average of the elasticity of non-export output with respect to capital, and
c_{2i} coefficient is the cross-country average of the elasticity of non-export output with respect to exports.

Following Siliverstovs and Herzer (2007), we distinguish three cases depending on coefficient c_{2i}:

- $c_{2i} = 0$, meaning that the coefficient b_{1i} reflects the share of exports in total output, as it was indicated in equation (3).
- $c_{2i} < 0$, meaning that the exports contribute less to output growth than the increase in export volume, which suggests that exports are productivity-reducing.
- $c_{2i} > 0$, meaning that the exports contribute more to output growth than the increase in export volume, which suggests that exports are productivity-inducing.

To control for unobserved heterogeneity which is time-invariant across countries, we include country-specific fixed effects. Furthermore, to capture any unobserved factors that vary over time, we include country-specific time trends. The empirical model used in our study is based on the following equation:

$$lnN_{it} = c_{1i}lnK_{it} + c_{2i}lnX_{it} + c_{3i} + c_{4i}t + \epsilon_{it} \tag{5}$$

where:

c_{3i} is the fixed effect for country i,

$c_{4i}t$ is the deterministic time trend for country i, and

ϵ_{it} is the error term.

In our model, not only is the labor input omitted, but also the variable of imports. Due to the fact that the employment variable seems to be a stationary process for the countries that are included in our sample, labor input is omitted from the model. We suppose that country-specific time trend is acting as a proxy for labor input. Finally, we suppose that imports affect output through productivity channel. So, we do not incorporate imports in our analysis because we can not measure the productivity effect of exports that operates through import channel.

4 Data

The validity of the ELG and MLG hypotheses is tested using data from 43 developing and developed countries and cover the annual time frame from 1980-2013. Due to the non-availability of data for all countries for the period 1980-2013, the analysis that follows is based on the annual data on each country for the periods specified in Table (7):

Of these countries, two are in Australia (Australia and New Zealand), six are in Central America and the Caribbean (Canada, Dominican Republic, El Savador, Honduras, Mexico and United states), six are in South America(Argentina, Bolivia, Chile, Colombia, Paraguay and Venezuela), three are in East Asia (Japan, Korea and Kyrgyz Republic), six are in South Asia (Bangladesh, Cambodia, India, Iran, Pakistan and Philippines), five are in West Asia (Armenia, Israel, Jordan, Oman and Turkey), three are in North Africa (Egypt, Morocco and Tunisia) and twelve are in Sub-Saharan Africa (Botswana, Burkina Faso, Cameroon, Central African Republic, Gabon, Gambia, Mozambique, Senegal, South Africa, Sudan and Togo).

The growth variable we consider in this study is real gross domestic product without exports and is denoted as GDPNET. The export variables are real total exports and real manufacturing exports, which are denoted as REX and RMEX, respectively. Real total exports include both goods and services, while manufacturing exports consist chemicals and related products, manufactured goods classified chiefly by material, machinery and transport equipments and miscellaneous manufactured goods (excluding miscellaneous non-ferrous base metals). As a proxy for capital, the present study uses real gross fixed capital formation, which is denoted as CAPITAL. GDP net of exports is deflated using GDP deflator while exports variables are deflated using export unit value indexes. All variables are expressed in American dollars (base year=2005) and they are transformed in natural logarithms.

Accordingly, all the data used in this study have been obtained from the *World bank: World Development Indicators - 2015*, except for export unit values, which have been obtained from *United Nations Conference on Trade and Development.*

Table 7: List of countries and time period

Country	Time Period
Argentina	1980-2013
Armenia	2000-2013
Australia	2000-2013
Bangladesh	1980-2013
Bolivia	1980-2013
Botswana	1980-2013
Burkina Faso	1980-2013
Cambodia	2000-2013
Cameroon	1980-2013
Canada	2000-2013
Central African Republic	1980-2013
Chile	1980-2013
Colombia	1980-2013
Dominican Republic	1980-2013
Egypt	1980-2013
El Salvador	1980-2013
Gabon	1980-2013
Gambia	1980-2013
Honduras	1980-2013
India	1980-2013
Iran	1980-2013
Israel	2000-2013
Japan	2000-2013
Jordan	1980-2013
Korea	1980-2013
Kyrgyz Republic	2000-2013
Mali	1980-2013
Mexico	1980-2013
Morocco	1980-2013
Mozambique	1980-2013
New Zealand	2000-2013
Oman	1980-2013
Pakistan	1980-2013
Paraguay	1991-2013
Philippines	1980-2013
Senegal	1980-2013
South Africa	1980-2013
Sudan	1980-2013
Togo	1980-2013
Tunisia	1980-2013
Turkey	1980-2013
United States	1980-2013
Venezuela	1980-2013

5 Econometric methodology

In this section the econometric methodology used in this study is presented. The econometric approach to investigate the nature of the relationship between export expansion and growth consists of the following four steps. First, we investigate the stationarity properties of the series in the model. Second, if the series are found to be integrated of order one, in other words $I(1)$, we proceed by testing for the long-run relationships among the set of the integrated series. Next, we estimate the long-run relationship across countries. Finally, once the long-run equilibrium relationship is established, we construct a dynamic vector error correction model to investigate the short-run and log-run causalities and dynamics.

5.1 Panel unit root tests

5.1.1 Im–Pesaran–Shin test

Lm, Pesaran and Shin (2003) propose a unit root test for dynamic heterogeneous panels based on the mean of individual unit root statistics. In particular it proposes a standardized t-bar test statistic based on the augmented Dickey–Fuller statistics averaged across the groups (equation 6).

$$\Delta y_t = \alpha_i + \beta_i y_{i,t-1} + \sum_{j=1}^{k} \psi_{i,j} \Delta y_{i,t-j} + \mu_{i,t} \tag{6}$$

The test allow β to vary across all sectional units i. The null hypothesis indicates that each series in the panel framework contains a unit root for all units i, while the alternative hypothesis indicates that at least one of the individual series in the panel is stationary. In other words:
$H_0 : \beta_i = 0$ for all i
$H_1 : \beta_i < 0$ for $i = 1, 2, ..., N$ or $\beta_i = 0$ for $i = N_1 + 1, N_1 + 2, ..., N$

To test the hypothesis, Im et al. (2003) propose a standardized t-bar statistic given by:

$$W_{tbar} = \frac{\sqrt{N}\left\{ tbar_{NT} - \frac{1}{N} \sum_{j=1}^{N} E\left[t_{iT}(\rho_i, 0) \| \beta_i = 0 \right] \right\}}{\sqrt{\frac{1}{N} \sum_{i=1}^{N} Var\left[t_{iT}(\rho_i, 0) \| \beta_i = 0 \right]}} \xrightarrow{\text{N,T}} N(0,1), \tag{7}$$

where, t_{iT} is the individual t-statistic for testing $\beta_i = 0$ for all i, $tbar_{iT}$ is the mean of the computed augmented Dickey-Fuller statistics for individual countries included in the panel. $E\Big[t_{iT}(\rho_i, 0)\Big]$ and $Var\Big[t_{iT}(\rho_i, 0)\Big]$ are the moments of mean and variance, respectively, obtained from Monte Carlo simulation and tabulated by Im, Pesaran and Shin (1997, 2003). The statistic Z_{tbar} approaches in probability a standard normal distribution as N and T tends to infinity.

5.1.2 Pesaran CIPS test

Pesaran (2007) proposed a version of the IPS-unit root test called cross-sectionally augmented IPS test, which can be executed using the command called "pescadf" in Stata software. This command runs the t-test for unit roots in heterogeneous panels with cross-section dependence, proposed by Pesaran (2003). Parallel to Im, Pesaran and Shin (IPS, 2003) test, it is based on the mean of individual DF (or ADF) t-statistics of each unit in the panel. Null hypothesis assumes that all series are non-stationary. To eliminate the cross dependence, the standard ADF regressions are augmented with the cross-section averages of lagged levels and first-differences of the individual series. The exact critical values of the t-bar statistic are given by Pesaran (2003). The Z_{tbar} statistic is similar to IPS (2003) and is distributed standard normal under the null hypothesis of non-stationarity.

5.1.3 The Fisher-ADF test

An alternative approach to panel unit root tests is Fisher-ADF test. This test combine the p-values from individual ADF unit root tests with different lag lengths. The Fisher-ADF test statistic λ, which has a chi-square distribution with $2N$ degrees of freedom under the null hypothesis, is expressed as:

$$\lambda = -2\sum_{i=1}^{N} log\pi_i \tag{8}$$

where π_i refers to the probability values from individual ADF unit root tests for each country in the panel.

5.2 Cross-sectional dependence test

5.2.1 Pesaran's CD test

A usual assumption in panel data models is that the error terms are independent across cross-sections. However, this assumption is not valid in the empirical investigation. Panel-data models are likely to exhibit substantial cross-sectional dependence in the errors, which may arise because of the presence of common shocks and unobserved components that ultimately become part of the error term, spatial dependence, and idiosyncratic pairwise dependence in the disturbances with no particular pattern of common components or spatial dependence (Hoyos and Sarafidis, 2006).

Pesaran (2004) relying on the LM statistic proposed by Breusch and Pagan, proposed a test for cross-sectional dependence in panel data with many cross-sectional units and few time series observations. [4] For balanced panels, Pesaran (2004) has proposed the following alternative to Breusch and Pagan (1980) LM test:

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left[\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}\right] \tag{9}$$

For unbalanced panels, Pesaran (2004) proposes a slightly modified version of equation (9), which is given by:

$$CD = \sqrt{\frac{2}{N(N-1)}}\left[\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\sqrt{T_{ij}}\hat{\rho}_{ij}\right] \tag{10}$$

where, T_{ij} is the number of common time-series observations between units i and j and $\hat{\rho}_{ij}$ is the sample estimate of the pairwise correlation of the residuals.

5.3 Panel cointegration tests

5.3.1 Pedroni's test

To determine whether a cointegrating relationship exits, the developed methodology proposed by Pedroni is presented. Pedroni (1999) has extended the framework of Engle-Granger (1987) to test involving cointegration in panel data framework in two steps. Consider the following time series panel regression:

$$y_{it} = \alpha_i + \beta it + \beta_{1i}X_{1it} + \beta_{2i}X_{2it}..... + \beta_{mi}X_{mit} + \epsilon_{it} \tag{11}$$

where, $t = 1, 2, ..., N$ shows the time period, $i = 1, 2, ..., N$ shows the number of sectional units and m is the number of regressors. α_i and $\delta_i t$ are the effects of country and

[4] For more details, see Pesaran, M. H., (2004), "General Diagnostic Tests for Cross-Section Dependence in Panels", Cambridge Working Papers in Economics no. 435. University of Cambridge.

time fixed effects, respectively. y_{it} and X_{it} are the observable variables with dimension of $(N \times T) \times 1$ and $(N \times T) \times m$, respectively. Similarly, ϵ_{it} is the autoregressive term of the form $\epsilon_{it} = \rho_i \epsilon_{i,t-1} + u_{it}$.

Pedroni proposes several test for cointegration that allow for heterogeneous intercepts and trend coefficients across cross-sections. The above test consists of four panel statistics and three group panel statistics to test the null hypothesis of no cointegration against the alternative of cointegration. The first type of the test is based on the within-dimension approach and includes the panel v-statistic, the panel ρ-statistic, the panel PP-statistic, and the panel ADF-statistic. The second type of the test is based on the between-dimension approach and includes group ρ-statistic, group PP-statistic, and group ADF-statistic. In the case of panel statistics, the first-order autoregressive term is assumed to be the same across all the cross-sections, while in the case of group panel statistics the parameter is allowed to vary over the cross-sections.

Following Pedroni (1999), the heterogeneous panel and heterogeneous group mean panel cointegration statistics are calculated as follows:

Panel v-statistic: $Z_v = \Big[\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\epsilon}_{it-1}^2 \Big]^{-1}$

Panel ρ-statistic: $Z_\rho = \Big[\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\epsilon}_{it-1}^2 \Big]^{-1} \Big[\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} (\hat{\epsilon}_{it-1} \Delta \hat{\epsilon}_{it} - \hat{\lambda}_i) \Big]$

Panel PP-statistic: $Z_t = \hat{\sigma}^2 \Big[\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\epsilon}_{it-1}^2 \Big]^{-1/2} \Big[\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} (\hat{\epsilon}_{it-1} \Delta \hat{\epsilon}_{it} - \hat{\lambda}_i) \Big]$

Panel ADF-statistic: $Z_t^* = \hat{S}^{*2} \Big[\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\epsilon}_{it-1}^{*2} \Big]^{-1/2} \Big[\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} (\hat{\epsilon^*}_{it-1} \Delta \hat{\epsilon^*}_{it}) \Big]$

Group ρ-statistic: $\tilde{Z}_\rho = \sum_{i=1}^{N} \Big[\sum_{t=1}^{T} \hat{\epsilon}_{it-1}^2 \Big]^{-1} \sum_{t=1}^{T} (\hat{\epsilon}_{it-1} \Delta \hat{\epsilon}_{it} - \hat{\lambda}_i)$

Group PP-statistic: $\tilde{Z}_t = \sum_{i=1}^{N} \Big[\hat{\sigma}^2 \sum_{t=1}^{T} \hat{\epsilon}_{it-1}^2 \Big]^{-1/2} \sum_{t=1}^{T} (\hat{\epsilon}_{it-1} \Delta \hat{\epsilon}_{it} - \hat{\lambda}_i)$

Group ADF-statistic: $\tilde{Z}_t^* = \sum_{i=1}^{N} \Big[\sum_{t=1}^{T} \hat{s}_i^2 \hat{\epsilon}_{it-1}^{*2} \Big]^{-1} \sum_{t=1}^{T} (\hat{\epsilon}_{it-1}^* \Delta \hat{\epsilon}_{it}^*)$

Here, $\hat{\epsilon}_{it}$ is the estimated residual and $\hat{L}_{11i}^2$ is the estimated long-run covariance matrix for $\Delta \hat{\epsilon}_{it}$. Similarly, $\hat{\sigma}_i^2$ and $\hat{s}_i^2$ are, respectively, the long-run and the contemporaneous variances for every single cross-sectional unit. Pedroni (1999) discusses these issues in detail with the appropriate lag length determined by the Newey-West method.

All seven test are asymptotic standard normal distributed. The panel v-statistic is a one-sided test where large positive values reject the null hypothesis of no cointegration. The remaining statistics diverge to negative infinitely, which means that large negative values reject the null. The critical values are also tabulated by Pedroni (1999). Small sample size and strength powerful of all of these seven tests are discussed in Pedroni (1999). In samplings in which cross-section unit number is above 100, all statistics produce sufficiently persuasive results. In smaller panels, on the other hand, proofs are variable. However, as the time dimension of the panel is small ($T \approx 20$), Pedroni (1999) states that group ADF-statistics and panel-ADF statistics are generally the best indicators. [5]

5.3.2 Kao's test

The Kao's test follows the same basic approach as the Pedroni tests, but specifies cross-section specific intercepts and homogeneous coefficients on the first-stage regressors. [6] In the bivariate case described in Kao (1999), we have:

$$y_{it} = \alpha_i + \beta X_{it} + \epsilon_{it} \tag{12}$$

where,

$$y_{it} = y_{it-1} + u_{it} \tag{13}$$

$$X_{it} = X_{it-1} + e_{it} \tag{14}$$

Here, $t = 1, 2, ..., T$ shows the time period and $i = 1, 2, ..., N$ shows the number of sectional units. α_i are the fixed effects varying across the cross-section observations, β is the slope parameter, y_{it} and X_it are independent random walks for all i. The residual series ϵ_{it} should be I(1) series. Kao, then, runs either the pooled auxiliary regression:

$$\epsilon_{it} = \rho\epsilon_{it-1} + u_{it} \tag{15}$$

[5] For more details, see Pedroni, P., (1999), "Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors", Oxford Bulletin of Economics and Statistics, 61: 653-70.

[6] For more details, see Kao, C. (1999) "Spurious regression and residual-based tests for cointegration in panel data", Journal of econometrics 90(1): 1-44.

or the augmented version of the pooled specification:

$$\epsilon_{it} = \tilde{\rho}\epsilon_{et-1} + \sum_{j=1}^{\rho} \psi_j \Delta\epsilon_{it-j} + u_{it} \tag{16}$$

Under the null of no cointegration, Kao employs the following statistics:

$$DF_\rho = \frac{\sqrt{N}T(\hat{\rho}-1) + 3\sqrt{N}}{\sqrt{10.2}}$$

$$DF_t = \sqrt{1.25t_\rho} + \sqrt{1.875N}$$

$$DF_\rho^* = \frac{\sqrt{N}T(\hat{\rho}-1) + 3\sqrt{N}\hat{\sigma}_u^2\hat{\sigma}_{0u}^2}{\sqrt{3 + 36\hat{\sigma}_u^4/(5\hat{\sigma}_{0u}^4)}}$$

$$DF_t^* = \frac{t_\rho + \sqrt{6N}\hat{\sigma}_{0u}/(2\hat{\sigma}_{0u})}{\sqrt{\hat{\sigma}_{0u}^2/(2\hat{\sigma}_{0u}^2) + 3\hat{\sigma}_{0u}^2/(10(\hat{\sigma}_{0u}^2)}}$$

and for p>0 (i.e. the augmented version),

$$ADF = \frac{t_{ADF} + \sqrt{6N}\hat{\sigma}_{0u}/(2\hat{\sigma}_{0u})}{\sqrt{\hat{\sigma}_{0u}^2/(2\hat{\sigma}_{0u}^2) + 3\hat{\sigma}_{0u}^2/(10(\hat{\sigma}_{0u}^2)}}$$

converge to N(0,1) asymptotically, where the estimated variance is $\hat{\sigma}^2 = \hat{\sigma}_u^2 - \hat{\sigma}_{ue}^2\hat{\sigma}_e^{-2}$ with estimated long variance $\hat{\sigma}_0^2 = \hat{\sigma}_{0u}^2 - \hat{\sigma}_{0ue}^2\hat{\sigma}_{0e}^{-2}$.

5.3.3 Westerlund's test

Westerlund (2007) implements the four error-correction–based panel cointegration tests which are general enough to allow for a large degree of heterogeneity, both in the long-run cointegrating relationship and in the short-run dynamics, and dependence within as well as across the cross-sectional units. [7] The underlying idea is to test for the absence of cointegration by determining whether the individual panel members are error-correcting or not. In order to determine the error-correction tests, consider the following data-generating processes:

[7] For more details, see Westerlund, J. (2007), "Testing for error correction in panel data. Oxford Bulletin of Economics and Statistics", 69: 709–748.

$$\Delta y_{it} = \acute{\delta}_i d_t + \alpha_i(y_{i,t-1} - \acute{\beta}_i \chi_{i,t-1}) + \sum_{j=1}^{\rho_i} \alpha_{ij} \Delta y_{i,t-j} + \sum_{j=-q_i}^{\rho_i} \gamma_{ij} \Delta \chi_{i,t-j} + \epsilon_{it} \tag{17}$$

$$\Delta y_{it} = \acute{\delta}_i d_t + \alpha_i y_{i,t-1} + \acute{\lambda}_i \chi_{i,t-1} + \sum_{j=1}^{\rho_i} \alpha_{ij} \Delta y_{i,t-j} + \sum_{j=-q_i}^{\rho_i} \gamma_{ij} \Delta \chi_{i,t-j} + \epsilon_{it} \tag{18}$$

where, $t = 1, 2, ..., T$ shows the time period and $i = 1, 2, ..., N$ shows the number of sectional units. Also, δ_t contains the deterministic components, for which there are three cases. In the first case, $\delta_t = 0$ so equation (17) has no deterministic terms; in the second case, $\delta_t = 1$ so Δy_{it} is generated with a constant; and in the third case, $\delta_t = (1, t)$ so Δy_{it} is generated with both a constant and a trend. In equation (18), $\acute{\lambda}_i = -\alpha_i \acute{\beta}_i$ and the parameter α_i determines the speed at which the system corrects back to the equilibrium relationship $y_{i,t-1} - \acute{\beta}_i \chi_{i,t-1}$ after a sudden shock. if $\alpha_i < 0$, then there is error correction, which implies that y_{it} and χ_{it} are cointegrated; if $\alpha_i = 0$, there is no error correction and, thus, no cointegration. Thus we can state the null hypothesis of no cointegration as $H_0 : \alpha_i = 0$ for all i. The alternative hypothesis depends on what is being assumed about the homogeneity of α_i. Two of the tests, called group-means tests, do not require the α_i coefficients to be equal, which means that H_0 is tested versus $H_1 : \alpha_i < 0$ for at least one i. The second pair of tests, called panel tests, assume that α_i is equal for all i.

Westerlund (2007) computes the group-mean tests in three steps. The first step consists of the estimation of equation (18) by least squares for each unit i. Having obtained $\hat{\epsilon}_{it}$ and $ga\hat{m}ma_{ij}$ the second step is the computation of $\hat{u}_i t$ and then of $\hat{\alpha}_i$. The third step is the calculation of the group-mean tests in the following way:

$$G_T = \frac{1}{N} \sum_{i=1}^{N} \frac{\hat{\alpha}_i}{SE(\hat{\alpha}_i)}$$

$$G_\alpha = \frac{1}{N} \sum_{i=1}^{N} \frac{T\hat{\alpha}_i}{SE(\hat{\alpha}_i)}$$

Similarly, Westerlund (2007) computes the panel tests in three steps. The first test is the same as for the group-mean tests and involves regressing Δy_{it} and and $y_{i,t-1}$ onto d_t, the lags ofΔy_{it}, and the contemporaneous and lagged values of$\Delta \chi_{it}$. Then, the second step focuses on the estimation of the common error correction parameter, $\hat{\alpha}$, and its standard error, $SE(hat\alpha)$. Finally, the panel tests are the following:

$$P_\tau = \frac{\hat{\alpha}}{SE(\hat{\alpha})}$$

$$P_\alpha = T\hat{\alpha}$$

The above cointegrations tests, proposed by Westerlund (2007), can be executed using the command called xtwest, which can be used in Stata software.

5.4 Estimation of long-run relationship

5.4.1 Group Mean Dynamic OLS

Pedroni (2001) proposed the Group mean Dynamic OLS panel estimators for cointegration regressions by averaging over the individual DOLS time-series estimators applied to i^{th} member of the panel. The procedure begins by augmenting the cointegrating regression with lead and lagged differences of the regressor to control for the endogenous feedback effect and serial correlation. Consider the following equation:

$$y_{it} = \alpha_i + \beta_i \chi_{it} + \sum_{j=-J_i}^{J_i} \gamma_{ik} \Delta \chi_{it-j} + u_{it} \tag{19}$$

Using the above panel Dynamic OLS regresion, Pedroni(2001) calculates the time-series Dynamic OLS estimator and its corresponding t-statistic. [8]

5.4.2 Common Correlated Effects Model

Pesaran (2006) proposed the Common Correlated Effects model to investigate the long-run relationship for a set of variables, that allows for cross-sectional dependence, static or dynamic specifications, exogenous or endogenous regressors, fixed effects, and heterogeneous slopes. [9]

Consider the following panel model:

[8] For more details, see Pedroni P (2001) "Purchasing power parity tests in cointegrated panels". Rev. Econ. Statistics 83: 727-731.

[9] For more details, see Pesaran, M.H. (2006), "Estimation and inference in large heterogeneous panels with a multifactor error structure", Econometrica, 74(4): 967-1012.

$$y_{it} = \rho_i y_{it-1} + \beta_i \chi_{it} + \mu_i + \gamma_i f_t + \nu_{it} \tag{20}$$

$$\chi_{it} = \Gamma_i f_t + \epsilon it \tag{21}$$

where, ρ_i is the autoregressive coefficient for individual i, χ_{it} is a $(NT \times K)$ matrix of regressors, β_i is a $(1 \times K)$ vector of coefficients for individual i, μ_i is the individual-specific fixed effect, f_t is a $1 \times M$ vector of unobserved common factors, γ_i and Γ_i are the heterogeneous factor loadings, and ν_{it} and ϵ_{it} are the error terms.

Since both the regressors χ_{it} and the dependent variable y_{it} depend on the vector of unobserved common factors f_t, pooled or mean group OLS will provide an inconsistent estimate of rho or beta. The presence of unobserved common factors is one representation of cross-sectional dependence in panel data. The idea of common correlated effects estimation, introduced in Pesaran (2006), is to approximate the projection space of the unobserved common factors with the inclusion of cross-section averages of the variables in the regression equation.

Pesaran (2006) proposed the common correlated effects model to consistently estimate β_i in the equation above when $\rho_i = 0$ for all i and the regressors are strictly exogenous. It can be estimated with pooled or mean group OLS, with the latter accounting for slope heterogeneity among panel units. Chudik and Pesaran (2015) extended this model to allow for a dynamic specification and weakly exogenous regressors. It achieves this by adding lags of the cross-section averages to the regression. [10] Neal (2015) further extended the CCE/DCCE approach by estimating the regressions equations with 2SLS or GMM to account for endogenous regressors and improve the efficiency of the DCCE estimator, using further lags of the variables to form the instrument set. [11]

5.5 Long-run and short-run causality

5.6 Panel vector error correction model

The Vector Error Correction Model (VECM) has cointegration relations built into the specification so that it restricts the long-run behavior of the endogenous variables to con-

[10] For more details, see Pesaran, M.H. and Chudik, A. (2015), "Common correlated effects estimation of heterogeneous dynamic panel data models with weakly exogenous regressors", Journal of Econometrics, 188(2): 393-420.

[11] For more details, see Neal, T. (2015), "Estimating Heterogeneous Coefficients in Panel Data Models with Endogenous Regressors and Common Factors", Working Paper.

verge to their cointegrating relationships while allowing for short-run adjustment dynamics. The cointegration term is known as the error correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments. In order to investigate the long-run and the short-run dynamics so as to examine the ELG and the MLG hypotheses, we construct the following model:

$$\begin{bmatrix} \Delta \ln GDPNET_{it} \\ \Delta \ln CAPITAL_{it} \\ \Delta \ln REX_{it} \end{bmatrix} = \begin{bmatrix} \mu_{1i} \\ \mu_{2i} \\ \mu_{3i} \end{bmatrix} + \sum_{j=1}^{\rho} \Gamma_j \begin{bmatrix} \Delta \ln GDPNET_{it-j} \\ \Delta \ln CAPITAL_{it-j} \\ \Delta \ln REX_{it-j} \end{bmatrix} + \begin{bmatrix} \alpha_{1i} \\ \alpha_{2i} \\ \alpha_{3i} \end{bmatrix} ec_{it-1} + \begin{bmatrix} \epsilon_{1i} \\ \epsilon_{2i} \\ \epsilon_{3i} \end{bmatrix} \quad (22)$$

where, μ_{1i}, μ_{2i} and μ_{3i} are fixed effects and the error correction term, ec_{it}, represents the residuals from the estimated long-run regression below:

$$ec_{it} = lnGDPNET_{it} - [c_{1i}lnCAPITAL_{1t} + c_{2i}lnREX_{it} + c_{3i} + c_{4i}t] \quad (23)$$

6 Results

6.1 Unit root tests

The first step of the analysis is to investigate the stationarity properties of the data to ensure that incorrect inferences are not made. The presence of unit roots in panel data framework is tested using three different tests. IPS test results are reported in Table (8), Pesaran-CIPS test results are presented in Table (9) and, finally, Table (10) contains Fisher-ADF test results. The tests are conducted to check for the presence of a unit root both in levels and first differences for every single variable. In all tests, the null hypothesis is that of existence of a unit root in data.

Our results indicate that lnGDPNET, lnCAPITAL, lnREX and lnRMEX have unit roots in their level and therefore they are integrated of order one. Whether or not considering trend in calculations, null hypothesis is rejected for all variables in levels in all three tests. On the other hand, we fail to reject null hypothesis for all variables in first differences, indicating that they are stationary in first differences. It is clear from the panel unit root results that all variables are integrated of order one and so we can proceed to cointegration analysis.

Table 8: IPS panel unit root test results

	Level		1st diff	
Variable	**No Trend**	**With Trend**	**No trend**	**With Trend**
lnGDPNET	6.173	1.196	-22.32^{*}	-20.31^{*}
lnCAPITAL	6.360	-0.44	-24.86^{*}	-21.76^{*}
lnREX	2.467	0.122	-24.28^{*}	-19.90^{*}
lnRMEX	0.672	0.624	-25.53^{*}	-23.80^{*}

Notes: W_t statistics reported. Null hypothesis: All panels contain a unit root. * indicates significance at 1%. The appropriate lag length is selected based on SBC with automatic selection of maximum lags. Intercept is included in calculations in all cases. Eviews 9 was used for the estimations.

Table 9: Pesaran's CIPS panel unit root test results

	Level		1st diff	
Variable	**No Trend**	**With Trend**	**No trend**	**With Trend**
lnGDPNET	-0.378	-0.57	-12.210^{*}	-10.542^{*}
lnCAPITAL	-0.135	1.476	-14.539^{*}	-11.645^{*}
lnREX	-0.652	0.241	-12.119^{*}	-10.639^{*}
lnRMEX	-1.156	1.443	-12.112^{*}	-9.809^{*}

Notes: Z_t statistics reported (panel is unbalanced). Null hypothesis: All panels are non-stationary. * indicates significance at 1%. The appropriate lag length is selected based on SBC. Intercept is included in calculations for all cases. Stata 13 was used for the estimations.

Table 10: Fisher-ADF unit root test results

	Level		1st diff	
Variable	**No Trend**	**With Trend**	**No trend**	**With Trend**
lnGDPNET	72.77	82.79	610.9^{*}	534.8^{*}
lnCAPITAL	30.70	93.34	685.5^{*}	564.6^{*}
lnREX	77.75	82.22	667.7^{*}	547.7^{*}
lnRMEX	73.62	80.70	704.3^{*}	633.1^{*}

Notes: χ^2 statistic reported. * indicates significance at 1%. Null hypothesis: All panels contain unit root. The appropriate lag length is selected based on SBC. Intercept is included in calculations in all cases. Eviews 9 was used for the estimations.

6.2 Cointegration analysis

The second step of our analysis consists of the examination of the long-run cointegration relationships among the set of the integrated series. Pedroni's, Kao's, Westerlund's cointegration tests as well as a test for cross-sectional independence are proposed in this section.

The results of Pedroni's panel cointegration test for both total and manufacturing exports are reported in Tables (11) and (12). Pedroni uses four within dimension (panel) test statistics and three between dimension (group) statistics to check whether the selected panel data are cointegrated. Within dimension statistics contain the estimated values of test statistics based on estimators that pooled the autoregressive coefficient across different cross-sections for the unit root test on the estimated residuals. Between dimensions on the other hand, report the estimated values of test statistics based on estimators that average individually estimated coefficients for each cross-section. More specifically, when considering total exports, Panel v-statistic is significant at 1% level, Panel ADF-Statistic is significant at 5% level and both Group PP-statistic and ADF-statistic are significant at 1% level. In the case of exports of manufactures, all statistics are significant at 1% level, except for Panel and Group rho-statistics. The results of within dimensions tests and between dimensions tests show that the null hypothesis of no cointegration can be rejected both for total and manufacturing exports.

According to Kao's cointegration test, the null hypothesis of no cointegration is rejected at 1% significance level in both cases, indicating a long-run relationship between variables. The estimated t-statistics are reported in Tables (13) and (14).

As already has been proved, both Pedroni's and Kao tests indicate a cointegration relationship, however results should be interpreted with caution. Pedroni's test fails to take into account the possible cross-country dependence while Kao's test relies on the assumption of homogeneous panels. Pesaran (2004) proposes a test for cross-sectional dependence and the results drawn from it are depicted in table (15). The null hypothesis of existence of cross-sectional independence is clearly rejected.

To continue with, the panel cointegration test proposed by Westerlund (2007), in addition to the Pedroni's and Kao's tests, is used to examine the long-run relationship between economic growth, capital and exports. An advantage of Westerlund (2007) is that it provides robust p-values against cross-sectional dependencies and thereby it allows for various forms of heterogeneity. The results are presented in Tables (16) and (17). The result is not as clear as in previous test results. In the case of aggregate exports, only

P_t is statistically significant at 5% level and in the case of manufacturing P_t and P_α are significant at 5% and 10% level, respectively.

However, it is not surprising that results are foggy, considering the fact that the time dimension of the panel is small. We will continue our investigation, relying on Pedroni's and Kao's test which strongly confirm a common trend in the movement of GDP net of exports, capital and exports.

Table 11: Pedroni's cointegration test results: The Case of Total Exports

Test	**Statistic**	**P-value**
Panel v-Statistic	14.684	0.0000
Panel rho-Statistic	1.0608	0.8556
Panel PP-Statistic	−0.837	0.2012
Panel ADF-Statistic	−2.119	0.0170
Group rho-Statistic	2.1693	0.9956
Group PP-Statistic	−2.845	0.0022
Group ADF-Statistic	−3.678	0.0001

Notes: The statistics are the standard residual-based panel and group test statistics suggested by Pedroni (1999, 2004). All test statistics are asymptotically normally distributed. The variance ratio test is right-sided, while the other tests are left-sided. Null Hypothesis: There is no cointegration. The appropriate lag length is selected based on SBC. Eviews 9 was used for the estimations.

Table 12: Pedroni's cointegration test results: The Case of Manufacturing Exports

Test	**Statistic**	**P-value**
Panel v-Statistic	7.0417	0.0000
Panel rho-Statistic	−0.162	0.4356
Panel PP-Statistic	−3.187	0.0007
Panel ADF-Statistic	−3.345	0.0004
Group rho-Statistic	2.1523	0.9843
Group PP-Statistic	−3.555	0.0002
Group ADF-Statistic	−4.598	0.0000

Notes: The statistics are the standard residual-based panel and group test statistics suggested by Pedroni (1999, 2004). All test statistics are asymptotically normally distributed. The variance ratio test is right-sided, while the other tests are left-sided. Null Hypothesis: There is no cointegration. The appropriate lag length is selected based on SBC. Eviews 9 was used for the estimations.

Table 13: Kao's cointegration test results: The Case of Total Exports

Kao Cointegration test	**t-statistic**	**P-Value**
ADF	−4.803646	0.0000

Notes: Null Hypothesis: There is no cointegration. The appropriate lag length is selected based on SBC. Eviews 9 was used for the estimations.

Table 14: Kao's cointegration test results: The Case of Manufacturing Exports

Kao Cointegration test	**t-statistic**	**P-Value**
ADF	−3.7250	0.0000

Notes: Null Hypothesis: There is no cointegration. The appropriate lag length is selected based on SBC. Eviews 9 was used for the estimations.

Table 15: Pesaran's cross-sectional dependence test results

Case:	**Statistic**	**P-value**
Considering Total exports	6.40	0.0000
Considering Manufacturing exports	7.73	0.0000

Notes: Null Hypothesis: cross-sections in the panel data are independent. Calculations hace been done in Stata 13.

Table 16: Westerlund's test results: The Case of Total Exports

Statistic	**Value**	**Z-value**	**P-value**
G_t	-2.367	1.259	0.340
G_α	-8.473	4.615	0.740
P_t	-16.733	-1.920	0.050
P_α	-8.312	2.110	0.160

Notes: Null Hypothesis: There is no cointegration. Robust p-values are reported (bootstrap values - 100 replications) Cointegration test was estimated with one lag. Estimations have been done using Stata 13.

Table 17: Westerlund's test results: The Case of Manufacturing Exports

Statistic	Value	Z-value	P-value
G_t	-2.108	3.244	0.780
G_α	-9.635	3.534	0.440
P_t	-16.760	-2.144	0.050
P_α	-10.370	0.112	0.090

Notes: Null Hypothesis: There is no cointegration. Robust p-values are reported (bootstrap values - 100 replications) Cointegration test was estimated with one lag. Iran was dropped from the test due to low number of observations. Estimations have been done using Stata 13.

6.3 Long-run effects

In this section, given the fact that all variables are cointegarted, the long-run relationship is presented. Tables (18) and (19) depict the long-run effects of exports and capital on not-export GDP using the Dynamic OLS and the Common Correlated Effects tests, proposed by Pedroni (2001) and Pesaran (2006), respectively.

The coefficient on lnCAPITAL is highly significant and positive, as expected both in two cases. The coefficient of the exports variable, in contrast, is highly significant and negative. More precisely, for DOLS estimations, the coefficient on lnREX is estimated to be -0.131 and the coefficient with respect to lnRMEX is estimated to be -0.02 implying that, in the long-run, an one percent increase in total exports leads to a 0.131 percent decrease in non-export GDP on average and an one increase in exports of manufactures leads to a 0.02 decrease in non-export GDP. The results follow the same pattern when the long-run effects are estimated using CCE model. The findings indicate that total exports does not contribute to GDP growth, while the effect of manufacturing exports is also negative, but much smaller.

6.3.1 Sensitivity check

Since the results challenges the conventional view that exports generally contribute more to GDP growth than the mere change in export volume, it is crucial investigate the

Table 18: Estimates of the long-run effects of total exports on non-export GDP

Test/Variable	lnCAPITAL	lnREX
Group-mean DOLS	0.415*	−0.131*
Group-mean CCE	0.294*	−0.149**

Notes: * and ** indicate significance at 1%, 5%, respectively. The DOLS regressions were estimated with one lead and one lag. Estimations have been done in Stata 13

Table 19: Estimates of the long-run effects of manufacturing on non-export GDP

Test/Variable	lnCAPITAL	lnRMEX
Group-mean DOLS	0.235*	−0.02*
Group-mean CCE	0.222*	−0.07*

Notes: * indicates significance at 1%. The DOLS regressions were estimated with one lead and one lag. Stata 13 was used for the estimations.

case in which a possible sample selection bias exists. [12] Tables (20) and (21) include sensitivity analysis results. For every single estimation, a specific region is dropped from the sample. As can be seen, regardless which region is excluded from the sample, the long-run coefficients of exports remain negative and statistically significant, except for the case in which Central America and the Caribbean is dropped, where the coefficient is positive and significant.

Table 20: Sensitivity analysis: The Case of Total Exports

Region excluding from sample	$lnCAPITAL$	$lnREX$
Excluding Australia	0.413*	−0.13*
Excluding Central America	0.435*	−0.13*
Excluding South America	0.348*	−0.09*
Excluding East Asia	0.450*	−0.10*
Excluding South Asia	0.462*	−0.09*
Excluding West Asia	0.508*	−0.09*
Excluding North Africa	0.424*	−0.14*
Excluding Sub-Saharan Africa	0.418*	−0.32*

Notes: * indicates significance at 1%. The DOLS regressions were estimated with one lead and one lag. Stata 13 was used for the estimations.

[12] An alternative robustness check could be a check for period-selection bias. However, the data framework is inappropriate due to low size of variables' time dimension

Table 21: Sensitivity analysis: The Case of Manufacturing Exports

Region excluding from sample	$lnCAPITAL$	$lnRMEX$
Excluding Australia	0.235^{*}	-0.02^{*}
Excluding Central America	0.174^{***}	0.003^{***}
Excluding South America	0.284^{*}	-0.08^{*}
Excluding East Asia	0.294^{***}	-0.01^{***}
Excluding South Asia	0.259^{*}	-0.06^{***}
Excluding West Asia	0.372^{**}	-0.05^{*}
Excluding North Africa	0.224^{*}	-0.05^{*}
Excluding Sub-Saharan Africa	0.251^{*}	-0.07^{*}

Notes: *, ** and *** indicate significance at 1%, 5% and 10%, respectively. The DOLS regressions were estimated with one lead and one lag. Stata 13 was used for the estimations.

6.3.2 Individual long-run effects

In order to see light in the end of the tunnel, in this section, we introduce the individual DOLS estimates of the coefficient on export variables. The most remarkable feature of the results is the presence of strong heterogeneity across countries. Figures (1) and (2) plot these estimates only for countries in which the coefficients are statistically significant. When considering total exports, the heterogeneity in the coefficients, ranging from -0.62 in Jordan to 0.63 in Gabon. In the case of manufacturing, the heterogeneity in the coefficients ranging from -0.44 in Honduras to 0.38 in Iran. Moreover, although the long-run effect of export variable on GDP net of exports is negative on average for the full sample, exports do not have a negative long-run effect on non-export GDP in all countries.

More precisely, our findings indicate that in 9 countries (Armenia, Bolivia, Chile, El Savador, Mozambique, Pakistan, United States and Venezuela) an increase in total exports is associated with an increase in non-export GDP, while in 14 cases (Botswana, Burkina Faso, Cameroon, Colombia, Dominican Rep., Gambia, Israel, Japan, Jordan, Korea, Mali, Oman, Philippines and Turkey) an increase in total exports is associated with a decrease in non-export GDP. On the other hand, an increase in exports of manufactures leads to an increase in non-export GDP in 10 countries (Australia, Central African Rep., Chile, Colombia, Iran, Mali, Morocco, Mozambique, Oman and Tunisia), while in 13 countries (Armenia, Egypt, Gabon, Gambia, Honduras, Japan, Korea, New Zealand, Philippines, Togo and Turkey) an increase in manufacturing exports is associated with a decrease in non-export GDP.

Figure 1: Individual DOLS: The Case of Total Exports

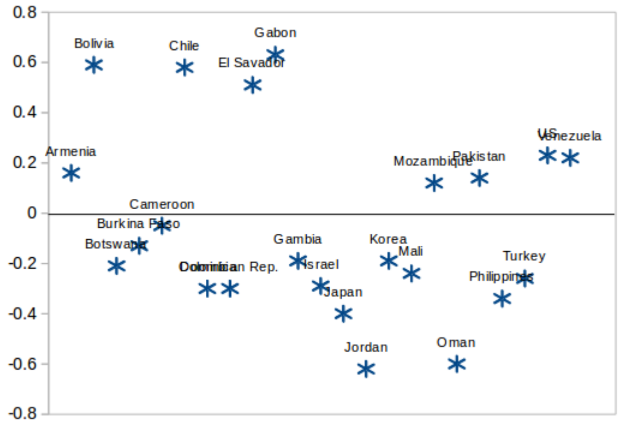
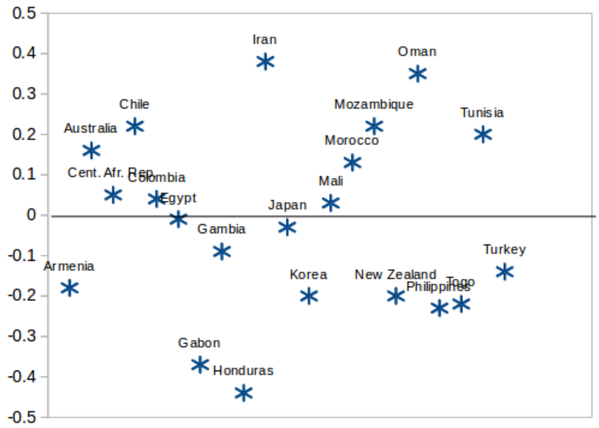


Figure 2: Individual DOLS: The Case of Manufacturing Exports



6.4 Short-run and long-run causality

According to panel cointegration analysis, in section (6.2), GDP net of exports, capital and export variables are bound together in the long-run. In this section, we discover the nature of the cointegration relationships under a dynamic panel vector error correction model. The results are reported in Tables (22) and (23).

To start with the interpretation of the results depending on total exports, the lagged error term coefficient of non-export GDP is negative and statistically significant at 1%, implying that cointegration results are consistent. The results indicates that the long-run causality is running from total exports and capital to non-export GDP. In the short-run analysis, the coefficient of $\Delta lnREX_{it-1}$, in column 2, is positive and statistically significant at 1% and the coefficient of $\Delta lnGDPNET_{it-1}$ in column 4 is also positive and significant at 10% level. The result implying that an increase in total exports is associated with an increase in non-export GDP and vice versa, in the short-run. In addition, there is evidence of bidirectional short-run causality between non-export GDP and capital and an undirectional causality running from exports to capital.

In the case of exports of manufactures, the lagged error term coefficient of non-export GDP is negative and statistically significant at 1%, as in the previous case, implying that there is long-run relationship running from manufacturing to non-export GDP growth. In the short-run analysis, a bidirectional causality between manufactures and capital is detected. Finally, there is evidence of one-way causality, running from non-export GDP to capital.

Table 22: Vector error-correction model, long-run causality and short-run dynamics: The Case of Total Exports

	Dependent Variables			
Regressors	$\Delta lnGDPNET_{it}$	$\Delta lnCAPITAL_{it}$	$\Delta lnREX_{it}$	Ec_{t-1}
$\Delta lnGDPNET_{it-1}$	0.171*	0.211*	0.127***	−0.187*
$\Delta lnCAPITAL_{it-1}$	−0.04***	0.011	−0.002	−0.028
$\Delta lnREX_{it-1}$	0.126*	0.075**	−0.079**	0.0284

Notes: *, ** and *** indicate significance at 1%, 5% and 10%, respectively. Stata 13 was used for the estimations.

Table 23: Vector error-correction model, long-run causality and short-run dynamics: The Case of Manufacturing Exports

	Dependent Variables			
Regressors	$\Delta lnGDPNET_{it}$	$\Delta lnCAPITAL_{it}$	$\Delta lnRMEX_{it}$	Ec_{t-1}
$\Delta lnGDPNET_{it-1}$	0.072^{**}	0.126^{**}	-0.16	-0.315^{*}
$\Delta lnCAPITAL_{it-1}$	-0.02	0.027	0.272^{**}	-0.026
$\Delta lnRMEX_{it-1}$	-0.007	-0.019^{***}	-0.07^{**}	-0.007

Notes: *, ** and *** indicate significance at 1%, 5% and 10%, respectively. Stata 13 was used for the estimations.

7 Concluding remarks

The present study examines the export-led growth hypothesis employing not only aggregate exports, but also exports of manufactures, using annual panel data from 43 countries over the period 1980–2013. The empirical analysis focuses on the cointegration relationship between non-export GDP, capital and export variables.

Panel unit root tests which take into account both panel heterogeneity and cross-sectional dependence have been applied to examine the integrating properties of the variables. The IPS, CIPS and Fisher-ADF panel unit root tests indicated that GDPNET, CAPITAL, REX and RMEX are integrated in order one, I(1).

Furthermore, we test the nature of the growth effect of exports by applying panel cointegration methods to a production function model with non-export GDP as the dependent variable. To investigate a possible common trend between variables, Pedroni's, Kao's and Westerlund's panel cointegration approaches have been applied. The first two tests strongly support the existence of a long-run relationship among variables, while Westerlunds's test leads to mixed results.

The dynamic OLS and the Common Correlated Effects estimation analysis reveal a negative, on average, long-run relation between non-export GDP and exports and a less negative long-run relationship when considering manufacturing exports. Also, the results are robust to sample selection. Our findings indicate that in 9 countries, an increase in total exports is associated with an increase in non-export GDP, while in 14 cases, an increase in total exports is associated with a decrease in non-export GDP. On the other hand, an increase in exports of manufactures leads to an increase in non-export GDP in 10 countries, while in 13 countries an increase in manufacturing exports is associated with a decrease in non-export GDP.

The causality analysis confirms the existence of long-run equilibrium relationship between non-export GDP, capital and exports. In the case of total exports, there is a positive short-run relationship between non-export GDP and exports and a bidirectional causality between non-export GDP and capital. The results are consistent with the findings of Dreger and Herzer (2013). A possible explanation for the positive short-run effect of exports is static specialization gains, whereas, in the long-run, the negative dynamic effects of exports on non-export GDP, possibly associated with primary export dependence and/or excessive business and labor regulations, which tend to offset the short-run gains. In addition, an one-way causality is detected, running from exports to capital. In the case of exports of manufactures, a feedback causality is confirmed between capital and manufacturing and, also, a causality running from non-export GDP to exports of manufactures is detected. Since economic growth is an extremely complex process depending upon many variables and given the relatively short sample period, estimations must be interpreted with caution, before policy makers implement policies.

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