THE CAUSAL RELATIONSHIP BETWEEN EXPORTS AND ECONOMIC GROWTH: TIME SERIES ANALYSIS FOR UAE (1975-2012)

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This thesis is submitted in partial fulfillment of the requirements of the Manchester Metropolitan University for the award of Doctor of Philosophy

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This study is dedicated to my parents, Styliano and Paraskevi and to my husband Ioanni.

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DECLARATION

I hereby declare that no part of this thesis has been submitted for another award at this or another university.

ACRONYMS AND ABBREVIATIONS

ADF	Augmented Dickey Fuller
AIC	Akaike Information Criterion
ECM	Error Correction Model
ELG	Export-Led Growth
GAFTA	Greater Arab Free Trade Agreement
GCC	Gulf Cooperation Council
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
GLE	Growth-Led Exports
GNP	Gross National Product
IFS	International Financial Statistics
IMF	International Monetary Fund
KPSS	Kwiatkowski-Phillips-Schmidt-Shin
MENA	Middle East and North African
OLS	Ordinary Least Squares
PP	Phillips Perron
SIC	Schwarz Information Criterion
SL	Saikkonen and Lutkepohl
UAE	United Arab Emirates
VAR	Vector Autoregression model
VECM	Vector Error Correction Model
WB	World Bank
WDI	World Development Indicators
WTO	World Trade Organization
T-Y	Toda and Yamamoto

ABSTRACT

The principal question that this thesis addresses is the validity of the Export-Led Growth hypothesis (ELG) in the United Arab Emirates (UAE), using annual time series data over the period 1975-2012. Therefore, the research identifies and evaluates the causal relationship between exports and economic growth, by shedding further light on the causal effects, subcategories of exports can have. In doing so, various unit root tests have been applied to examine the time-series properties of the variables, while the Johansen cointegration test is employed to test the existence of a long-run relationship between the variables. Moreover, the multivariate Granger causality test and a modified version of Wald test are applied to examine the direction of the short-run and long-run causality respectively.

The findings confirm that the ELG hypothesis is valid for UAE in the short-run, highlighting the importance of export sector in the UAE economy. However, by disaggregating merchandise exports into primary and manufactured exports, this research provides evidence that a circular causality exists between manufactured exports and economic growth in the short-run. Primary exports and especially fuel and mining exports, contrary to the generally held belief, do not cause economic growth in UAE, however are essential for the industrial production. In addition, the research provides statistically significant evidence to support the existence of a bidirectional causality between re-exports and economic growth in the long-run. Thus, further increase in the degree of export diversification from oil could accelerate economic growth in UAE.

CHAPTER 1. INTRODUCTION AND OBJECTIVES OF THE STUDY

1.1 Introduction

The relationship between exports and economic growth is a frequent topic of discussion, when economists try to explain the different levels of economic growth between countries. The growth of exports increases technological innovation, covers the foreign demand and also increases the inflows of foreign exchange, which could lead to greater capacity utilization and economic growth (Balassa, 1978; Edwards, 1998; Ramos, 2001; Yanikkaya, 2003). The export-led growth is still the strategy favored by governments in order to enhance economic growth, but is the export-led growth hypothesis valid in the case of UAE?

The relationship between exports and economic growth has been analysed by several studies. Most of these studies indicate that the growth of exports has a positive effect on economic growth, through the impact on economies of scale, the adoption of advanced technology and the higher level of capacity utilization (Emery, 1967; Michaely, 1977; Balassa, 1978; Feder, 1982; Al-Yousif, 1997; Vohra, 2001; Abou-Stait, 2005). However, few studies note that the expansion of exports can affect negatively economic growth (Myrdal, 1957; Berill, 1960; Meier, 1970; Lee and Huang 2002; Kim and Lin, 2009).

In addition, some studies investigate the export effect on economic growth, highlighting the differences between developed and less developed countries. These studies conclude that export expansion exerts a positive impact on economic growth for more developed countries and this can be explained by the fact that less developed countries are not characterized by political and economic stability and do not provide incentives for capital investments (Michaely, 1977; Kavoussi, 1984; Kohli and Singh, 1989; Levine et al., 2000; Vohra, 2001; Kim and Lin, 2009).

Other studies such as those by Tyler (1981), Fosu (1990), Ghatak et al. (1997), Tuan and Ng (1998), Abu-Qarn and Abu-Bader (2004), Herzer et al. (2006), Siliverstovs and Herzer (2006, 2007), Kilavuz and Altay Topcu (2012) and Hosseini and Tang (2014) investigate the impact of export composition on economic growth, indicating that not all exports contribute equally to economic growth. The reliance of developing countries on exports of primary products, can slow down economic growth, while the expansion of diversified exports can have a positive and significant effect on economic growth.

Moreover, a number of previous studies investigate the causal relationship between exports and economic growth. Most of these studies conclude that there is a unidirectional causality from exports to economic growth (Thornton, 1996; Ghatak et al., 1997; Ramos, 2001; Yanikkaya, 2003; Awokuse, 2003; Abu Al-Foul, 2004; Shirazi and Manap, 2004; Abu-Stait, 2005; Siliverstovs and Herzer, 2006; Ferreira, 2009; Gbaiye et al., 2013). Other studies argue that causality runs from growth to exports (GLE) or conclude that there is a bidirectional causal relationship (ELG-GLE) between exports and economic growth in developing countries (Edwards, 1998; Panas and Vamvoukas, 2002; Abu Al-Foul, 2004; Love and Chandra, 2005; Awokuse, 2007; Narayan et al., 2007; Elbeydi et. al, 2010; Ray, 2011; Mishra, 2011). In contrast, several studies indicate no causal link between exports and economic growth (Jung and Marshall, 1985; Kwan and Cotsomitis, 1991; El-Sakka and Al- Mutairi, 2000; Tang, 2006). Thus, there is no consensus on whether exports cause economic growth.

Within the context of UAE economy, evidence on the causal relationship between exports and economic growth has been limited and mixed, warranting further investigation. To date, no study has yet examined the causal relationship between different export categories and economic growth in UAE. This research attempts to examine the validity of ELG and to investigate the causal relationship between primary exports, manufactured exports and economic growth in the UAE's context. In addition, given that aggregate measures may mask the different causal effects that subcategories of exports can have, fuel and mining exports as well as non-oil exports and re-exports are disaggregated from merchandise exports.

1.2 Justification of Research

The UAE has achieved strong economic growth and significant export diversification over the last three decades. In 2012, the Gross Domestic Product of UAE increased 25 times, comparing with the 1975 level, with an average annual growth of 10 per cent. Three years after the global financial crisis of 2008-2009, the UAE GDP has increased by 51 per cent, with an average annual growth of approximately 15 per cent, when the global average annual growth for the same period is estimated around 3 per cent.

In terms of export diversification, the share of manufactured exports in total merchandise exports increased from around 3.4% in 1981 to approximately 23.0% in 2012, while the share of fuel-mining exports decreased from around 83.8% in 1981 to around 43.1% in 2012, indicating that there is a significant diversification process in the UAE. Moreover, further evidence of significant diversification process is the fact that the value of non-oil exports in 2012 has increased by 99 times, comparing with the 1981 level, while the value of re-exports increased by approximately 56 times, comprising around 12% and 15.5% of GDP in 2012, respectively. Accordingly, this research will provide evidence on whether merchandise exports and diversifed exports cause economic growth in short-run and long-run in UAE.

In sum, this study will help in designing future policies for enhancing and sustaining economic growth in UAE and also would be useful for future studies of small oil-producing countries.

1.3 Research Objectives

A large number of studies provided evidence on the causal effect of exports on economic growth, which led modern empirical economists to highlight the vital role of exports as “the engine of economic growth”. To the best of my knowledge, two studies have investigated the causality between exports and economic growth in the UAE, while their results are contradictive. The aim of this research is to examine the causal relationship between different categories of exports and economic growth in UAE and this may help in designing future policies for accelerating economic growth. The specific objectives of this research are to investigate:

- The nature of the link between merchandise exports and economic growth in UAE over the period 1975-2012.
- The causal relationship between primary exports, manufactured exports and economic growth for the period 1981-2012.
- The existence of a causal relationship between fuel-mining exports and economic growth for the period 1981-2012.
- The existence of a causal relationship between diversified exports and economic growth for the period 1981-2012.

The present study aims to answer the following research questions:

1. Do merchandise exports cause economic growth or vice versa in UAE?
2. Do manufactured exports contribute more than primary exports to the economic growth of UAE?
3. Do abundant fuel-mining exports cause economic growth in UAE?
4. Do diversified exports cause economic growth or vice versa in UAE?

In order to investigate the existence of a causal relationship between exports and economic growth in UAE, this research applies the following tests: a) Unit root tests in order to ensure that all variables included in the model are stationary, b) Cointegration test to confirm the existence of a long-run relationship between exports and economic growth, c) a Vector Autoregression model (VAR) in order to investigate whether exports affect economic growth d) the multivariate Granger causality test to investigate the direction of the short-run causality and e) a modified Wald test (MWALD) in an augmented vector autoregressive model, developed by Toda and Yamamoto (1995).

1.4 Contribution and Limitation of the study

Most of the empirical studies have used bivariate or trivariate models in order to test the validity of the export-led growth hypothesis and this might led to misleading and biased results. In other words, these studies have examined the relationship between exports and economic growth, ignoring the complex causal nature of events and the human dimension of economic growth. Can this be considered as an adequate method for drawing conclusions on this multi-dimensional process? As Slaus and Jacobs (2011) noted, economists should understand that the human capital is one of the basic goal and source of economic growth and the central determinant of sustainability. For this reason, the present study includes variables omitted in most of the previous studies, such as human capital, physical capital and imports of goods and services.

Moreover, most of the previous studies have applied unit root tests that are considered to be biased toward the non-rejection of a unit root, in the presence of a structural break. For this reason, the unit root test with structural break proposed by Saikkonen and Lutkepohl (2002) was applied to this research in order to evaluate the time series properties. Another issue that has been overlooked by previous studies on ELG hypothesis is that the Johansen's cointegration test can be biased toward rejecting the null hypothesis of no cointegration. In order to remedy this issue, the adjustment for small sample proposed by Reinsel and Ahn (1992) was used in this study.

In addition, most of the previous studies have investigated the existence of a long-run causality between exports and economic growth based on the Error Correction Model. Nevertheless, in the case of multivariate models, it is not possible to indicate which explanatory variable causes the dependent variable. In addition, the long-run causality test based on ECMs requires pretesting for the cointegrating rank and this may result in overrejection of the non-causal null, due to pretest biases. For this reason, this study also uses a modified Wald test in an augmented vector autoregressive model, developed by Toda and Yamamoto (1995), overcoming the limitations of the previous studies.

It should be recognised that this study might have a number of limitations. First, given the data availability, the examined period for the disaggregated models are limited to 1981-2012. Second, the data for capital accumulation and imports of goods and services come from several sources. The time series are obtained from IMF, while the missing data for the years 1999-2000 and 2010-2012 are obtained from the National Bureau of Statistics and the World Bank respectively. However, the consistency of the series is ensured by comparison with the available data obtained from World Bank and National Bureau of Statistics.

In addition, this study uses population, as a proxy for human capital, due to the fact that the data related with the labor force was not obtainable for the period 1975-2012. In order to overcome the overestimation problem may exist due to the use of population, the aggregate model is estimated with and without the variable of population.

In addition, the fact that UAE is defined by different characteristics may limit the generalizability of our findings to oil-producing countries. However, researching the causal relationship between exports and economic growth in UAE could help in designing future policies for accelerating socio-economic growth in less developed resource-abundant countries.

1.5 Structure of the research

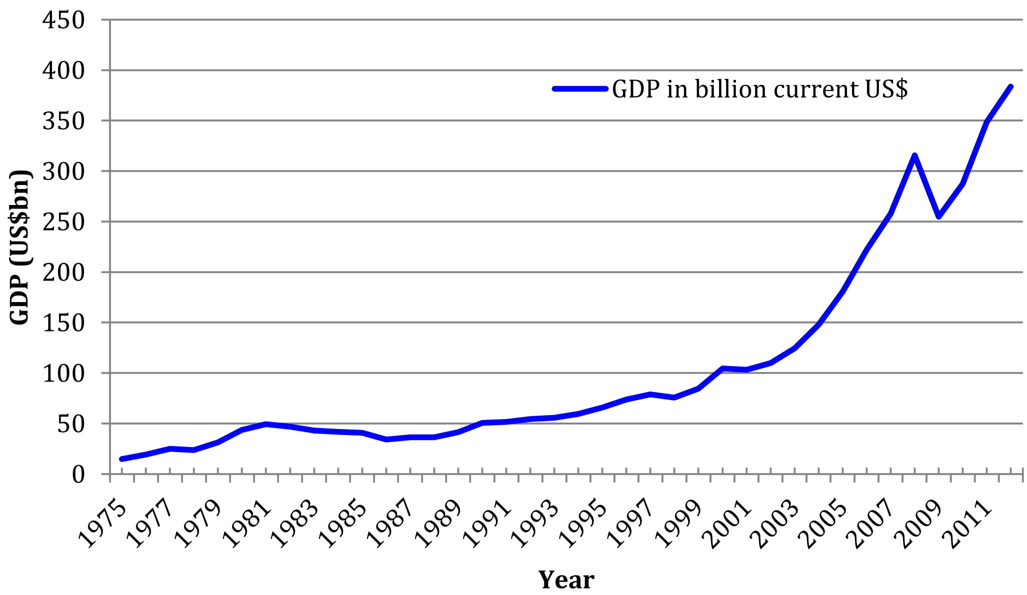
The remaining chapters of this study are organized as follows: Chapter two provides an overview of the UAE economy, highlighting the main features of the national economy and its foreign trade partners. Chapter three reviews the literature on the relationship between exports and economic growth. Specifically, Chapter three is structured chronologically, while the previous studies are presented in two sections. The first section includes the studies that investigate the impact of exports on economic growth based on simple correlation tests and ordinary least squares method, while the second section presents the more recent studies that investigate the causality between exports and economic growth. The chosen methodology and data sources are described in chapter four, while Chapter five, Chapter six and Chapter seven report and interpret the empirical results. Chapter eight presents the summary, conclusion and policy implications of this research.

CHAPTER 2. AN OVERVIEW OF THE UAE ECONOMY

2.1 Gross Domestic Product

In 1975 the Gross Domestic Product of UAE was estimated at 14.72 billion US$, rising to 49.33 billion US$ in 1981. Between 1982 and 1986, GDP decreased gradually to US$33.94 billions, when it started to rise steadily until 1997. During 1998-2001, GDP fluctuated slightly, increasing from US$75.67 billions in 1998 to US$103.31 billions in 2001, when it began to increase dramatically, reaching a total of US$315.47 billions in 2008. In 2012, the GDP of UAE increased by 51 per cent comparing with the 2009 level, estimated at around 383.79 billion US$ (figure 2.1).

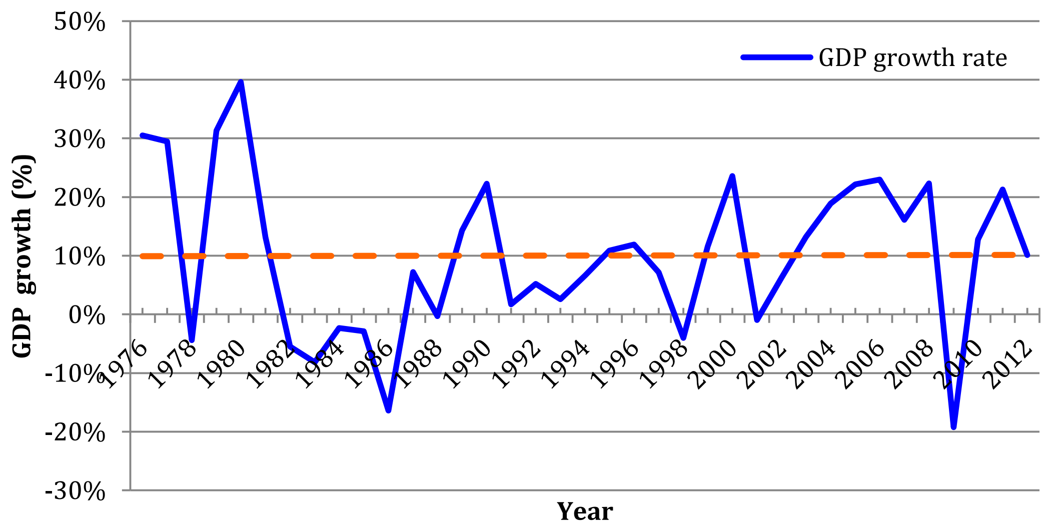
Figure 2.1: Gross Domestic Product of UAE for the period 1975-2012



Source: Author’s elaboration based on World Development Indicators, World Bank

Figure 2.2 shows the UAE's annual GDP growth rate over the period 1975-2012. As it can be seen, the annual growth rate of UAE GDP fluctuated around 10% during the examined period. In particular, the annual GDP growth in 1976 was estimated around 31%, followed by a sharp decline to -4% in 1978 due to the Iranian revolution. In 1980, the growth rate reached its peak at 40%, while it plunged to -16% in 1986, due to the collapse in oil price by over 50% (see figure A.1, Appendix A). One year after the crisis of 2008, the growth rate decreased to -19% and by 2011 it reached 21%.

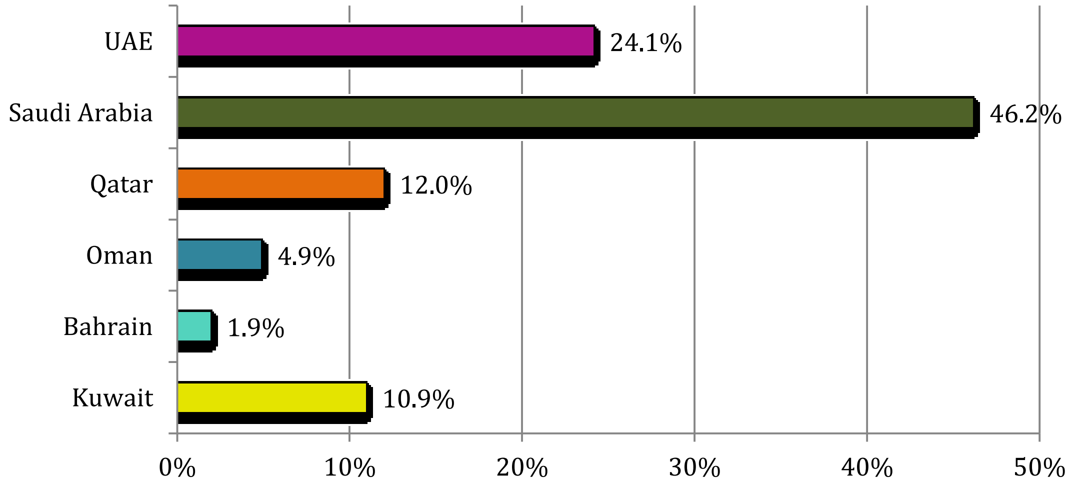
Figure 2.2: GDP annual growth rate over the period 1975-2012



Source: Author's calculation based on World Development Indicators for the period 1975-2012, World Bank

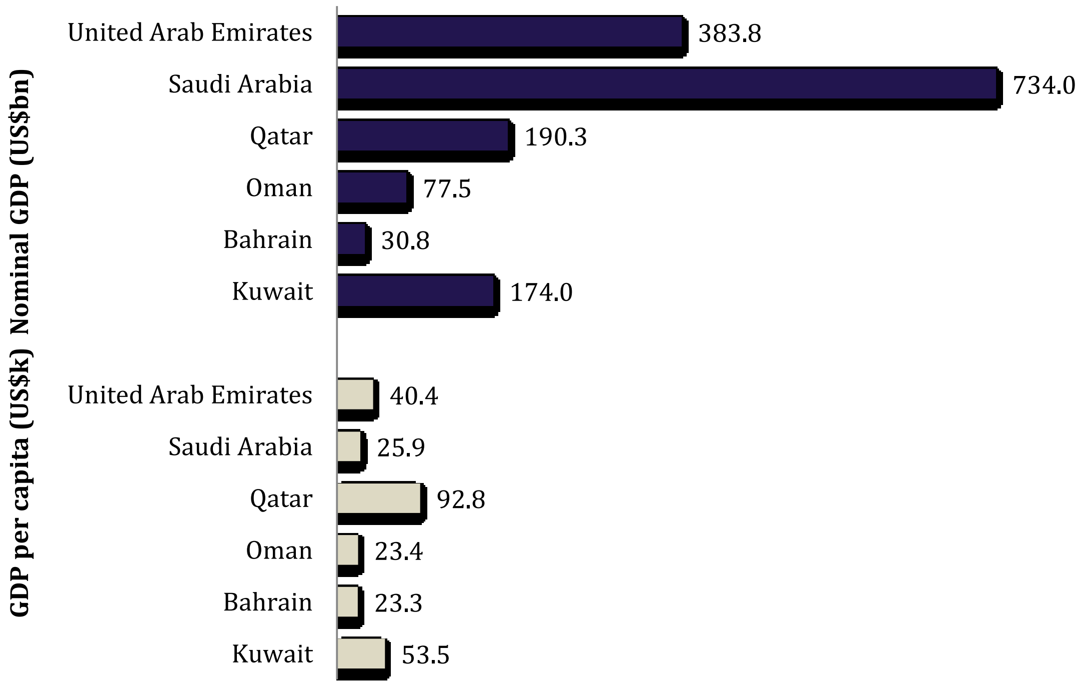
For the same year, the UAE's nominal GDP represents 24.1% of the total GDP of the Gulf Cooperation Council countries (GCC), making UAE the second largest economy in the GCC region. As far as the UAE GDP per capita is concerned, it is the third highest in the region, estimated at US$40.4 thousands in 2012. Figure 2.3 shows the GDP of UAE, Saudi Arabia, Qatar, Oman, Bahrain and Kuwait at current US$ as a share of total GCC GDP in 2012, while figure 2.4 presents the nominal GDP and GDP per capita for the same year.

Figure 2.3: GDP at current US$ as a share of total GDP of GCC (per cent) 2012



Source: Author's calculation based on World Development Indicators, World Bank

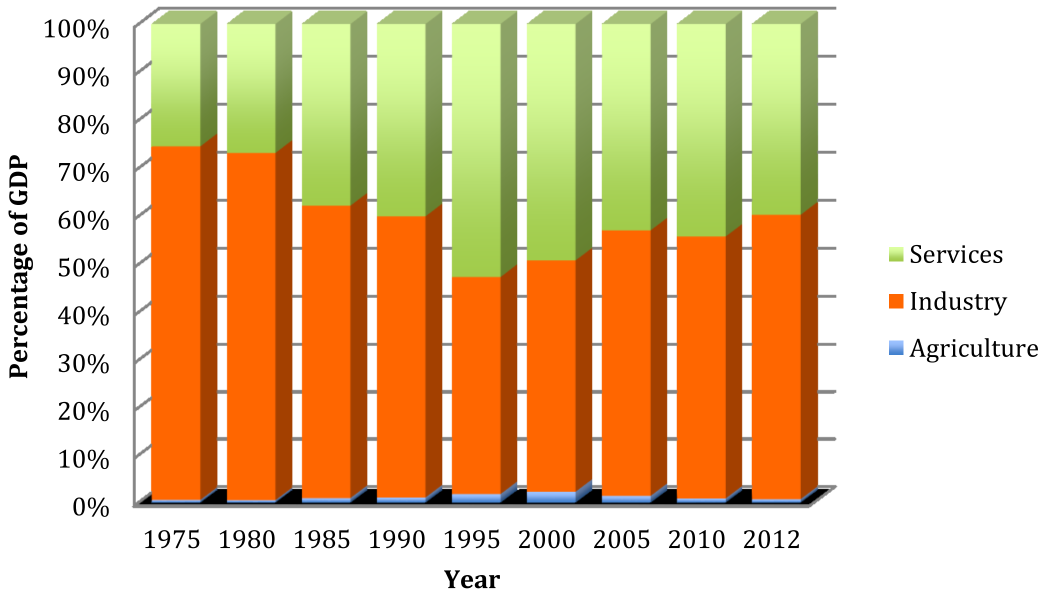
Figure 2.4: Nominal GDP and GDP per capita in the GCC region (2012)



Source: Author's calculation based on World Development Indicators, World Bank

In 1975, the agricultural sector contributed approximately 0.54 per cent of UAE's GDP, while in 2012 the contribution of this sector increased to less than 1 per cent. The industrial sector and service sector, in 1975, contributed to approximately 74.00% and 25.46% of GDP respectively, while in 2012 these percentages were 59.59 and 39.72 respectively. Figure 2.5 shows the economic sectors' contribution to UAE's GDP over the period 1975-2012.

Figure 2.5: Sectoral Structure of UAE Economy for the period 1975-2012

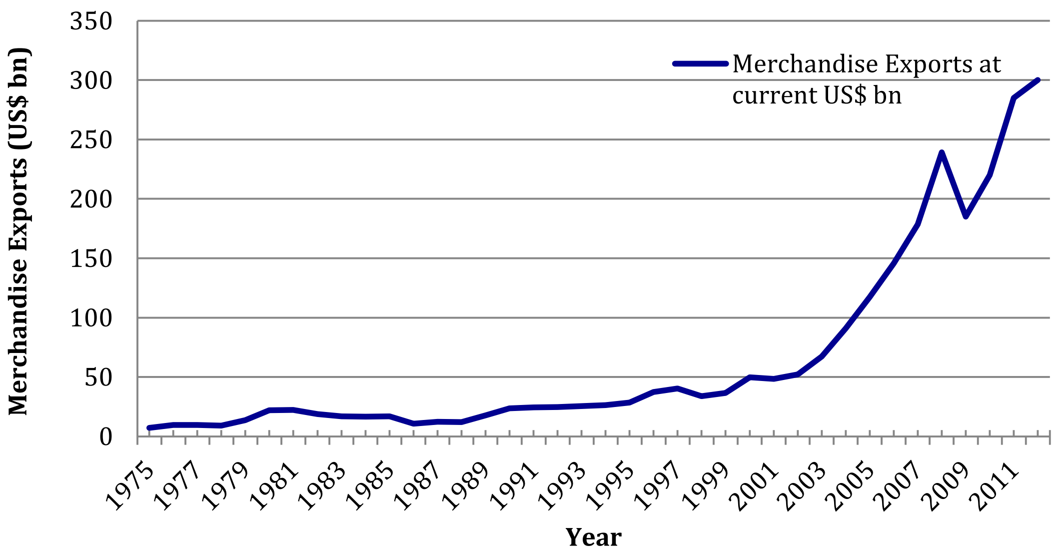


Source: Author's calculation based on World Development Indicators, World Bank

2.2 Merchandise Exports of UAE

In 2012 the UAE was ranked 17th among the leading exporters in world merchandise trade (International Trade Statistics, WTO, 2013), while was ranked 1st and 6th in re-exports among Arab countries and globally, respectively (World Trade Policy Review: UAE, WTO, 2012). In particular, the value of UAE merchandise exports in 2012 is estimated around US$300 billions, with an average growth per annum around 12.6% for the whole period. In particular, during the period 1975-2001 the growth of merchandise exports averaged 5.7%, while the average annual growth rate during the period 2002-2012 was around 19%. The highest growth rate of merchandise exports was 60.9% in 1981, while the lowest was -36.6% in 1986.

Figure 2.6: The Merchandise Exports of UAE in US$ billions for the period 1975-2012



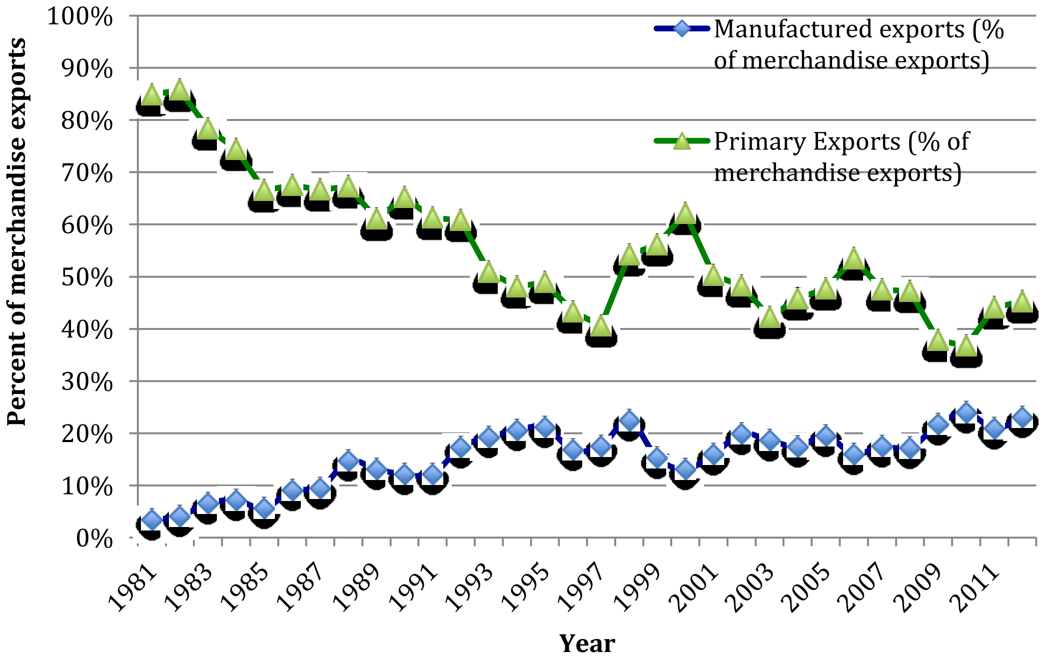
Source: Author's elaboration based on Time Series on International Trade, World Trade Organization

As figure 2.6 reveals, although the value of merchandise exports fell slightly during 1983, it remained fairly constant at just over US$16.8 billions per year until 1985. After 1986, the value of merchandise exports increased gradually, reaching around US$23.5 billions in 1990 and hovering around this level until the year 1995. Thereafter, the value of merchandise exports increased dramatically, reaching a total of US$239.2 billions in 2008. During the last four years of the examined period, the value of merchandise exports increased by 5.3%.

2.2.1 The Structure of UAE Merchandise Exports

As figure 2.7 reveals, the share of primary export in total merchandise exports decreased from around 84.9% in 1981 to approximately 45.2% in 2012, indicating that there is a significant diversification process in the country. Furthermore, export diversification is reflected by the share of manufactured exports, which increased from around 3.4% in 1981 to approximately 23.0% in 2012.

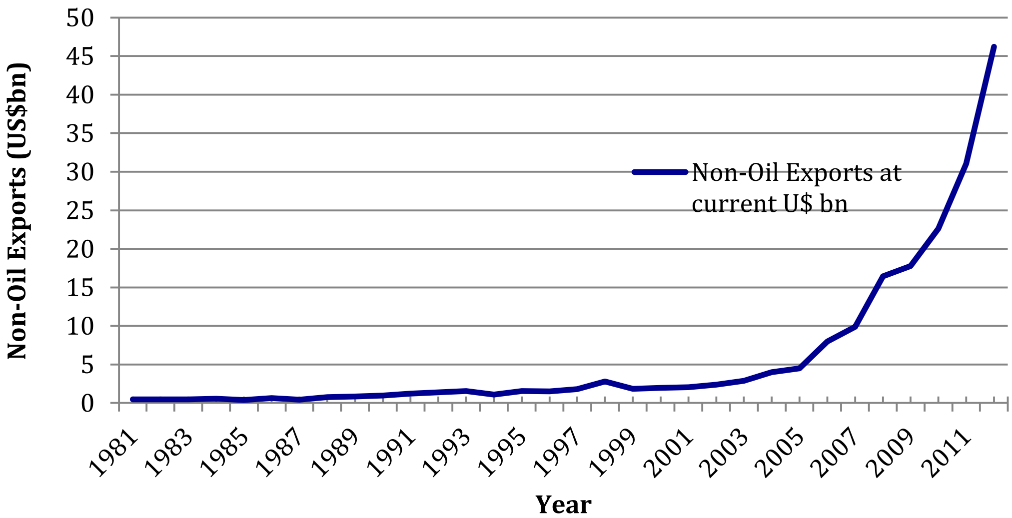
Figure 2.7: The ratio of Primary and Manufactured Exports to total Merchandise Exports of UAE (1981-2012)



Source: Author's elaboration based on Time Series on International Trade, World Trade Organization. For more details about the commodity structure of Merchandise exports see Appendix B

Export diversification is also reflected by the increase of non-oil exports and re-exports during the last three decades. The value of non-oil exports has increased from around US$500 millions in 1981 to US$46.2 billions in 2012, an increase of about 99 times. In particular, the value of non-oil exports remained fairly constant at around US$0.5 billions per year during 1981-1987, while during the period 1988-2005, the growth of non-oil exports averaged 16.6%, reaching around US$4.5 billions in 2005. Thereafter, the value of non-oil exports increased dramatically, with an average annual growth rate 37.8%, reaching a total of US$46.2 billions in 2012. The highest growth rate was 77.6% in 2006, while the lowest was 8.2% in 2009 (figure 2.8).

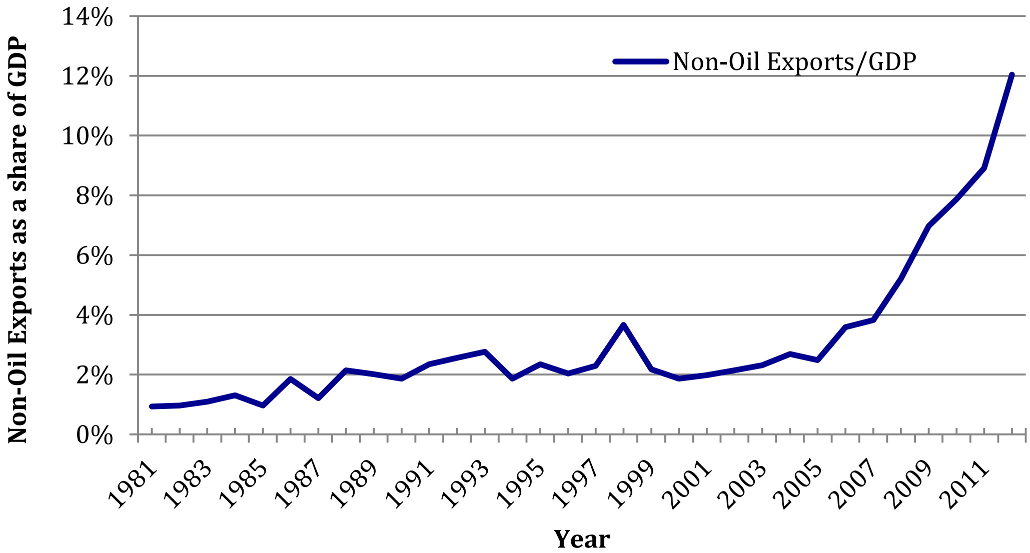
Figure 2.8: Non-Oil Exports of UAE at current US$ billions for the period 1981-2012



Source: Author's elaboration based on time series data taken from the National Bureau of Statistics of United Arab Emirates. For more details about the commodity structure of Non-Oil exports see table C.1, Appendix C

In addition, the share of non-oil exports in GDP averaged at just below 1% in 1981, while this proportion increased to approximately 12% in 2012, which was the highest share over the period 1981-2012. Figure 2.9 shows the share of this export category in GDP over the period 1981-2012.

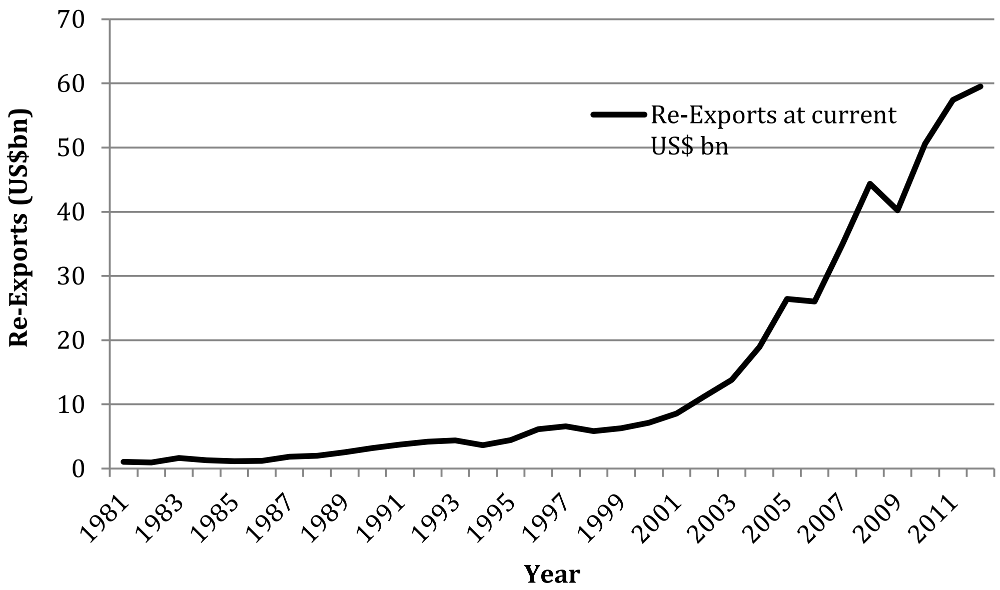
Figure 2.9: Non-Oil Exports as a share of GDP over the period 1981-2012



Source: Author's elaboration based on time series data taken from the World Bank and National Bureau of Statistics of United Arab Emirates

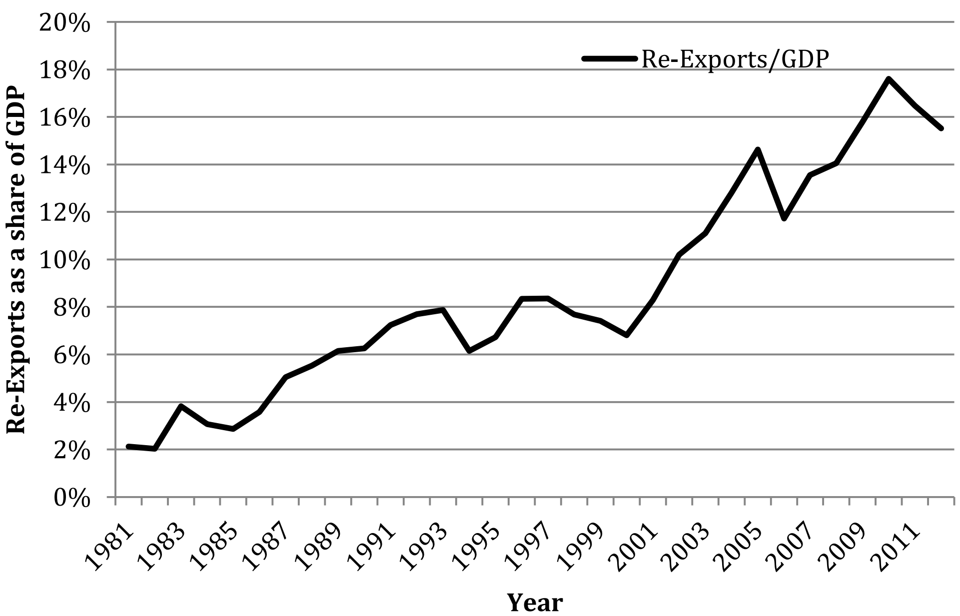
As far as the value of re-exports is concerned, it increased gradually with some fluctuations, from just over U$1 billion in 1981 to approximately US$8.6 billions in 2001, when it started to rise dramatically until 2005. Thereafter, the value of re-exports fell slightly in 2006 and then dramatically in 2009, reaching a total of US$40.2 billions. In 2012, the value of re-exports increased by 48 per cent comparing with the 2009 level, estimated at around US$ 59.5 billions, an increase of about 56 times comparing with the 1981 level (figure 2.10). As figure 2.11 reveals, the share of re-exports in GDP averaged at around 6% during the period 1981-2001, while this proportion for the period 2002-2012 increased to 14%.

Figure 2.10: Re-Exports of UAE at current US$ billions for the period 1981-2012



Source: Author's elaboration based on time Series data taken from the National Bureau of Statistics of United Arab Emirates. For more details about the commodity structure of re-exports see table C.2, Appendix C

Figure 2.11: Re-Exports as a share of GDP over the period 1981-2012



Source: Author's elaboration based on time series data taken from the World Bank and National Bureau of Statistics of United Arab Emirates

2.2.2 Destination of Merchandise Exports

The UAE merchandise exports to the Arab countries remained relatively limited, compared to the value of UAE exports to other countries in the world. In particular, the share of Arab countries over the period from 2005 to 2012 hardly changed at all. Although it increased by 1.2 % in 2009, it remained fairly constant at around 8% per year. Within this group, Oman ranked first, as the value of exports to this country reached 2123.9 millions of US$ in 2005, forming 29.2 per cent of total merchandise exports to Arab region. For the same year, the value of merchandise exports to Saudi Arabia and Syria reached 1422.2 and 827.1 millions of US$ respectively, accounting for 19.5 and 11.4 per cent of total merchandise exports to Arab World respectively.

In 2012, the value of merchandise exports to Oman, Saudi Arabia and Syria reached 6576.3, 3210.2 and 2089.8 millions of US$ respectively, accounting for more than 60.9 per cent of exports to Arab World. Meanwhile, the share of Advanced Economies decreased from approximately 48.9% in 2005 to around 32.4% in 2012 and that of the Rest of the World from 19.1% to 17.6% respectively. In contrast, the share of Developing Economies increased from approximately 24.5% in 2005 to around 42.4% in 2012. Tables 2.1 and 2.2 show the direction of UAE merchandise exports for the period from 2005 to 2012, while and figure 2.12 presents the UAE merchandise exports by destination in 2012.

Table 2.1: Merchandise Exports of UAE to Arab World (Millions of US$)

Arab Countries	**2012**	**2011**	**2010**	**2009**	**2008**	**2007**	**2006**	**2005**
Jordan	536.2	646.5	366.2	304.3	281.5	261.2	195.4	192.5
Bahrain	381.6	359.1	278.4	212.5	312.6	238.7	202.4	169.0
Tunisia	108.4	138.7	87.9	65.3	122.0	33.1	36.6	37.9
Algeria	236.8	314.1	199.5	83.3	51.2	47.2	34.3	44.5
Djibouti	60.6	55.4	43.6	33.3	47.8	36.3	30.1	24.0
S. Arabia	3210.2	3021.2	2342.0	1787.8	2629.6	2008.5	1702.6	1422.2
Sudan	449.2	844.9	854.4	479.0	569.4	436.7	404.2	358.9
Syria	2089.8	1910.5	1504.3	1148.3	1648.8	1254.4	1039.8	827.1
Somalia	75.3	68.8	54.2	41.4	59.4	45.2	37.4	29.8
Iraq	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oman	6576.3	5888.0	5097.4	3858.8	5.668.4	3842.5	2562.3	2123.9
Qatar	1822.6	1640.2	1447.5	1603.1	1681.1	1489.8	900.7	588.4
Comoros	25.2	23.0	18.1	13.8	19.9	15.1	12.5	10.0
Kuwait	996.1	937.5	726.7	554.8	816.0	623.2	528.3	441.3
Lebanon	378.5	540.1	336.0	237.5	296.8	198.4	120.1	124.4
Libya	97.7	91.9	71.3	54.4	80.0	61.1	51.8	43.3
Egypt	723.5	730.4	661.4	393.4	794.7	171.6	118.0	123.9
Morocco	404.2	258.9	165.8	162.5	222.0	142.6	133.4	88.4
Mauritania	1.7	1.6	1.3	1.0	1.4	1.0	0.9	0.7
Yemen	1859.7	1750.2	1356.7	1035.7	1523.4	1163.5	986.4	823.9
Total	19497.	18574.	15246.	11765.	16544.4	11809.	8901.9	7281.4

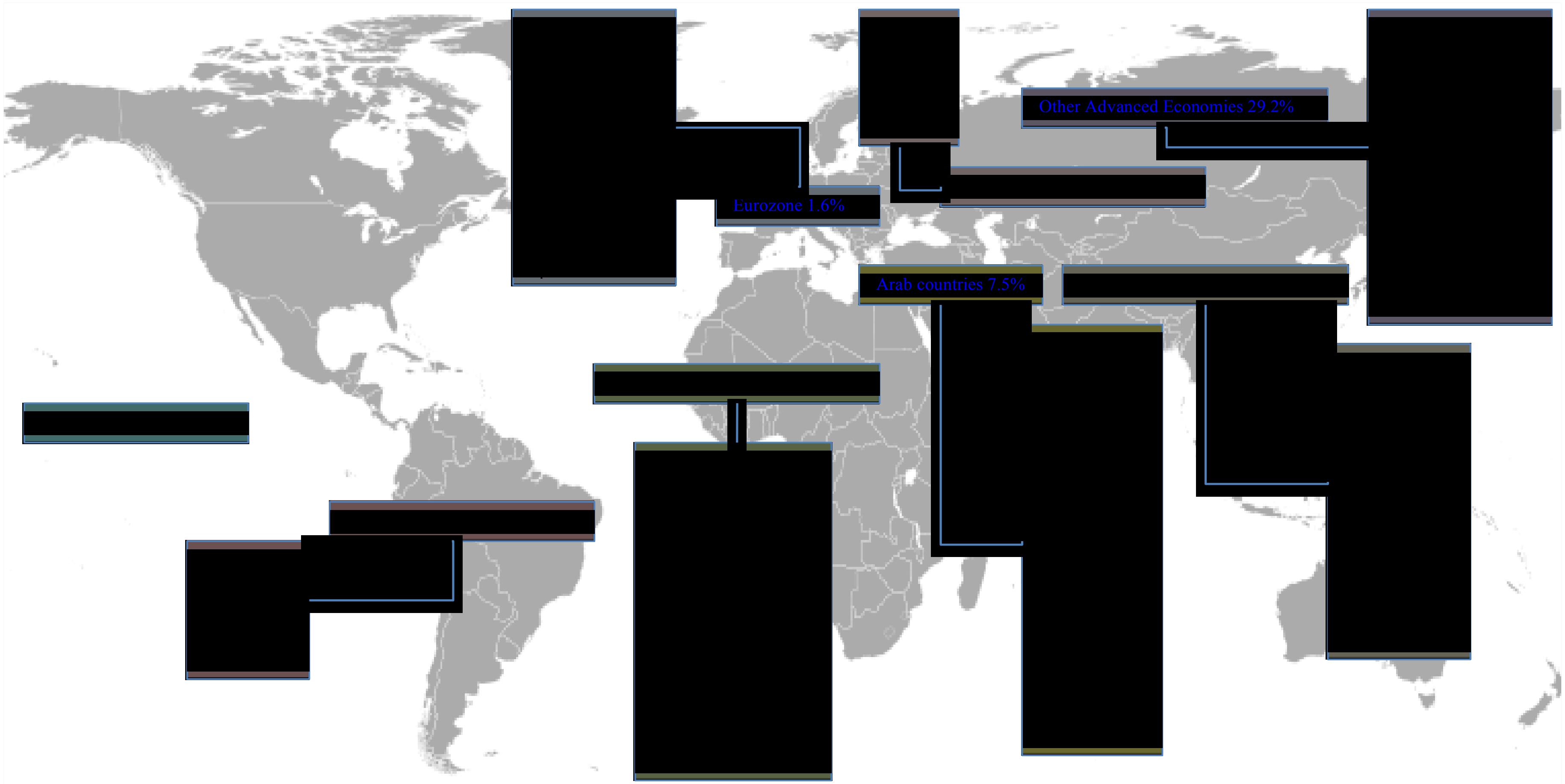
Source: Arab Monetary Fund, Economic Statistics Bulletin, 2015

Table 2.2: Merchandise Exports of UAE to the World (Millions of US$)

Countries	2012	2011	2010	2009	2008	2007	2006	2005
Arab Countries	19497.2	18574.4	15246.6	11765.6	16544.4	11809.0	8901.9	7281.4
Advanced Economies	84054.9	81456.6	54113.3	42096.0	77573.2	56760.8	54347.4	47691.3
Eurozone	4136.1	5687.7	3238.5	2533.1	4249.0	37893.0	2652.0	5587.8
Other Advanced	75768.9	50874.8	39562.9	73324.2	52971.5	51695.4	42103.4	30318.5
Developing Economies	109945.1	97758.9	73684.1	43599.0	64892.6	39747.8	32323.5	23897.3
Non-Arab Asian	105570.6	93087.6	70574.7	41174.4	60769.5	36782.0	29728.4	22210.7
Non-Arab African	3570.2	3857.0	2731.7	2155.8	3302.2	2485.2	2008.9	1451.2
Other European	433.8	257.4	133.2	131.0	202.4	125.9	227.0	135.0
Latin American	370.6	556.9	244.5	137.8	618.5	354.7	359.1	100.4
Rest of the world	45684.8	42594.0	32644.1	24611.4	36789.8	28437.4	24021.3	18608.1
Total	259182.0	240383.9	175688.1	122072.0	195800.0	136755.0	119594.1	97478.1

Source: Arab Monetary Fund, Economic Statistics Bulletin, 2015

Figure 2.12: UAE Merchandise Exports by destination, 2012

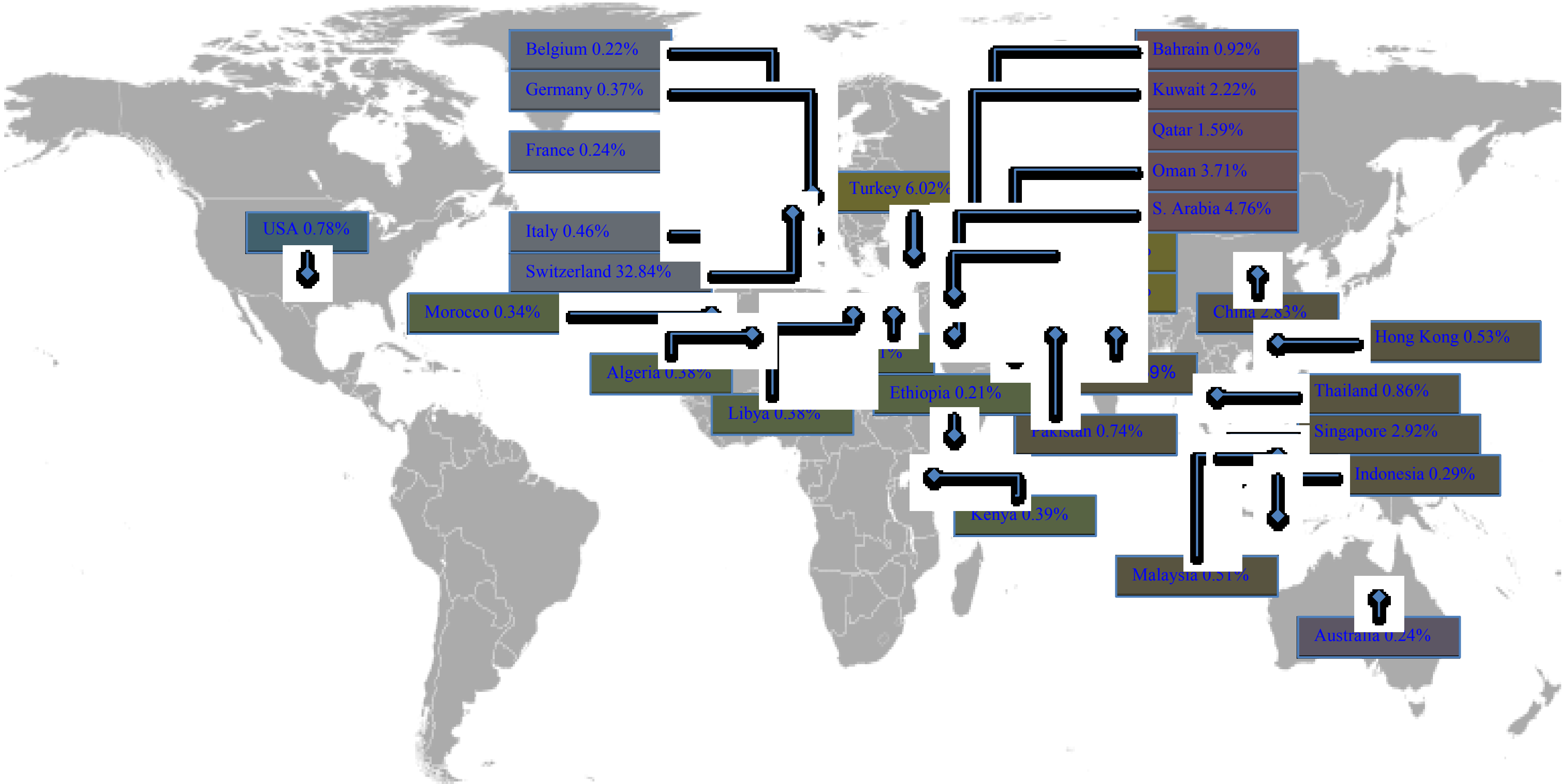


Source: Created by the author for the purpose of this study. Data taken from the Arab Monetary Fund, Economic Statistics Bulletin, 2015

As far as the non-oil exports are concerned, in 2012, the value of non-oil exports to Switzerland reached 15.17 billions US$, forming 32.84 per cent of non-oil exports to the world. For the same year, the value of non-oil exports to GCC region reached 6102.7 millions of US$, accounting for 13.3 per cent of total non-oil exports. Within GCC region, Saudi Arabia ranked first, as the value of non-oil exports to this country reached 2199.6 millions of US$, forming 4.76 per cent of total UAE non-oil exports. In Middle East, the non-oil exports to Turkey reached 2780.9 millions of US$, comprising 6.02 per cent, while the non-oil exports to Iraq and Iran reached 678.03 and 627.01 millions of US$ respectively, accounting for 4.3 per cent of total non-oil exports.

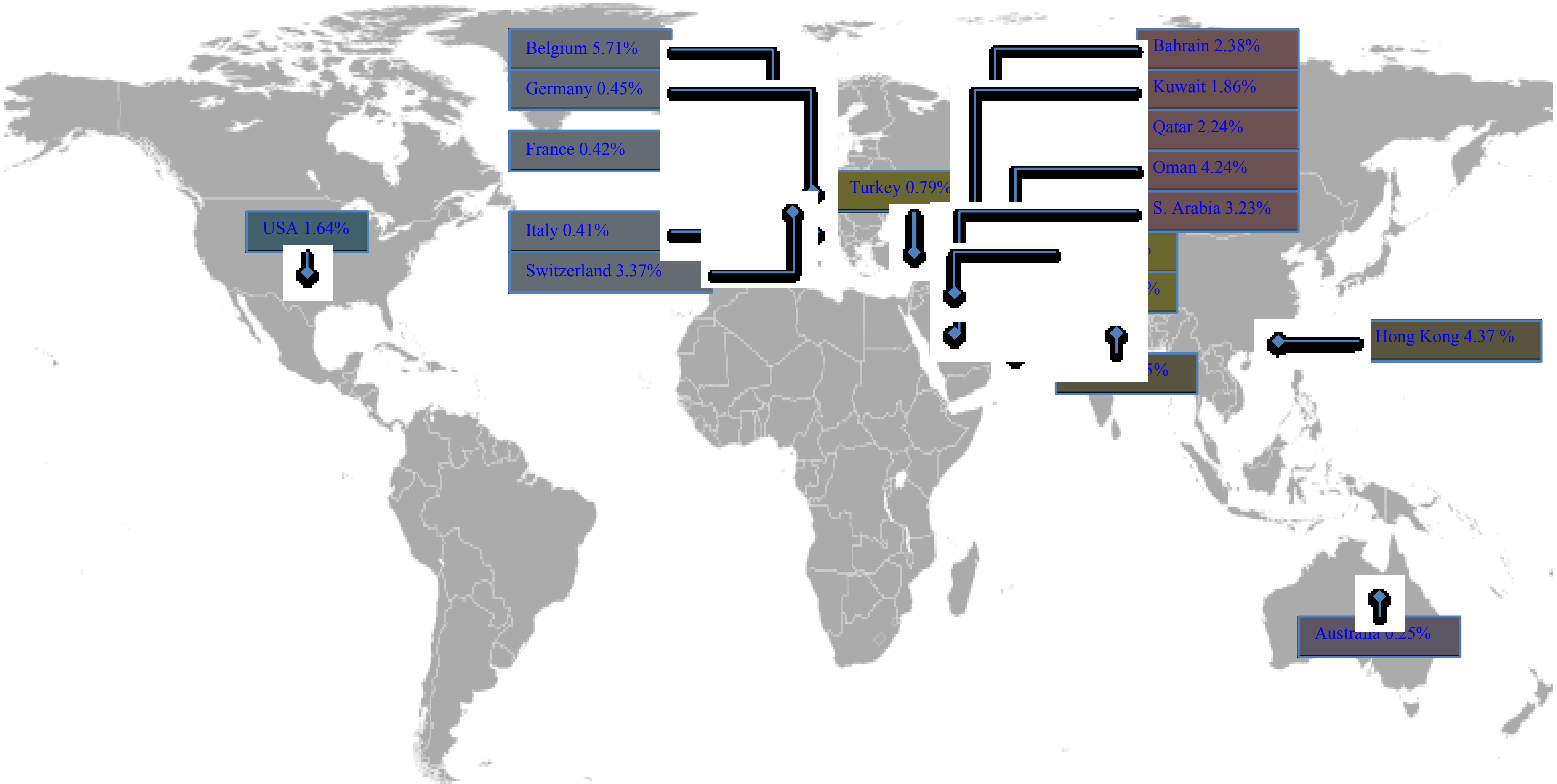
In 2012, the value of re-exports to the GCC region comprises 13.95 per cent of the total re-exports. Within GCC region, Oman ranked first, as the value of re-exports to this country reached 2.53 billions of US$, forming 4.24 per cent of total UAE re-exports. Within Europe, the value of re-exports to Belgium reached 3.40 billions of US$, comprising 5.71 per cent, while re-exports to Switzerland reached approximately 2 billions of US$, accounting for 3.37 per cent of total re-exports. In Middle East, the re-exports to Iran and Iraq reached 11.45 and 2.65 billions of US$ respectively, accounting for 23.69 per cent of total re- exports. Figures 2.13 and 2.14 show the UAE non-oil exports and re-exports by destination in 2012 respectively.

Figure 2.13: Non-Oil Exports by destination, 2012



Source: Created by the author for the purpose of this study. Data taken from the National Bureau of Statistics of UAE

Figure 2.14: UAE Re-Exports by destination, 2012



Source: Created by the author for the purpose of this study. Data taken from the National Bureau of Statistics of UAE

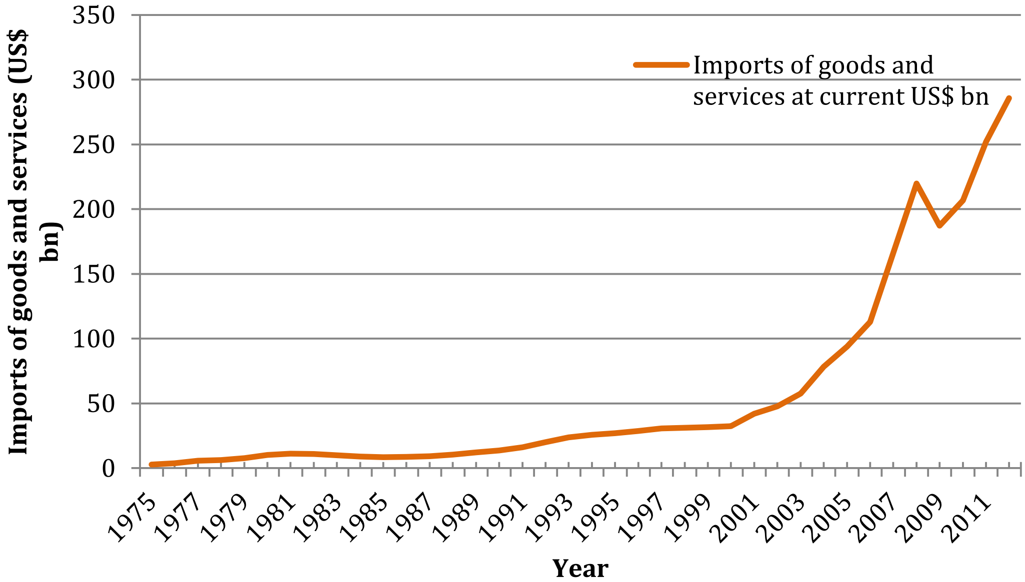
2.3 Imports of Goods and Services

The value of UAE imports in 1975 was estimated around US$2.93 billions, rising to US$285.8 billions in 2012, with an average growth per annum around 14.1%. In particular, during the period 1975-2000 the growth of imports averaged 10.9%, while the average annual growth rate during the period 2001-2012 was around 20.8%. The highest growth rate of imports was 52.6% in 1977, while the lowest was -14.8% in 2009.

In particular, after 1989, the value of imports of goods and services increased gradually, reaching around US$32.5 billions in 2000. Thereafter, the value of imports began to increase dramatically, reaching a total of US$219.7 billions in 2008. It is noticeable that in 2012, the imports of UAE increased by 53 per cent comparing with the 2008 level. Figure 2.15 shows the value of UAE imports of goods and services over the period 1975-2012.

The UAE value of merchandise imports from the Arab countries is limited, comparing to the value of UAE merchandise imports from other countries in the world. In particular, the value of merchandise imports from Arab world is estimated to around 13.62 billions of US$, forming 7.3% of total imports. For the same year, the value of imports from Non-Arab Asian countries reached 74.38 billions of US$, accounting for 39.9 per cent of merchandise imports. It is noticeable that, a significant share of UAE imports inflow from the European and American countries, accounting for around 43% of merchandise imports. In particular, in 2012, UAE imports from European countries and American countries reached 54.33 and 25.73 billions of US$ respectively, while imports from the rest of the world is estimated around 3.1% of total imports. Table 2.3 shows the Merchandise Imports of UAE from the world in 2012.

Figure 2.15: The imports of goods and services in US$ billions for the period 1975-2012



Source: Author's elaboration based on time series data taken from IMF, National Bureau of Statistics of United Arab Emirates (years 1999-2000) and World Bank (years 2010-2012)

Table 2.3: Merchandise Imports of UAE from the World, 2012 (Billions US$)

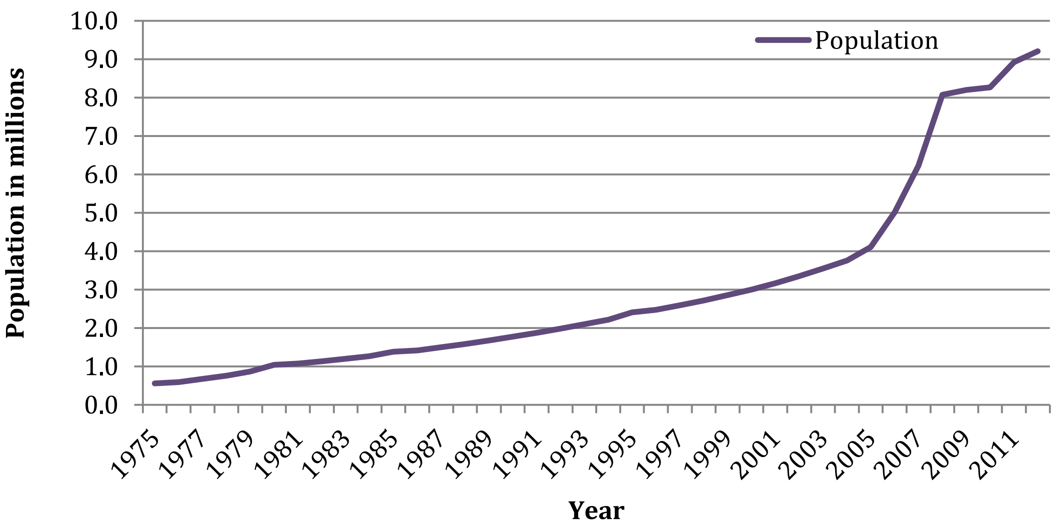
Countries	2012	% of total imports
Arab countries	13.62	7.3%
Non-Arab Asian countries	74.38	39.9%
Total Non-Arab African countries	12.76	6.8%
European Countries	54.33	29.1%
American countries	25.73	13.8%
Oceanic countries	3.09	1.7%
Other countries	2.62	1.4%
Total	186.54	100.0%

Source: Arab Monetary Fund, Economic Statistics Bulletin, 2015

2.4 UAE Population

In the last three decades, the population of UAE has increased from approximately 558 thousands in 1975 to 9.2 millions in 2012, an increase of about 15.5 times (figure 2.16). During the period 1975-2012 the growth of UAE population averaged 8%, while the average annual growth rate during the period 1975-2004 and 2005-2012 was around 7% and 12% respectively. The highest population growth rate was 29.8% in 2008, while the lowest was 0.8% in 2010.

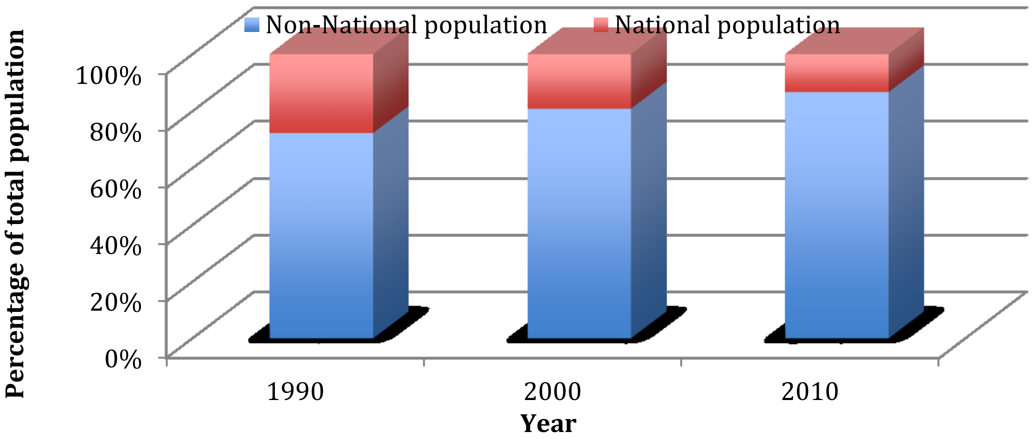
Figure 2.16: Population of UAE over the period 1975-2012



Source: Author's elaboration based on time series data taken from the National Bureau of Statistics of United Arab Emirates

As it can be seen from figure 2.17, in 1990 the Non-national population was estimated around 1.28 millions, representing 72.3 per cent of the total population of UAE. In 2000, the non-national population reached approximately 2.42 millions, while in 2010 it reached 7.16 millions, representing 80.8 and 86.7 of the total population.

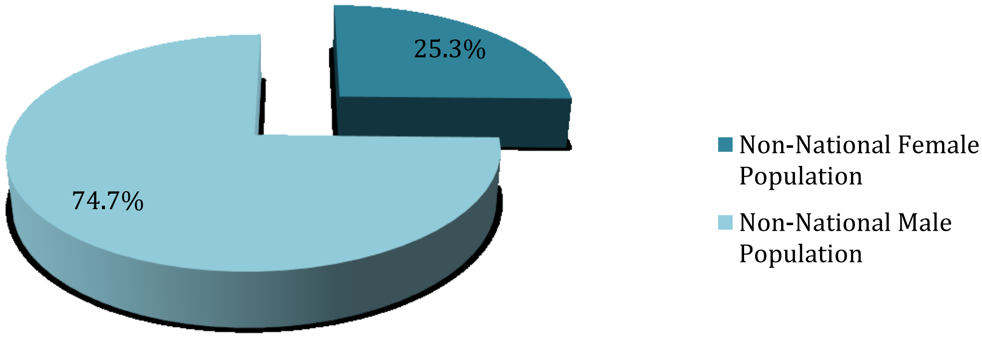
Figure 2.17: National and Non-National population in UAE



Source: United Nations, Trends in International Migrant Stock: The 2013 Revision

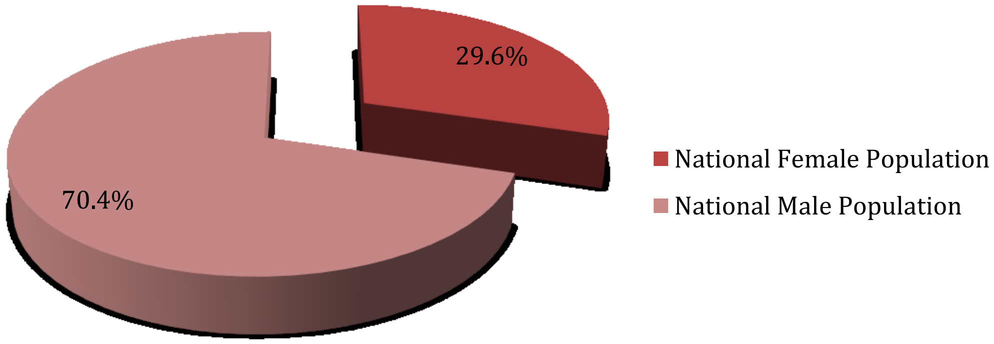
In 2010, the Non-national population was comprised of 1.81 millions females and 5.35 millions males, representing 25.3% and 74.7% of the total non-national population (figure 2.18). As far as the national population is concerned, in 2012, is comprised of 2.72 millions females and 6.47 millions males, representing 29.6% and 70.4% of the total national population (figure 2.19).

Figure 2.18: Female and Male population as a percentage of the Non-National population, 2010



Source: United Nations, Trends in International Migrant Stock: The 2013 Revision

Figure 2.19: Female and Male population as a percentage of the National population, 2012



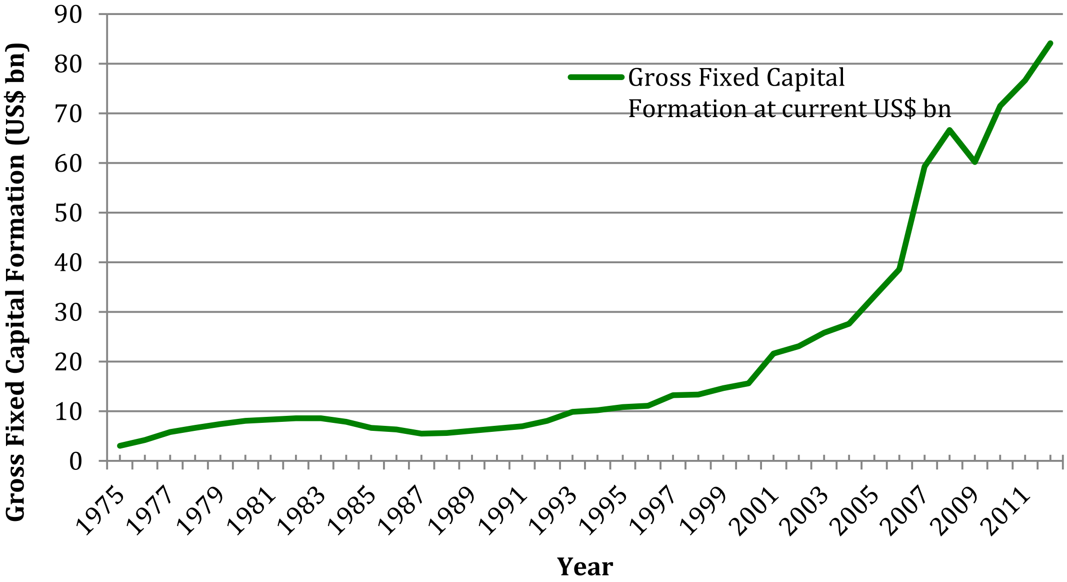
Source: Author's elaboration based on data taken from the Gender Statistics Database, World Bank

2.5 Gross Fixed Capital Formation

In 1975 the Gross Fixed Capital Formation (GFCF) of UAE was estimated at 3.05 billion US$, rising to 8.63 billion US$ in 1982. Between 1983 and 1987, GFCF decreased gradually to US$5.53 billions, when it started to rise steadily until 2000. In 2001, GFCF began to increase dramatically, reaching a total of US$66.70 billions in 2008. Although the value of GFCF of UAE fell during 2009, it increased by 39.7 per cent in 2012, estimated at around 84.19 billion US$ (figure 2.20).

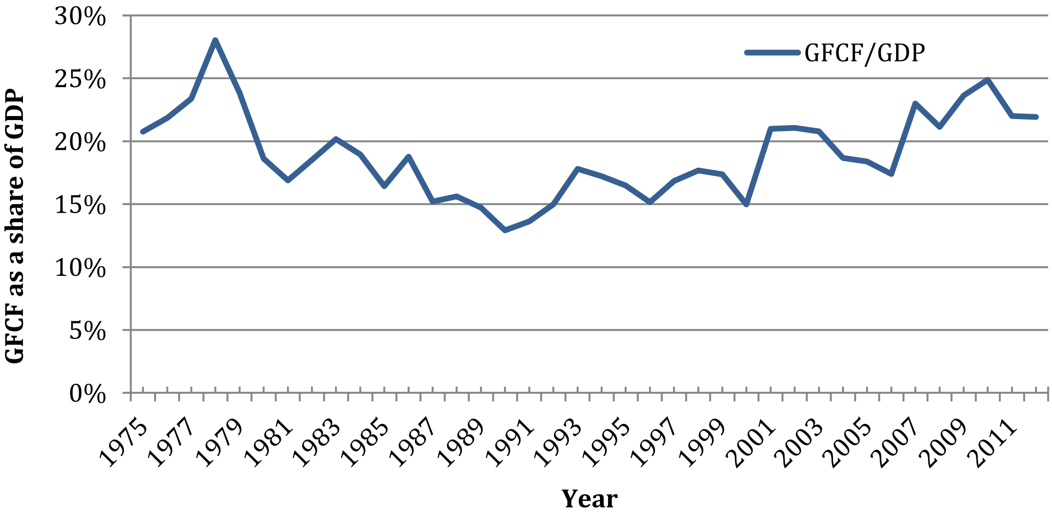
In 1975, GFCF averaged at around 21% of GDP in UAE. This proportion increased to 28% in 1978 and declined to 13% in 1990, which are the highest and lowest share over the period 1975-2012 respectively. During the period 1991-2012, the share of GFCF in GDP averaged at around 19%, a share similar to the share during the period 1975-1990. Figure 2.21 shows the share of GFCF in GDP over the period 1975-2012.

Figure 2.20: Gross Fixed Capital Formation of UAE in US$ billions for the period 1975-2012



Source: Author's elaboration based on time series data taken from IMF, National Bureau of Statistics of United Arab Emirates (years 1999-2000) and World Bank (years 2010-2012)

Figure 2.21: Gross Fixed Capital Formation as a share of GDP over the period 1975-2012



Source: Author's elaboration based on time series data taken from IMF, National Bureau of Statistics of United Arab Emirates (years 1999-2000) and World Bank (years 2010-2012)

CHAPTER 3. LITERATURE REVIEW

3.1 Introduction

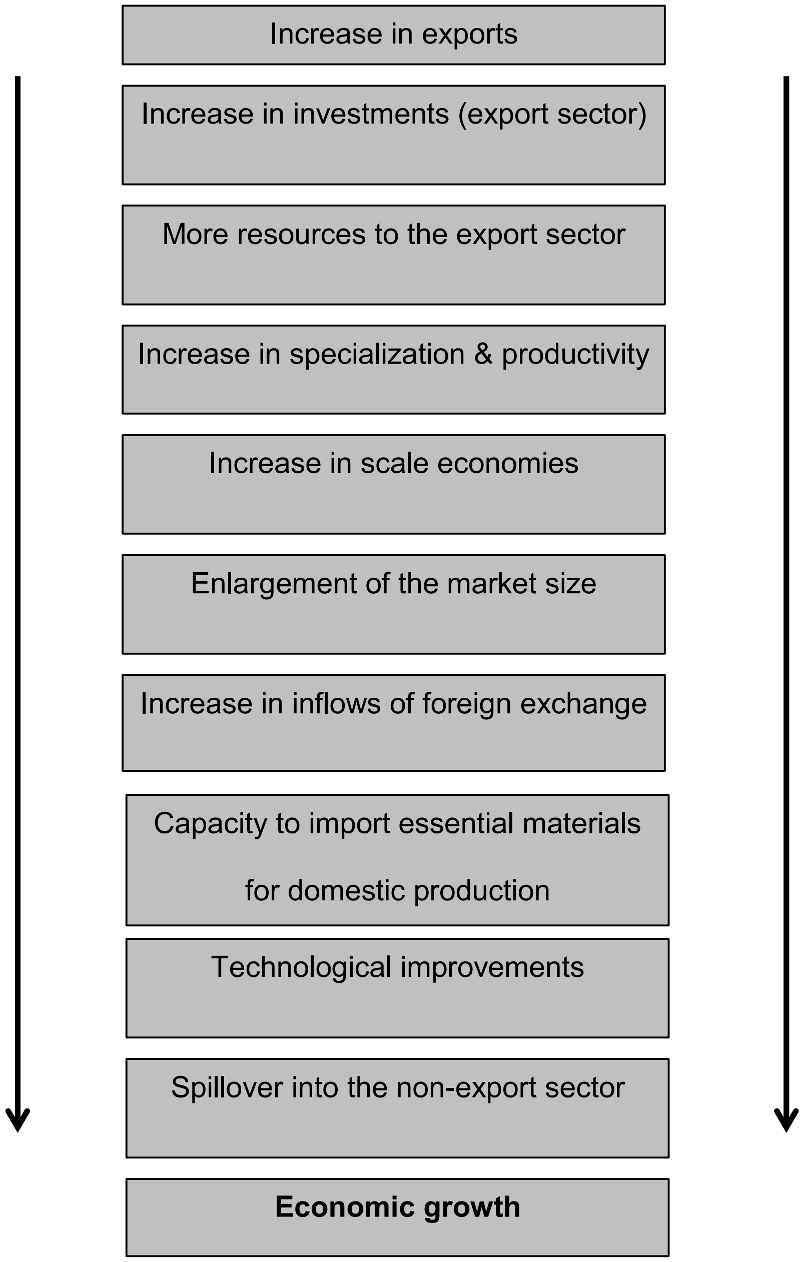
A number of previous studies have found that export growth exerts a positive impact on economic growth, but also it is possible to widen the gap between rich and poor countries. Over the past years, an increasingly larger role granted to exports compared with the post war period, when import substitution and coverage of the rising domestic demand were given the greatest importance by economists. In more recent years, most economists argue that export expansion could have a significant positive impact on economic growth. In addition, some studies demonstrate that this positive impact appears to be particularly strong among the more developed countries and in some cases could be negligible among the least developed countries.

The strategies of export promotion and import substitution are widely used to accelerate the economic growth in developing countries. The import substitution increases the production of the domestic “infant industrial sector”, by substituting the imported goods with goods, which could be produced domestically. This strategy could lead to an increase in both employment rate and national product, developing a strong base for local industry, which can cover the rising domestic demand. However, export-led growth is still the strategy favored by governments in order to enhance economic growth. In the case of ELG, the growth of exports increases technological innovation, covers the domestic and foreign demand and also increases the inflows of foreign exchange, which could lead to greater capacity utilization and economic growth.

Several studies indicate that exports have a statistically significant positive impact on economic growth, through the impact on economies of scale, the adoption of advanced technology and the higher level of capacity utilization (Emery, 1967; Michaely, 1977; Balassa, 1978; Feder, 1982; Lucas, 1988; Al-Yousif, 1997; Vohra, 2001; Abou-Stait, 2005). In particular, export growth increases the inflows of investment in those sectors where the country has comparative advantage and this could lead to the adoption of advanced technologies, increasing the national production and the rate of economic growth. Moreover, an increase in exports causes an increase in the inflows of foreign exchange, allowing the expansion of imports of services and capital goods, which are essential to improving productivity and economic growth (Gylfason, 1998; McKinnon, 1964; Chenery and Strout, 1966). Figure 3.1 depicts the link between exports and economic growth.

However, few studies confirm the negative impact of exports on economic growth (Myrdal, 1957; Berill, 1960; Meier, 1970; Lee and Huang 2002; Kim and Lin, 2009). For example, Berrill (1960) indicates that the export expansion could be an obstacle for the development of small developing countries, while Myrdal (1957) notes that the commercial exchanges between developed and developing countries could widen the gap between them. In addition, Myint (1958) shows that the export growth was not an important factor for economic growth in Asian and African countries.

Figure 3.1: The link between exports and economic growth



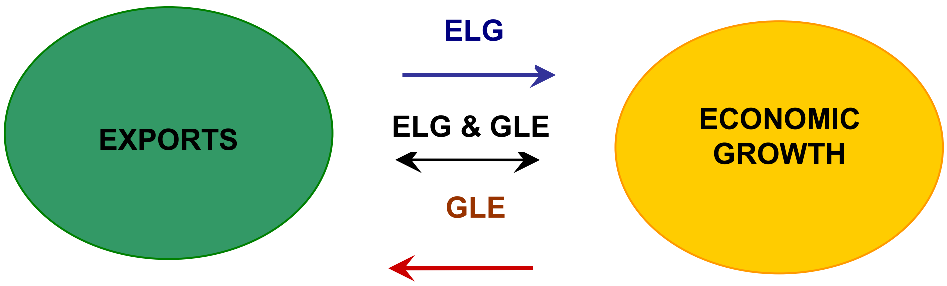
Source: Created by the author for the purpose of this study

A number of previous studies analyse the export effect on economic growth, specifically for developing countries and highlight the differences between developed and less developed countries. These studies conclude that export expansion exerts a positive impact on economic growth for more developed countries and this can be explained by the fact that less developed countries are not characterized by political and economic stability and do not provide incentives for capital investments (Michaely, 1977; Kavoussi, 1984; Kohli and Singh, 1989; Levine et al., 2000; Vohra, 2001; Kim and Lin, 2009).

In addition, other studies such as those by Tyler (1981), Fosu (1990), Ghatak et al. (1997), Tuan and Ng (1998), Abu-Qarn and Abu-Bader (2004), Herzer et al. (2006) and Siliverstovs and Herzer (2006, 2007) investigate the impact of export composition on economic growth, indicating that manufactured exports contribute more to economic growth than primary exports. In particular, the effect of manufactured exports on economic growth can be positive and significant, while the expansion of primary exports can have negligible or negative impact on economic growth. As Herzer et al. (2006) notes, primary exports do not offer knowledge spillovers and other externalities as manufactured exports. In general, as Sachs and Warner (1995) notes, a higher share of primary exports is associated with lower growth.

In more recent years, several studies investigate the causality between exports and economic growth. Most of these studies conclude that causality flows from exports to economic growth and in this case, an export-led growth exists (Thornton, 1996; Ghatak et al., 1997; Ramos, 2001; Yanikkaya, 2003; Awokuse, 2003; Abu Al-Foul, 2004; Shirazi and Manap, 2004; Abu-Stait, 2005; Siliverstovs and Herzer, 2006; Ferreira, 2009; Gbaiye et al., 2013). The growth of exports increases technological innovation, covers the domestic and foreign demand and also increases the inflows of foreign exchange, which could lead to greater capacity utilization and economic growth. In contrast, other studies argue that causality runs from growth to exports (GLE) or conclude that there is a bidirectional causal relationship (ELG-GLE) between exports and economic growth in developing countries (Thornton, 1996; Edwards, 1998; Panas and Vamvoukas, 2002; Abu Al-Foul, 2004; Love and Chandra, 2005; Awokuse, 2007; Narayan et al., 2007; Elbeydi et. al, 2010; Ray, 2011; Mishra, 2011). In the case of growth-led exports, economic growth can cause an increase in exports, by increasing the national production and the country's capacity to import goods and services. In particular, growth creates new needs, which cannot initially be covered by the local production, increasing the country's imports, especially for capital equipment, improving the existing technology (Kindleberger, 1962). It is noticeable that several studies indicate no causal link between exports and economic growth (Jung and Marshall, 1985; Kwan and Cotsomitis, 1991; El-Sakka and Al- Mutairi, 2000; Tang, 2006). Figure 3.2 presents the causal relationship between exports and economic growth.

Figure 3.2: The causality between exports and economic growth



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

The statistical techniques and econometric methods used in the empirical literature are simple correlation tests, OLS, cointegration tests, VAR and causality tests. In particular, most of the earlier studies conducted before 1990 used rank correlation methods in order to examine the relationship between exports and economic growth (Emery, 1967; Michaely, 1977; Heller and Porter, 1978). Subsequent studies examined the relationship between exports and economic growth based on single equation models, using the ordinary least square (OLS) estimation method (Balassa, 1978; Tyler, 1981; Feder, 1982; Kavoussi, 1984; Kohli and Singh, 1989). In contrast, the more recent studies investigate the causal relationship between exports and economic growth, using cointegration techniques, error-correction modeling and Granger causality tests (Jung and Marshall, 1985; Kwan and Cotsomitis, 1991; Ghatak et al., 1997; Al- Yousif, 1997; Al- Yousif, 1999; El- Sakka and Al- Mutairi (2000); Vohra, 2001; Lee and Huang, 2002; Awokuse, 2003; Abu Al-Foul, 2004; Abu-Qarn and Abu-Bader, 2004; Abu Stait, 2005; Love and Chandra, 2005; Al Mamun and Nath, 2005; Siliverstovs and Herzer, 2006; Awokuse, 2007; Kim and Lin, 2009; Elbeydi et al., 2010; Mishra, 2011; Kilavuz and Altay Topcu, 2012; Gbaiye et al., 2013, Hosseini and Tang, 2014).

For this reason, it is important to present these studies in two sections. The first section includes the studies that investigate the impact of exports on economic growth based on simple correlation tests and OLS, while the second section presents the more recent studies that investigate the causal relationship between exports and economic growth.

3.2 The impact of exports on economic growth

The role of exports as an engine for economic growth is a constant subject of debate in the economic growth literature. The classical school of economics argues that trade stimulates the economic growth through exports of surplus (Smith, 1776) and utilization of comparative advantage (Ricardo, 1817). According to these theories, countries can benefit from trade by specializing in the production of those goods, for which their resources are best suited and gaining materials, which could not produce. However, these gains are once for all and could be raised through Free Trade Agreements. In contrast, the indirect gains, so-called “dynamic gains” such as the increase in investments, the inflows of foreign exchange and technology, the imports of capital goods and the specialization in production could accelerate economic growth. It is interesting to note that these theories do not take into account negative factors for economic growth, such as differences in price behaviour between countries and the decreasing demand for primary products, which could lead to deterioration in country’s terms of trade.

According to other theories, trade often strengthens in the first instance the developed countries whose exports consisting of manufacturing products, while the under-developed countries are in danger of deterioration in terms of trade. As noted in Chaudhuri (1989:39), Ricardo argues that trade can increase output if the country imports “the commodity that used the fixed input (land) in production and export non land-using manufactures, but not otherwise” (Chaudhuri,1989:39). Berrill (1960) indicates that the international trade and the export expansion could be an obstacle for the growth of small developing countries. In particular, as Chaudhuri (1989) notes, if trade between low and high income countries lead to the former specializing in the production of labor-intensive goods, trade can be an obstacle for further growth. Specifically, the exports of low-income countries are mainly primary products, which are subject to excessive price fluctuations and have inelastic demand in the export market. Therefore, the export market for the least developed countries is not greatly enlarged. Moreover, the revenues of these exports are directed towards increasing the primary production and this often develop an on-going cycle, widening the gap between developed and developing countries (Myrdal, 1957).

In addition, Myrdal (1957) notes that the commercial exchanges between developed and developing countries could lead to deterioration in the terms of trade, increasing the differences between them. As Myint (1954) argues, the deterioration in terms of trade in developing countries is caused by the differences in price behavior between developed and developing countries and the decreasing demand for primary products.

The study by Meier (1970) demonstrates that an increase in exports of industrial products leads to the expansion of industrial sector and affects positively the domestic income, only if there is an increase of demand for the domestic production. In addition, according to Kindleberger (1962), for a positive effect from exports to economic growth, "there must be capital formation, technical change and reallocation of recourses" (Kindleberger, 1962:204). In addition, Myint (1958) shows that the export growth was not an important factor for economic growth in Asian and African countries.

According to the study by Emery (1967), an increase in the level of exports can lead to an increase in imports and especially to an increase in capital goods which are important in enhancing economic growth. In addition, the export development increases specialization in the production of goods that the country has a comparative advantage. Moreover, the enlargement of the market and the pressure of competition can cause economies of scale and improvements in the quality of country's exports. Emery (1967) notes that except from the direct effects of exports on economic growth, such as the increase in consumption, foreign investment and the adoption of advanced technology, there are some indirect benefits of export growth. In particular, Emery (1967) examines the relationship between exports and economic growth using annual data for 50 countries over the period 1953-1963, using multiple correlations and simple least squares regression. The variables used in this study are the real GNP per capita growth rate, the deflated export growth rate and deflated growth of goods and services (two components of current account). The export data and the current account earnings are deflated using the U.S wholesale price index, while the per capita GNP is obtained by subtracting the annual rate of population growth from GNP growth rate. The results show that countries with higher rates of export growth tend to have high rates of economic growth. This study suggests that countries should adopt policies that can stimulate exports in order to increase the level of economic growth.

This study by Emery (1967) is criticized by Michaely (1977) on the ground that, since exports are included in GNP, a positive correlation between these variables is inevitable. For this reason, Michaely (1977) tried to avoid this problem, using different export variable from his predecessors. His study is confined to 41 less developed countries during the period 1950-1973, examining the hypothesis that “the more rapid the change in exports, the more rapid the economy’s growth” (Michaely, 1977:50). These countries are divided into two groups based on per capita income[1] and the variables, which are used to define this relationship, are the average annual change in the ratio of exports to GNP and the average annual change in per capita GNP. Michaely (1977), using Spearman’s rank correlation, concludes that the relationship between exports and growth seems to be particularly strong among the more developed countries, while it is possible not to exist among the least developed countries. It is interesting to note that article is a valuable contribution to this subject, because the data was taken from the World Bank, compared with other studies, whose data set were mainly taken from previous studies.

Heller and Porter (1978:192) have criticized Michaely’s work, noting that “Michaely’s criticism also applies to his own test”. Heller and Porter (1978) have based their argument on the fact that any change in the growth rate of the exports/GNP will change the growth rate of the per capita GNP in the same direction, even if it causes no change at all in the growth rate of the non export-output. For this reason Heller and Porter (1978), using the data from Michaely’s work, correlate the non export-output growth rate, instead of the rate of per capital GNP, and the rate of exports, both in per capita terms. The results indicate a significant correlation between exports and non-export components of output.

Another criticism on Michaely’s work comes from Balassa (1978). According to Balassa (1978), Michaely's results are considered to be biased, because of the heterogenous sample. For this reason Balassa (1978) investigates the relationship between exports and economic growth in 11 countries, which have already established an industrial base, for the period 1960-1973. In addition, Balassa (1978) examines the subperiods 1960-1966 and 1966-1973, because of policy changes in some of the countries in mid-sixties. This study uses the Spearman's rank correlation between total exports and total output growth as well as between manufactured exports and manufacturing output. The correlation results confirm "the importance of the indirect effects of exports" in the entire period 1960-1973 and in the subperiod 1966-1973. Moreover, this study also investigates the relationship between exports and GNP based on regression analysis for 10 out of 11 countries (Singapore is excluded due to the unavailability of relevant data) for the periods 1960-1966 and 1966-1975. Balassa (1978) includes additional variables in the production function, such as the labour force, domestic capital and foreign capital. The results show that the export expansion permits the exploitation of economies of scale, increases the rate of employment in labour-surplus developing countries and leads to adoption of advanced technologies, covering the increasing domestic and foreign demand.

The study by Tyler (1981) argues that Balassa's sample was relatively small and homogenous and therefore biased as Michaely's. Tyler (1981) extends the earlier study by Balassa (1978) and differs from Michaely's (1977) in that it uses a different method of measuring the export growth variable and a larger sample of developing countries, which is restricted to middle-income countries. This study by Tyler, analyses the empirical relationship between export and economic growth through an inter country cross-section analysis, using data from 55 developing countries over the period 1960-1977 and correlation tests. As it is mentioned above, the lower income developing countries with GNP per capita of US$6300[2] or less are excluded, while 6 out of 55 countries are OPEC oil exporters. Tyler argues that there is a positive and significant relationship between economic growth and export growth and that the use of manufactured exports into the bivariate model instead of total exports has the same results.

The study by Feder (1982) analyses the relationship between export performance and economic growth and especially the contribution of export-oriented sector in growth, for a sample of semi-industrialized less developed countries. This study is based on cross-country regression analysis of growth, using the conventional production function with averaged data over the period 1964-1973. The variables used are the growth rate of GDP in constant prices, share of investment in GDP, growth of population as a proxy for labor force growth and growth of exports in constant prices multiplied by exports share in GDP. In this sample are also included marginally semi-industrialized Arab countries such as Egypt, Morocco, Syria and Tunisia and the results indicate that "economies which shift resources into exports will gain more than inward-oriented economies" (Feder, 1982:71).

Kavoussi (1984) investigates the impact of exports on economic growth, using a large and heterogeneous sample of 73 low and middle-income developing countries, over the period of 1960-1978. The study applies Spearman's correlation test between growth rate of exports and GNP and regression analysis based on a simple production function. Total exports and the share of manufactured goods in total exports are included in the production function as additional inputs of production. Karoussi (1984) finds that there is a positive relationship between exports and economic growth for both middle and low-income countries in the sample, noting that the higher the rate of export growth, the higher the country's growth rate. In addition, the results indicate that in more advanced developing economies, the exports of manufactured exports can strengthen the effects of export expansion on economic growth. It is interesting to note this study includes low-income countries in the sample, in contrast with Tyler's study, in which the lower income developing countries are excluded.

Kohli and Singh (1989) investigate the impact of exports on economic growth over the periods 1960-1970 and 1970-1981. This study follows the study by Balassa (1978) in comparing the relationship between exports and economic growth and uses the same sample of countries and regression equation as Feder (1982). Kohli and Singh compare the export effects on economic growth between 1960s and 1970s and the findings for the first period are similar to those of Feder for the period 1964-1973. In contrast, in the second period, the export variable is statistically significant, but the link between exports and economic growth is weak.

The study by Fosu (1990) argues that the heterogeneity of exports plays an important role in explaining the economic growth differentials between countries. This study uses cross-sectional data for 64 developing countries over the period 1960-1980 and ordinary least squares based on a simple production function. The variables used are the mean annual GDP growth, the growth of capital, measured as the mean annual gross domestic investment as a percentage of GDP, the mean annual labor force growth, mean annual growth of merchandise exports and the average percentage share of manufactured exports in exports. The results indicate that the primary exports have negligible impact on economic growth among the less developed countries. In contrast, the manufacturing export sector has a positive and significant effect on economic growth. Although the period and the sample are almost similar to previous study by Tyler (1981), Fosu adopts different method and comes to opposite conclusions regarding the impact of manufacturing exports on economic growth.

Other studies have found that export growth increases the inflows of investment in those sectors where the country has comparative advantage and this could lead to the adoption of advanced technologies, increasing the national production and the rate of economic growth. As demonstrated by Gylfason (1998), an increase in exports can cause a vast expansion of imports of services and capital goods, which are essential to improving productivity, while the increasing inflows of technology have considerable effects on economic growth. Also, Rodrik (1997) notes that the rate of economic growth is affected by the rate of exports, because of the increase in investments in export-oriented firms and in those that cover the increasing domestic demand.

Most of the early studies that are mentioned above, are based on a single equation model, using the OLS estimation method or simple correlation tests, ignoring the interrelationships between the variables. In contrast, the more recent studies presented in the following section use cointegration tests, vector autoregression model and Granger causality test in order to investigate the direct and indirect causal relationships between the variables.

3.3 The long-run relationship and causality between exports and economic growth

In more recent years, several studies investigate the causality between exports and economic growth. Most of these studies conclude that causality flows from exports to economic growth, while other studies argue that causality runs from growth to exports (GLE) or conclude that there is a bidirectional causal relationship (ELG-GLE) between exports and economic growth. However, few studies indicate no causal link between exports and economic growth.

The study by Jung and Marshall (1985) found that in some countries there is no causal relationship between exports and economic growth. In particular, this study used the Granger causality test and time-series data set taken from IMF for 37 countries, over the period 1950-1981. The results show that there is no causal relationship between exports and economic growth, except from Indonesia, Egypt and Costa Rica, where a unidirectional causal relationship runs from exports to growth. It is interesting to note that countries, which have achieved high level of economic growth in the examined period such as Taiwan, Korea and Brazil, provided no evidence of exports to growth causality. This is in contrast with several studies, which have found that the relationship between exports and economic growth is particularly strong among the more developed countries. In addition, the study by Kwan and Cotsomitis (1991) found that in China the ELG and GLE hypothesis is supported by the data for the period 1952-1985, but during the period 1952-1978, there is no causality between exports and economic growth.

The empirical study by Al-Yousif (1997) examines the existence of a long-run relationship between exports and economic growth in four of the Arab Gulf countries countries, namely Saoudi Arabia, Kuwait, UAE and Oman over the period 1973-1993. This study uses the two-step cointegration technique proposed by Engle and Granger (1987) and the results indicate that there is no long-run relationship between exports and economic growth in these countries. In addition, this study uses an augmented production function with exports, government expenditure and terms of trade as additional inputs of production. Moreover, the framework proposed by Feder (1982) is used in order to examine the impact of exports on economic growth in the short-run. The regression results show that the short-run impact of exports on economic growth is statistically significant and positive for the countries, while the coefficient estimates of the two-sector model indicate that there is a significant effect of the export sector on the other sectors of economy, with a further impact on economic growth.

The study by Ghatak et al. (1997) examines the export-led growth hypothesis for Malaysia over the period 1955-1990. This study focuses on the relationship between the aggregate and disaggregated exports on the real GDP and non-export real GDP, using cointegration and causality testing. The results show that the ELG hypothesis for aggregate exports is valid not only due to the “accounting” effect. In particular, when non-export real GDP is used in the analysis instead of real GDP, the results indicate that aggregate exports also

Granger cause non-export GDP. In addition, Ghatak et al. (1997) uses two production functions, where except from the human and physical capital, manufactured exports, fuel and non-fuel primary exports are included as additional inputs. Specifically, the real gross domestic investment as percentage of real GDP is used as a proxy for physical capital, while the enrolment ratio in primary and secondary school is used as a proxy for human capital. The results suggest that manufactured exports can be considered as “the major engine of growth” for Malaysia for this time period. In other words, this study indicate that manufactured exports have a positive impact on both real GDP and non-export real GDP.

The study by Tuan and Ng (1998) examines the long-run relationship between trade and economic growth in Hong Kong over the period 1961-1995. In particular, trade is first measured by total exports and also measured by domestic exports and re-exports, while GDP is used as a proxy for economic growth. In this study, all variables are expressed in logarithmic form and in both nominal and real terms. Tuan and Ng (1998) perform the Augmented Dickey-Fuller test in order to test the time series properties of the variables, while the Johansen’s cointegration method is applied to examine the long-term effects of total exports and export components on economic growth, using 2 and 3 lags in the estimations. The ADF results indicate that the variables are integrated of order I(1) and a Vector error correction model is specified to test the long-run relationships between exports and GDP. The results of the Johansen cointegration using 2 lags, indicate that a long-run relationship between total exports and economic growth does not exist in both nominal and real terms. In contrast, when total exports are decomposed into domestic exports and re-exports, a long-run relationship exists between the variables, either in nominal or real terms. In addition, the existence of a long-run relationship is examined using only the variables of re-exports and GDP, including time trend in the equation. The variables of re-exports and GDP, either in nominal or real terms are found to be cointegrated. The cointegration results using 3 lags, between the export components and GDP in current and real term are consistent regardless of the lag length, while in the case of re-exports and GDP, the cointegration results are found to be sensitive to the lag length selection. As noted by Tuan and Ng (1998:125), “While no long-run relationship seemingly exists between growth of GDP and total exports, the growth of GDP and export trade are related by components”. In addition, the results show that 1 per cent increase in real domestic exports and real re-exports would increase GDP by 0.7 and 0.2 percent respectively, indicating that “manufacturing operations would have much higher value-added contents than trading firms” (Tuan and Ng (1998:128).

The study by Al-Yousif (1999), re-examines the relationship between exports and economic growth in Malaysia over the period 1955-1996, using data taken from the IMF. As demonstrated by Al-Yousif (1999:68), “previous studies on export-led growth on the case of Malaysia are biased due of the omission of-variable phenomenon”. For this reason, the study by Al-Yousif uses a multivariate model, and specifically a VECM in which capital, labor and the exchange rate exert their impact on exports and economic growth. In particular, this model analyses the relationship between real GDP, real exports, employment index as a proxy for labor, real gross fixed capital formation and the real effective exchange rate of the Malaysian ringett per US dollar. The findings of this study indicate that all the variables under consideration are cointegrated and thus have a long-run relationship. In addition, Granger causality results show that there is a unidirectional causality from real exports to real GDP in the short-run, but not in the long-run. Over the long-run, the results of this study support the internally-generated growth hypothesis.

In addition, some more recent studies have found that there is no causal relationship between exports and economic growth and in some cases, exports do not accelerate economic growth. The study by El-Sakka and Al-Mutairi (2000) examines the relationship between exports and growth in Arab countries, using annual time-series data and different versions of Granger's causality test. This study is based on a bivariate framework and the results show that there is no long-run relationship between exports and economic growth for all the countries under consideration. In the short run, no causal relationship between exports and economic growth exists in the case of Kuwait (1970-1997), Qatar (1970-1995), Libya (1970-1992), Tunis (1970-1998) and Sudan (1970-1997), while there is a bi-directional causal relationship between exports and growth in the case of Oman (1970-1997), Algeria (1970-1996), Egypt (1970-1998), Jordan (1970-1997), Bahrain (1975-1997) and Mauritania (1970-1995). It is noticeable that in the case of UAE (1972-1996) a unidirectional causality runs from growth to exports, while a unidirectional causality runs from exports to growth in Saudi Arabia (1970-1997), Iraq (1970-1993), Morocco (1970-1997) and Syria (1970-1997). According to El-Sakka and Al-Mutairi (2000:164), "This may be partially explained by the fact that abundance of oil revenues in 9 of the 16 countries has, directly or indirectly, negatively affected the development of the export sector in the Arab region. Arab oil-exporting countries got direct benefits out of the high oil prices and foreign exchange inflows".

The study by Vohra (2001) investigates the role of exports on economic growth in India, Pakistan, Philippines, Malaysia and Thailand, using time series data for the period from 1973 to 1993. This study uses a production function augmented with exports and the two–sector model proposed by Feder (1982) in which except from the capital and labor, the exports are included as additional input of production. The analysis is based on the two-step Engle-Granger cointegration test in order to investigate the existence of long-run relationship between exports and economic growth and ordinary least squares to test the short-run relationship between the variables. The countries are separated into two groups based on the gross national product per capita of US$695 or less in 1993. The first group consists of the low-income economies, India and Pakistan and the second of the middle-income countries, Malaysia, Philippines and Thailand. The results of the cointegration test show that there is no long-run relationship between exports and economic growth for all the countries under investigation. The regression analysis demonstrates that exports have a positive and significant short-run impact on economic growth, especially for countries that have already achieved a minimum level of economic development. Specifically, India has negative export coefficient, but it is statistically insignificant, while in the case of the middle-income countries, Malaysia, Philippines and Thailand, exports have a statistically significant and positive impact on economic growth. This is in addition to an earlier study by Michaely (1977), which demonstrated that the relationship between exports and growth seems to be particularly strong among the more developed countries, while it is possible not to exist among the least developed countries.

Lee and Huang (2002) conduct a study to examine the relationship between exports and economic growth in Hong Kong, Japan, Korea, Philippines and Taiwan, using quarterly data over time periods ranging from 1961 to 2000. This study applies the ADF unit root test, Johansen's cointegration test, Granger causality test and multivariate threshold model. The variables used are the GDP, exports, gross fixed capital formation and imports, while are expressed in real terms using the GDP deflator. The labor input of production is not included in the model due to non-availability and therefore the study is based on an augmented AK production function. The cointegration results show that there is no long-run relationship between the variables for all countries, except for Japan. The Granger causality test indicate that there is no evidence to support the Export-led growth relationship for Hong Kong, Korea and Philippines, while the results from the multivariate threshold model indicate that export-led growth relationship is valid for all the countries under investigation except from Hong Kong.

The study by Panas and Vamvoukas (2002) investigates the validity of the Export-led growth hypothesis in the case of Greece. The methodology used in this research involves the Phillips and Perron (1988) unit root test, the Johansen cointegration test and the Granger causality test in the empirical framework of bivariate and multivariate systems. Moreover, the robustness of the causality results is examined by plotting Impulse response functions. This study uses time series data over the period 1948-1997 taken from the National

Statistical Service of Greece and the Bank of Greece. In particular, the variables used in this study are the real Gross National Product, exports in real terms, the index of the nominal effective exchange rate of Greek drachma and the price level calculated by the Consumer Price Index. All data except from the price level, which is used as a percentage, are expressed in logarithmic form. The Phillips Perron unit root test suggests that the variables are integrated of order one, while the johansen cointegration test with one and two lags indicates the existence of a long-run relationship between exports and economic growth in either bivariate or multivariate system. The Granger multivariate tests shows that the null hypothesis of non causality from exports to growth is not rejected for all systems in long-run or short-run. In contrast, the results indicate that output Granger-causes exports in the case of Greece. In addition, the sensitivity vector autoregression analysis shows that the responses of exports to output shock are positive at all periods, which is consistent with the Granger causality results. Therefore, the results of the study by Panas and Vamvoukas (2002) do not support the export-Led growth hypothesis in the case of Greece.

Awokuse (2003) examines the ELG for Canada using quarterly time series data for the period 1961:1-2000:4, taken from IMF. This study, except from the real exports, real GDP and real terms of trade (export unit value divided by import unit value), includes variables that are omitted in most of the previous studies for the Canadian case, such as the labour force, real capital and foregin output shock. In particular, manufacturing employment is used as proxy for labour, gross capital formation as proxy for capital, while industrial production index for all industrialized nations is used as the proxy for foreign output shock. All the variables are expressed in real terms and in logarithmic form. In order to test for the validity of ELG in Canada, this study is based on VECM and the augmented VAR model (MWALD) developed by Toda and Yamamoto (1995). The results from cointegration analysis show that there is a long-run relationship between the variables, while the VECM and MWALD results indicate that the ELG is valid in the long-run. In the short-run, Granger causality test based on VECM confirms the validity of the export-led growth.

In addition, a more recent study by Abu Al-Foul (2004) analyses the relationship between exports and economic growth in Jordan, using annual data over the period 1976-1997. All the data are taken from World Development Indicators and the analysis is based on Hsiao's version of Granger causality test (Hsiao, 1981) in a bivariate framework. The findings of this study indicate that there is a unidirectional causal relationship between exports and economic growth and partially agree with the earlier study by El-Sakka and Al-Mutairi (2000).

The empirical study by Abu-Qarn and Abu-Bader (2004) investigates the relationship between exports and economic growth for nine Middle East and North Africa countries during specified periods. Specifically, this study examines the cases of Algeria, Egypt, Israel, Morocco (1963-1999), Jordan (1976-1998), Sudan (1960-1991), Iran (1976-1999), Tunisia (1963-1998), and Turkey (1966-1996). The methodology used in this research involves the Phillips and Perron unit root test, the Johansen cointegration test and the Granger causality test in the empirical framework of trivariate systems. In particular, the variables used are the real GDP, real total exports, real manufactured exports and real imports taken in constant prices and local currencies, while are expressed in logarithmic form. The cointegration results using total exports in the trivariate system, show that there is a long-run relationship between the variables in the case of Jordan, Egypt, Morocco and Tunisia. In the short-run, Granger causality indicates that a unidirectional causality runs from exports to economic growth in the case of Iran, while in the case of Israel, Sudan and Turkey the causality runs from growth to exports. It is noticeable that there is no causality between total exports and economic growth for Algeria, Egypt, Jordan, Morocco and Tunisia. When manufactured exports are used in the trivariate system, the cointegration results show that a long-run relationship exists between the variables except from Algeria. The Granger causality results show that the causality runs from manufactured exports to growth in the case of Israel and Turkey, while a bidirectional causality exists between growth and exports for Morocco and Tunisia. In addition, GLE is valid in the case of Egypt and no causality is found in the cases of Jordan and Algeria. Therefore, the results of this study demonstrate that "not all exports contribute equally to economic growth" and that the promotion of manufactured exports in MENA region could accelerate economic growth.

In addition, the study by Abou-Stait (2005), investigates the relationship between exports and economic growth in Egypt, using historical data taken from IMF over the period 1977-2003. The Johansen's cointegration test, Granger causality test and Impulse Response Function are applied in order to confirm or not the ELG hypothesis in Egypt for the whole period and also for 1991-2003. The variables used in this study are the GDP, GDP net of exports,

exports, net exports, imports and gross fixed capital formation, expressed in real terms using the GDP deflator. Following the two-sector framework proposed by Feder (1982), the findings for the period 1977-2003 indicate that exports cause economic growth irrespective of the proxy used for growth. For the 1991-2003 sub-period, the results show that the causality runs from economic growth to exports when the GDP is used, while the export-led growth is supported when the GDP net of exports is used. Thus, there is a positive and significant impact of exports on economic growth of Egypt, despite the fact that Egypt's domestic production relies on imported raw materials.

Love and Chandra (2005) examine the Export-led growth hypothesis for South Asia in a bivariate framework, using cointegration and error correction modelling. This study uses annual time-series data taken from IMF and the period for each country in the region is different due to the availability problems. In particular, the period of each country is: India (1950-1998), Nepal (1964-2000), Sri Lanka (1965-1997), Pakistan (1970-2000), Bangladesh (1973-2000), Maldives (1977-2000) and Bhutan (1980-1997). In addition, Love and Chandra (2005:137) uses the period 1980-2000 for each country in order to "ensure some uniformity". The real exports and real GDP figures in form of index number are used as proxies for exports and economic growth, while these variables are expressed in logarithmic form so that the first difference can be interpreted as growth rates. In order to obtain the real terms of the export variable, this study uses the unit export value index, but in the case of Bangladesh, Bhutan, Maldives and Nepal, the consumer price index is used to deflate exports, due to unavailability of export value index. The results indicate that there is a long-run relationship between real exports and real GDP in Bhutan, and Bangladesh, while the causality runs from growth to exports (GLE). In contrast the ELG hypothesis is valid for India, Nepal and Maldives, while no causal relationship exists between real exports and real GDP (index) in Pakistan and Sri Lanka. It is interesting to note that the findings remain the same when the period is reduced to 1980-2000, but the fact that cointegration methodology requires at least 30 years (Gujarati, 2003) should be taken into consideration.

Al Mamun and Nath (2005), investigate the relationship between exports and economic growth in Bangladesh for the period 1976-2003. This study uses quarterly data taken from International Financial Statistics of IMF. In particular, exports of goods and services and exports of goods are used as two alternative measures of exports, while the industrial production index is used as a proxy for economic growth. It is interesting to note that this index is used due to the unavailability of GDP at quarterly frequency for Bangladesh. These variables are expressed in logarithmic form, while the base year for all data series is the year 2000. This study applies the Engle-Granger cointegration test in order to examine the existence of a long-run relationship between exports and industrial production. In addition, the study by Al Mamun and Nath (2005), estimates an Error Correction Model and performs the Granger causality test to investigate the existence of a causal relationship between expose and industrial production. The results of ADF test, including an intercept and trend in the equation suggest that the series are integrated of order one. Moreover, the Engle-Granger cointegration test for the two alternative measures of exports confirms the existence of a long-run relationship between industrial production and exports. The results of the Error

Correction Model and Granger test indicate no short-run causality between these variables, while the long-run causality runs from exports to industrial production.

The study by Herzer et al. (2006), examines the export-led growth hypothesis for Chile using annual time series data over ther period 1960-2001. The variables used in this study are real imports, real exports of manufactured goods and the real primary exports as proxies for exports and the real non-export output as a proxy for economic growth. The traditional inputs of the neoclassical production function, the physical and human capital, are represented by the real capital stock and the working population respectively. All data series are taken from the Chilean Central Bank and are expressed, except from the labour variable, in Chilean pesos at constant 1996 prices and logarithmic form. The study by Herzer et al. (2006) applies the unit root test developed by Perron (1997) and Kapetanios (2002) test in order to test the series for unit root in the presence of structural changes. In addition, the two step Engle-Granger test and the Johansen's cointegration test are used to test for the existence of long-run relationship between the variables. After testing for cointegration, Herzer et al. (2006), estimates a Vector Error Correction Model to test for long-run Granger causality. The results indicate the existence of a long-run relationship between the variables, while a long-run Granger causality runs from human capital, capital stock, capital goods imports, manufactured exports and primary exports to non-export GDP. It is interesting to note that manufactured exports and the exports of primary products are found to have a statistically positive and negative impact on economic growth respectively. According to this study by Herzer et al. (2006:325), "manufactured exports might offer greater potential for knowledge spillovers and other externalities than primary exports". Herzer et al. (2006) confirms the robustness of these results by estimating the Dynamic OLS (DOLS) procedure developed by Saikkonen (1991) which performs well in small samples.

The study by Tang (2006) investigates the causality between exports expansion and economic growth in China over the period 1970-2001, using a trivariate framework. The variables used in this study are real GDP, real exports of goods and services and real imports of goods and services. The Phillips-Perron test is applied to test for the existence of a unit root, while long-run relationship between the variables is examined using the ARDL-bounds test, the Johansen's cointegration test and the Error correction model. The results indicate that there is no long-run relationship between the variables under consideration and therefore, in Granger's sense, no long-run causality exists between exports and economic growth in China.

Siliverstovs and Herzer (2006) perform the Granger non-causality test in Vector Autoregressive model, using annual time series data for Chile, over the period 1960-2001. In this study, the exports are divided into manufactured and primary exports, while all the variables are expressed in real terms. The results show that there is a uni-directional Granger causality from the manufactured exports to the real net of exports GDP, while primary exports does not cause economic growth.

In addition, Siliverstovs and Herzer (2007) examine the export-led growth hypothesis using annual time series data for the same country and over the same period. This study uses Johansen's cointegration methodology to investigate the impact of manufactured and mining exports in the context of the export-led growth hypothesis. In particular, Siliverstovs and Herzer (2007) estimate an augmented neoclassical production function, including the manufactured exports, mining exports and imports of capital goods. As far the human capital and physical capital variables are concerned, this study uses the total working population and the accumulated capital expenditure (using the perpetual inventory method). It is interesting to note that this study uses the Chilean GDP net of mining and manufactured exports, in order to separate the economic influence of exports on output (Greenaway and Sapford, 1994; Ghatak and Price, 1997). All variables, except from human capital, are expressed in real terms and are measured in local currency at constant 1996 prices. The results indicate that there is a unidirectional Granger causality from manufactured exports to economic growth, while a bidirectional causality exists between mining exports and real non-export GDP.

The study by Awokuse (2007) investigates the causal relationship between exports and economic growth in Bulgaria, Czech Republic and Poland, using quarterly data taken from IMF. In particular, the period for each country is: 1994:1–2004:3 for Bulgaria, 1993:1–2002:4 for Czech Republic, and 1995:1–2004:2 for Poland. The study is based on an augmented production function and the variables used are the real GDP growth, real exports, real imports, gross capital formation and labor force. The findings of this study indicate that there is a bi-directional causal relationship between exports and growth in Bulgaria, while in the case of Czech Republic, both the ELG and ILG hypotheses are supported at the 5% level of significance. In addition, the

Granger causality in the case of Poland, runs from imports to economic growth, indicating that imports play an important role in economic growth. This is in contrast with most of the studies, which are based on the general assumption of macroeconomics, that “imports are considered to be a leakage of export revenues, which could lead to a lower rate of growth”.

Narayan et al. (2007) examine the export-led growth hypothesis for Fiji and Papua New Guinea, using annual data taken from the IMF for the period 1960-2001 and 1961-1999 respectively. This study uses a trivariate framework and the variables included are the real GDP, real exports and imports. This study applies the KPSS unit root test in order to investigate the existence of a unit root, the bounds testing procedure developed by Pesaran et al. (2001) and the Granger causality test in order to examine the direction of the causality. In particular, the unit root test shows that all the data series for Fiji and PNG are found to be integrated of order one. In addition, the cointegration test for the case of Fiji indicates a long-run relationship between GDP, exports and imports only when GDP was the dependent variable, while in the case of PNG a long-run relationship exists among the variables only when import is the dependent variable. The results of the Granger causality test, in the case of Fiji, indicate that exports and imports Granger cause GDP in the long-run, while in short-run neutrality exists between the variables. In the case of PNG, in the long-run, exports and GDP Granger cause imports, while in short-run a bi-directional causality exists between GDP and exports. Therefore, the study by Narayan et al. (2007) confirms the existence of ELG-GLE only in short-run and the ELG in the long-run for the case of PNG and Fiji respectively.

Ferreira (2009) examines the causal relationship between exports and economic growth in Costa Rica, using three different models over the period 1960-2007 and 1965-2006. The first model includes real exports and real GDP, while in the second model real imports are included in order to avoid potential variable omission bias. The third model is based on the Cobb-Douglas production function, augmented with real exports. The variables used in this study are real GDP, real gross fixed capital formation, labour force, real exports and real imports. In addition, the above models are also estimated including the US real GDP and a dummy variable as proxies for foreign economic shocks and economic crisis respectively. This study applies the Toda-Yamamoto Granger causality test and except of the conventional unit root tests, it also applies the Zivot- Andrews unit root test with structural break. The results based on the conventional unit root test, ADF, PP, KPSS and modified Dickey-Fuller test (DFGLS) indicate that all the variables are not stationary at level. In contrast, the Zivot-Andrews unit root test with structural break shows that all series are integrated of order one, except of the imports variable. The Granger causality results shows that only in the model where imports are included, the causality runs from exports to economic growth, with and without the inclusion of the exogenous variables. The results also suggest that the relationship between exports and economic growth is affected indirectly through imports, while a direct causality exists from imports to exports, indicating that imports are used as inputs for the export-oriented production.

Kim and Lin (2009) investigate the relationship between trade and economic growth at different stages of economic development, using the instrumental variable threshold regressions approach. This study uses cross-country data for 61 countries over the period 1960–2000, which is taken from the study by Levine et al. (2000), extended the sample into 2000 with data from the World Development Indicators. Three theoretical models are used in this study, where the growth rate of real GDP per capita is used as a proxy for long-run economic growth, while the logarithm of investment as a share of GDP and total factor productivity growth are used alternatively as dependent variables. In addition, the logarithm of sum of imports and exports over GDP is used as proxy for trade, while exports and imports as a share of GDP are included separately in the equation for robustness check. Kim and Lin (2009) note that the export effects vary between countries, depending on the level of income and the absorptive capacity of each country. The results indicate that trade has significant and positive impact on economic growth in high-income countries, while there is a negative relationship between these variables for the less developed countries.

The study by Elbeydi et al. (2010) examines the relationship between exports and economic growth for Libya over the period 1980-2007. This study is based on the Johansen cointegration test and Granger causality test in a trivariate framework, using annual data for GDP, exports and exchange rate from local and international sources, such as the Central Bank of Libya, Research and Statistics Department Planning and Programming Department/Public Planning Council and World Development Indicators. The cointegration results show that a long-run relationship exists between the variables, while based on the significance of the lagged error correction coefficients, a long-run bidirectional causation exists between exports and economic growth. Thus, the results of this study suggest that exports promotion policies could contribute to Libya’s economic growth.

The study by Mishra (2011) investigates the export-led growth hypothesis for India using annual data for the period 1970-2009. Mishra (2011) uses the sum of oil and non- oil exports as a proxy for total exports, while real GDP is used as a proxy for economic growth. All data series are taken from the Handbook of Statistics on Indian Economy, published by Reserve Bank of India, and are expressed in logarithmic form. Mishra (2011) applies the Johansen's cointegration test in order to test whether a long-run relationship exists between the variables, the error correction model technique to indicate the speed of adjustment from the short-run equilibrium to the long-run equilibrium and the Granger causality test. Before applying the unit root test and estimating the error correction model, Mishra (2011), calculates the Pearson's correlation coefficient in order to examine the relationship between the variables. In particular, exports and real GDP are found to be positively and strongly correlated with each other. The results of the cointegration test indicate the existence of a long-run relationship between total exports and economic growth. In addition the estimation of the VECM shows a long-run unidirectional causality from economic growth to exports at 10% significance level, while indicates the absence of short-run causality from economic growth to exports or from exports to economic growth. The standard Granger causality test confirms the VECM results, indicating that there is no short-run causality between exports and economic growth at 5% significance level. Therefore, this study provides evidence of growth-driven exports in the long-run for India over the period 1970-2009.

The study by Zang and Baimbridge (2012) examines the relationship between exports, imports and economic growth for Japan and South Korea, using seasonally adjusted quarterly time series data for the period 1957-2003 and 1963-2003 respectively. The data is taken from International Monetary Fund-International Financial Statistics and the variables used are real GDP, real imports and real exports, which are expressed in logarithmic form. Nominal GDP of Japan and South Korea is deflated using GDP deflator, while exports and imports of Japan are deflated using export price index and import price index respectively. In the case of South Korea, imports and exports are deflated using unit value of imports and unit value of exports, due to unavailability of imports and export price indices. This study applies the Augmented Dickey Fuller unit root test, the Johansen cointegration test, a Vector Error Correction model and Granger causality test. The unit root test results indicate that the series are integrated of order one, while the cointegration test results indicate the existence of one cointegrating equation between the variables for both Japan and South Korea. The short-run causality test results for Japan indicate no relationship between real GDP and real exports as the joint test of the coefficients of the lagged differenced variables of exports is not statistically significant from zero. In South Korea, a negative effect from real GDP to real exports exists, as the sign of the sum of the estimated coefficients of lagged differenced variables of exports is negative. Moreover, there is no long-run effect amongst real GDP, real exports and real imports for South Korea, but a positive long-run effect exists from real exports to real GDP in the case of Japan. As Zang and Baimbridge (2012:370) noted, “The long-run effect on economic growth that exports appear to possess could be seen as a possible solution to aid its depressed domestic economy".

The study by Kilavuz and Altay Topcu (2012) investigates the impact manufacturing industry exports on growth over the period 1998-2006, using data for 22 developing countries, including Algeria and Egypt. This study uses OLS and PCSE, within the framework of two models. In the first model, the variables used are the real GDP growth rate, the share of real investment in real GDP, the growth of population and the share of the high and low-tech real manufacturing exports in real GDP. In the second model, the share of high and low-tech real manufacturing imports in real GDP were also included in the analysis. The estimation results of the first model have shown that the investment and high-tech manufacturing industry export variables have a positive and significant effect on growth. In addition, the impact of low-tech manufacturing industry export and population variables are found to be positive and insignificant. These results are in line with those by Cuaresma and Wörz (2005) who investigated the effect of export classifications on growth. The results of the second model were not different from the initial analysis in terms of the common variables, while the effect of low-tech manufacturing imports and high-tech manufacturing imports on economic growth are found to be positive and negative respectively. Therefore, the study by Kilavuz and Altay Topcu (2012:213) suggests that "a foreign trade policy that encourages high-tech manufacturing industry export and imports of low-tech goods for production, and thus for export, is essential for sustained growth".

Gbaiye et al. (2013) investigate the existence of a long-run relationship between agricultural exports and economic growth for Nigeria over the period 1980-2010, based on the Export-led growth hypothesis and the Neo-Classical Growth Model. This study applies the Augmented Dickey Fuller (ADF) and Phillip Peron tests in order to examine the existence of a unit root in all data and the Johansen cointegration test to investigate the long-run relationship between the variables. This study employs an augmented production function, using the real GDP as a proxy for economic growth, the agricultural exports, the Gross Fixed Capital Formation, the labor force and the Foreign Direct Investment. The results indicate that there is a long-run relationship between agricultural exports and economic growth. In particular, a unit increase in agricultural exports can cause a more than proportionate increase in the real GDP in Nigeria. Gbaiye et al. (2013:4) notes that “the tradability of Nigerian agricultural products in the world markets must be increased. This can be achieved through crop specialization, linking farmers more directly to markets and creating strong supply-chains”.

Kaberuka et al. (2014) investigate the validity of the export-led growth hypothesis in Uganda over the period 1960-2010, using the ADF unit root test, Johansen’s cointegration test, error correction model and Pairwise Granger causality test. The analysis is also performed over two sub-samples, the first covers the period 1960-1987, while the second sub-period covers the period after trade liberalization, 1988-2010. This study is based on an augmented growth model, where exports and imports are included as additional inputs of production. In particular the variables used in this model are the logarithms of real gross domestic product, real gross fixed capital formation, total labour force, real exports of goods and services, real imports of goods and services and degree of openness. In addition, after applying the CUSUM test and Chow-breakpoint test, a dummy for trade liberalization is used for the full sample, which takes the value of 1 for the years after 1988 and zero for the years 1960-1987. The unit root results indicate that the variables are integrated of order one, while the cointegration results for the three models show that the variables are cointegrated. The estimated ECM suggests that the effect of exports is positive and statistically significant, implying that a 10 percent increase in exports leads to 4 percent increase in economic growth. The Pairwise Granger causality test at level, indicates that the Export-led growth hypothesis is rejected for the period model 1960-2010 and for the model 1960-1987. In contrast, the Export-led growth hypothesis cannot be rejected for the post-trade liberalization model 1988-2010.

The study by Hosseini and Tang (2014) investigates the causal relationship between oil and non-oil exports in Iran, using the Johansen's cointegration test and the Granger causality test in VECM framework. This study is based on a two-input production function augmented with oil exports, non-oil exports and imports of goods and services, using annual data over the period 1970-2008. This study, except from the ADF and DF unit root tests, applies the Lee and Strazicich unit root test with one and two structural breaks. The conventional unit root tests results show that all variables are integrated of order one, while the Lee-Strazicich test suggests that the labour force is stationary at level. The cointegration results indicate that a long-run relationship exists between the variables, while all the variables are found to have positive effect on economic growth, except from oil exports and imports. Moreover, this study shows that oil and gas exports and non-oil exports Granger cause economic growth, indicating that the ELG hypothesis is valid in the short-run in the case of Iran. In addition, a bidirectional causality is found between imports-economic growth and capital-economic growth.

3.4 Conclusions

Most of the earlier studies mentioned above have found a positive correlation between exports and GDP. In particular, an increase in exports raises the level of GDP and for this reason a positive correlation between the exports and GDP variables is inevitable (Ahmad, 2001). In addition, the use of the correlation coefficient as evidence of export-led growth is not adequate, as the correlation coefficient does not show the direction of the causality (Ekanayake, 1999).

In addition, some empirical studies have found that the ELG hypothesis is valid, based on the statistical significance of the coefficient of the export variables, which is not an appropriate way to draw conclusions for the causal relationship between exports and economic growth (El-Sakka and Al-Mutairi, 2000). As El-Sakka and Al-Mutairi (2000:155) notes, “if a bi-directional causality between these two variables (exports and output) exists, the estimation and tests used in the impact studies are inconsistent”. In addition, the estimation of a single equation time series suffers from misspecification problem, as causality does not necessarily run from exports to economic growth.

It should be noted that most of the empirical studies have used bivariate or trivariate models to test the ELG hypothesis and this might led to misleading and biased results, as causality tests are sensitive to omitted variables. To overcome this problem, the present study included variables omitted in previous studies, such as capital accumulation, population and imports of goods and services.

In addition, earlier empirical studies have been based on a single-equation model in order to test the validity of ELG hypothesis, ignoring the existence of interrelationships, while the majority of the more recent studies investigates the existence of a long-run causality in an ECM context. Nevertheless, in the case of multivariate ECMs, it is not possible to indicate which explanatory variable causes the dependent variable. In addition, the test of a long-run relationship based on ECMs requires pretesting for the cointegrating rank and this may result in overrejection of the non-causal null, due to pretest biases. For this reason, except from the causality test in VECM context, this study used the Toda Yamamoto Granger causality test, overcoming the limitations of previous studies. The following chapter presents the data and accounts for the econometric methodology adopted.

CHAPTER 4. METHODOLOGY AND DATA

4.1 Methodology

4.1.1 Theoretical Framework

The classical school of economics argues that trade stimulates the economic growth through exports of surplus (Smith, 1776) and utilization of comparative advantage (Ricardo, 1817). According to these theories, countries can benefit from trade by specializing in the production of those goods, for which their resources are best suited and gaining materials which could not produce. The Neoclassical trade theory is based on the principles of comparative advantage, but in contrast with the classical theory, assumes two production factors (Krugman and Obstfeld, 2006; Feenstra, 2008).

This research proposes five theoretical frameworks to investigate the validity of the ELG hypothesis in UAE:

Model 1: Y= *f* (K, HC, X, IMP) (4.1.1.1)

Model 2: Y= *f* (K, X, IMP) (4.1.1.2)

Model 3: Y= *f* (K, HC, PM, MX, IMP) (4.1.1.3)

Model 4: Y= *f* (K, HC, FX, IMP) (4.1.1.4)

Model 5: Y= *f* (K, HC, NOILX, REX, IMP) (4.1.1.5)

Where Y represents GDP, while K, HC, X, IMP represent the physical capital, human capital, merchandise exports and imports of goods and services. In addition PX, MX, FX, NOILX and REX represent primary exports, manufactured exports, fuel and mining exports, non-oil exports and re-exports respectively.

According to Dreger and Herzer (2013) when imports are included "the estimated effect of exports on output through productivity would preclude any effect operating through the import channel". In other words, if the earnings of exports are used to import all the necessary capital goods for the domestic production, by including imports in the model, the effect of exports via imports would be eliminated. In contrast, as Riezman et al. (1996) suggest, the imports should be included in the estimation, because the omission of this variable could lead to biased results. This is because imported goods can be considered as inputs for export-oriented production. Based on Riezman at al. (1996), this study includes imports in the estimates, as in UAE, imports of goods and services are used as inputs for the merchandise exports and especially for diversified exports.

Another issue raised by Ghatak and Price (1997), Herzer et al. (2006), Heller and Porter (1978) and Michaely (1977), is that since exports (X_t), via the growth accounting identity, are component of output (Y_t), a positive correlation between these variables is almost inevitable. However, the study by Atukeren (1994) has shown that Granger-causality tests do not suffer from an accounting identity relationship. In particular, a variable X does not Granger-cause Y if the only relationship between the two is an accounting identity.

Following Atukeren (1994), this study uses the real GDP as proxy for economic growth.

This research starts with the AK production function augmented with exports and imports, where capital can include physical capital as well as human capital and R&D capital (Romer, 1986; Lucas, 1988) and continues with the augmented Cobb-Douglas neoclassical production function augmented with exports and imports. The models are presented in the following section.

4.1.2 Theoretical models

Model 1

The present study examines the relationship between merchandise exports and economic growth, assuming that the aggregate production of the economy can be expressed as a function of physical capital, imports and merchandise exports:

$$Y_t = A_t K_t^{\alpha}, \alpha=1 \quad (4.1.2.1)$$

Where Y_t denotes the aggregate production of the UAE economy at time t, A_t is the total factor productivity, while K_t represents the physical, human and R & D capital. As it is mentioned above, in order to examine the impact of exports via changes in productivity, it is assumed that the productivity parameter can be expressed as a function of merchandise exports, X_t, imports of goods and services, IMP_t and other exogenous factors $C_{t:}$

$A_t = f(X_t, IMP_t, C_t) = X_t^{\beta} IMP_t^{\gamma} C_t$ (4.1.2.2)

Combing the equation (4.1.2.1) and (4.1.2.2) the following equation is obtained:

$Y_t = C_t K_t^{\alpha} X_t^{\beta} IMP_t^{\gamma}$ (4.1.2.3)

Where α, β and γ represent the elasticities of production with respect to the inputs of production: K_t, X_t and IMP_t. After taking the natural logs of both sides of equation (4.1.2.3), the following equation is obtained:

$LY_t = c + \alpha LK_t + \beta LX_t + \gamma LIMP_t + \varepsilon_t$ (4.1.2.4)

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

<u>Model 2</u>

The ELG hypothesis is also examined, assuming that the aggregate production of the economy can be expressed as a function of physical capital, population, imports and merchandise exports:

$Y_t = A_t K_t^{\alpha} HC_t^{\beta}$, $0 < \alpha + \beta < 1$ (4.1.2.5)

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

$$A_t = f(X_t, IMP_t, C_t) = X_t^{\gamma} IMP_t^{\delta} C_t \qquad (4.1.2.6)$$

Combing the equation (4.1.2.5) and (4.1.2.6) the following equation is obtained:

$$Y_t = C_t K_t^{\alpha} HC_t^{\beta} X_t^{\gamma} IMP_t^{\delta} \qquad (4.1.2.7)$$

Where α, β, γ and δ represent the elasticities of production with respect to the inputs of production: K_t, HC_t, X_t, and IMP_t. After taking the natural logs of both sides of equation (4.1.2.7), the following equation is obtained:

$$LY_t = c + \alpha LK_t + \beta LHC_t + \gamma LX_t + \delta LIMP_t + \varepsilon_t \qquad (4.1.2.8)$$

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

Model 3

In addition, the present study tests the ELG hypothesis assuming that the aggregate production of the economy can be expressed as a function of physical capital, human capital, primary exports, manufactured exports and imports, following Siliverstovs and Herzer (2006):

$$Y_t = A_t K_t^{\alpha} HC_t^{\beta}, \quad 0< \alpha+\beta <1 \qquad (4.1.2.9)$$

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

$$A_t = f\,(PX_t, MX_t, IMP_t, C_t) = PX_t^{\gamma} MX_t^{\delta} IMP_t^{\zeta} C_t \qquad (4.1.2.10)$$

Combing the equation (4.1.2.9) and (4.1.2.10) the following equation is obtained:

$$Y_t = C_t K_t^{\alpha} HC_t^{\beta} PX_t^{\gamma} MX_t^{\delta} IMP_t^{\zeta} \qquad (4.1.2.11)$$

Where α, β, γ, δ and ζ represent the elasticities of production with respect to the inputs of production: K_t, HC_t, PX_t, MX_t and IMP_t. After taking the natural logs of both sides of equation (4.1.2.11), the following equation is obtained:

$$LY_t = c + \alpha LK_t + \beta LHC_t + \gamma LPX_t + \delta LMX_t + \zeta IMP_t + \varepsilon_t \qquad (4.1.2.12)$$

Where c is the intercept, the coefficients α, β, γ, δ and ζ are constant elasticities, while ε_t is the error term.

Model 4

In addition, the fuel and mining exports are disaggregated from primary exports to investigate whether this export category causes economic growth in UAE. To do this, it is assumed that the aggregate production of the economy can be expressed as a function of physical capital, human capital, fuel-mining exports and imports.

$$Y_t = A_t K_t^{\alpha} HC_t^{\beta}, 0< \alpha+\beta <1 \qquad (4.1.2.13)$$

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

$$A_t = f(FX_t, IMP_t, C_t) = FX_t^{\gamma} IMP_t^{\zeta} C_t \qquad (4.1.2.14)$$

Combing the equation (4.1.2.13) and (4.1.2.14), the following equation is obtained:

$$Y_t = C_t K_t^{\alpha} L_t^{\beta} FX_t^{\gamma} IMP_t^{\zeta} \qquad (4.1.2.15)$$

Where α, β, γ and ζ represent the elasticities of production with respect to the inputs of production: K_t, HC_t, FX_t and IMP_t. After taking the natural logs of both sides of equation (4.1.2.15), the following equation is obtained:

$$LY_t = c + \alpha LK_t + \beta LHC_t + \gamma LFX_t + \zeta IMP_t + \varepsilon_t \qquad (4.1.2.16)$$

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

Model 5

Moreover, the present study tests whether diversified exports cause economic growth, assuming that the aggregate production of the economy can be expressed as a function of physical capital, human capital, imports, non-oil exports and re-exports. This study follows Tuan and Ng (1998) and Hosseini and Tang (2014) in defining the export variables used in this model:

$$Y_t = A_t K_t^{\alpha} HC_t^{\beta}, 0< \alpha+\beta <1 \qquad (4.1.2.17)$$

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

$$A_t= f\,(NOILX_t, REX_t, IMP_t, C_t) = NOILX_t^{\gamma} REX_t^{\delta} IMP_t^{\zeta} C_t \qquad (4.1.2.18)$$

Combing the equation (4.1.2.17) and (4.1.2.18) the following equation is obtained:

$$Y_t = C_t K_t^{\alpha} HC_t^{\beta} NOILX_t^{\gamma} REX_t^{\delta} IMP_t^{\zeta} \qquad (4.1.2.19)$$

Where α, β, γ, δ and ζ represent the elasticities of production with respect to the inputs of production: K_t, HC_t, $NOILX_t$, REX_t and IMP_t. After taking the natural logs of both sides of equation (4.1.2.19), the following equation is obtained:

$$LY_t = c + \alpha LK_t + \beta LHC_t + \gamma LNOILX_t + \delta LREX_t + \zeta IMP_t + \varepsilon_t \qquad (4.1.2.20)$$

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

4.2 Variables and Data Sources

In most of the previous studies on the relationship between exports and economic growth, the variables used are the nominal or real total exports and nominal or real GDP. In the first two models of the present research, the export variables consist of merchandise exports, while in the third model, real primary exports and real manufactured exports are used as proxies for exports, following Siliverstovs and Herzer (2006). In the models 4 and 5, the exports are disaggregated into fuel and mining exports, non-oil exports and re-exports following Hosseini and Tang (2014) and Tuan and Ng (1998). In addition, except from the export variables, the variable of imports of goods and services is employed as additional input of production following Riezman et al. (1996). Moreover, this study uses the population as a proxy for human capital in the analysis, following Medina-Smith (2001). In all models, real GDP is used as a proxy for economic growth.

In particular, this research uses annual time series for UAE over the period 1975-2012, obtained from the World Bank, the International Monetary Fund, the World Trade Organization and the UAE National Bureau of Statistics. Specifically, the Gross Domestic Product (Y) and merchandise exports (X) are derived from the World Development Indicators- World Bank, while the population (HC) is taken from the UAE National Bureau of Statistics. Imports of goods and services (IMP) and Gross Fixed Capital Formation (K) are taken from the IMF International Financial Statistics, UAE National Bureau of Statistics and World Bank. The merchandise exports are disaggregated into primary (PX) and manufactured exports (MX), according to Revision 3 of the

Standard International Trade Classification (SITC) and are derived from the World Trade Organization-Time Series on International Trade. In addition non-oil exports (NOILX) and re-exports (REX) are obtained from National Bureau of Statistics of UAE.

The data used in this research may have a number of limitations. First, given the data availability, the sample period for model one and two is from 1975 to 2012, whereas the examined period for the disaggregated models is limited to 1981-2012. Second, the data for Gross Fixed Capital Formation and for Imports of goods and services comes from several sources. In order to employ a consistent series for these two variables, the time series for the periods 1975-1998 and 2001-2009 are taken from the IMF and are evaluated by comparing them with the available data obtained from the World Bank and the National Bureau of Statistics. The missing data for the years 1999-2000 are obtained from the National Bureau of Statistics of UAE, while the data for the more recent period 2010-2012 are taken from the World Bank.

In addition, the data related with the labor force or statistics regarding employment was not obtainable for the period 1975-2012. In particular, the total labor force was available from the World Bank only for the period 1990 to 2012, while the employment to population ratio, 15+ total (%) from the International Labour Organization (ILO) was only available for the years from 1991 to 2012. The limited size of these series can cause robustness concerns and for this reason are not included in the models. Previous studies with the same issue of data availability have used the population growth as a proxy for labor force, however “this could result in overestimating the contribution of labor force as a factor of production to the rate of economic growth" (Medina-Smith, 2001:16). This research uses the UAE population taken from the National Bureau of Statistics of UAE and in order to overcome the overestimation problem, the relationship between exports and economic growth is examined by estimating the aggregate model with and without the inclusion of human capital.

All the macroeconomic variables are expressed in real terms, using the GDP deflator (2007=100) taken from World Bank. In addition, the variables are transformed into logarithmic form, which can solve the potential problem of heteroscedasticity. Table 4.1, 4.2 and 4.3 present the descriptive statistics of the log-transformed data for the periods 1975-2012 and 1981-2012 respectively.

Table 4.1: Descriptive statistics of the series for the period 1975-2012

Statistics	LY	LK	LHC	LX	LIMP
Mean	25.608	23.930	14.621	24.896	24.580
Median	25.522	23.777	14.584	24.730	24.681
Maximum	26.355	24.883	16.035	26.111	26.061
Minimum	24.564	22.992	13.232	23.858	22.949
Std. Dev.	0.482	0.534	0.778	0.693	0.877
Jarque-Bera	1.152	2.613	1.045	2.422	1.801
(Probability)	0.562	0.271	0.593	0.298	0.406
Observations	38	38	38	38	38

Source: Author's calculation

Table 4.2: Descriptive statistics of the series for the period 1981-2012

Statistics	LY	LK	LHC	LPX	LMX
Mean	25.734	24.020	14.831	24.433	23.070
Median	25.716	23.896	14.743	24.315	23.190
Maximum	26.355	24.883	16.035	25.316	24.641
Minimum	25.144	23.293	13.885	23.591	21.250
Std. Dev.	0.401	0.523	0.653	0.501	1.037
Jarque-Bera	2.610	2.629	2.160	1.718	1.770
(Probability)	0.271	0.269	0.340	0.423	0.413
Observations	32	32	32	32	32

Source: Author’s calculation

Table 4.3: Descriptive statistics of the series for the period 1981-2012 (cont.)

Statistics	LNOILX	LREX	LFX	LIMP
Mean	22.028	23.134	24.385	24.792
Median	21.903	23.188	24.278	24.735
Maximum	24.239	24.538	25.267	26.061
Minimum	20.660	21.454	23.545	23.745
Std. Dev.	0.981	0.956	0.504	0.777
Jarque-Bera	2.050	1.725	1.714	2.236
(Probability)	0.359	0.422	0.424	0.327
Observations	32	32	32	32

Source: Author’s calculation

4.3 Econometric Methods

In order to achieve the research objectives, this study will apply the following tests: a) Unit root tests in order to examine the stationarity of the variables included in the model, b) Cointegration test to confirm the existence of a long-run relationship between exports and economic growth, c) a Vector Autoregression model (VAR) in order to investigate whether exports affect economic growth d) the multivariate Granger causality test in VECM framework to investigate the direction of the causality and e) the modified Wald test (MWALD) in an augmented vector autoregressive model proposed by Toda and Yamamoto (1995).

4.3.1 Unit Root Test

As demonetrated by Bahamani-Oskooee and Alse (1993) and Khan et al. (1995) one of the major shortcomings of time-series variables is that exhibit non-stationary tendencies. In other words, time-series variables are non-stationary and one observation can influence another with a time lag (t-1, t-2, t-3, t-4…….t-k). In this case it is likely to have a spurious regression, where the adjusted coefficient of determination (R^2) exceeds the Durbin-Watson statistic (Granger and Newbold 1974). In particular, in a spurious regression, high R^2 does not necessarily indicate the existence of true relationship between the variables, while the low Durbin- Watson statistic is an indication that the residuals are correlated over time. One of the reasons for autocorrelated residuals, is the use of non-stationary time series data. In other words, a high Adjusted R squared and a very low D-W statistic indicate that nonstationarity problem exists.

The most widely method to overcome this problem, is to use the first difference of the data. As demonstrated by Granger and Newbold (1974:119) "In any case, if a 'good' theory holds for levels, but is unspecific about the time-series properties of the residuals, then an equivalent theory holds for changes so that nothing is lost by model building with both levels and changes". For this reason, before applying the Granger causality test it is important to ensure that the time-series variables are stationary, which means that they have a constant mean and variance.

According to Enders (1995), there are important differences between non-stationary and stationary data. In particular, shocks to a stationary time series are temporary, while shocks to a non-stationary time series are permanent. In addition, a stationary series returns to a long-run mean and has a time-invariant finite variance. In contrast, in the case of non-stationary data, there is no long-run mean and the variance is time-dependent. As far as the theoretical correlogram is concerned, the correlogram of a stationary time series have a small number of significant spikes and diminishes as lag length increases. In other words, the autocorrelations at various lags hover around zero (Gujarati, 2003). In contrast, the autocorrelation coefficient in the case of non-stationary series starts at a very high values and decreases very slowly toward zero as the lag length increases (Enders, 1995; Gujarati, 2003). In this research, the pattern and stationarity of the variables are initially investigated by performing visual inspection of plots and correlograms of the variables at level and first difference. As Hall (1986) notes, it is important to inspect the correlograms of the variables with short time length in order to determine their integrating properties.

Although the inspection of time series plot and correlogram is very useful to identify whether a time-series variable is non-stationary, it is important to test for the presence of a unit root (Enders, 1995, Harris, 1995). The unit root test is introduced by considering the following model (Enders, 1995, Gujarati, 2003):

$$Y_t = \rho Y_{t-1} + \varepsilon_t , \qquad -1 \leq \rho \leq 1 \tag{4.3.1.1}$$

Where ε_t is a white noise error term, having the following properties:

$$E(\varepsilon_t) = 0$$

$$Var(\varepsilon_t) = \sigma^2_\varepsilon$$

$$Cov(\varepsilon_t, \varepsilon_{t+s}) = 0, \qquad s \neq 0 \quad \text{(non autocorrelated residuals)}$$

If $\rho = 1$, this means that the time series Y_t is non-stationary. In other words, if regress Y_t on Y_{t-1} we will find if the estimated ρ is statistically equal to 1 (Gujarati, 2003). The above equation can be expressed in alternative form by subtracting Y_{t-1} from both sides:

$$Y_t - Y_{t-1} = \rho Y_{t-1} - Y_{t-1} + \varepsilon_t = (\rho - 1) Y_{t-1} + \varepsilon_t \tag{4.3.1.2}$$

Therefore:

$$\Delta Y_t = \gamma Y_{t-1} + \varepsilon_t \qquad (4.3.1.3)$$

Where $\gamma = (\rho - 1)$ and Δ represents the first difference operator (Gujarati, 2003).

The next step is to regress the ΔY_t on Y_{t-1} and see if the estimated coefficient γ in the regression is equal to zero or not. If $\gamma = 0$, this means that $\rho = 1$ and in this case the time series variable is non-stationary. If γ is negative (ρ must be less than one) the time series is stationary.

Dickey and Fuller (1979) consider three different equations in order to test for the existence of a unit root:

$$\Delta Y_t = \gamma Y_{t-1} + \varepsilon_t \qquad (4.3.1.4)$$

$$\Delta Y_t = \alpha_0 + \gamma Y_{t-1} + \varepsilon_t \qquad (4.3.1.5)$$

$$\Delta Y_t = \alpha_0 + \gamma Y_{t-1} + \alpha_2 t + \varepsilon_t \qquad (4.3.1.6)$$

The first equation is a random walk, the second equation is a random walk with intercept only, while the last equation is a random walk with intercept and time trend (Gujarati, 2003). In addition it is assumed that the random errors are identically distributed with zero mean and variance σ^2 { $\varepsilon_t \sim ii(0,\sigma^2)$ for t = 1, 2, ….} and are not correlated. In each case, the null hypothesis is that $\gamma = 0$; H_o:

a unit root exists, while the alternative hypothesis is that $\gamma < 0$; H_a: the time series is stationary.

Dickey and Fuller extended the unit root test procedure by including extra lagged terms of the dependent variable in order to eliminate autocorrelation, as the error term is unlikely to be white noise (Asteriou and Hall, 2007). The following three equations are given in order to test for the existence of the unit root test:

$$\Delta Y_t = \gamma Y_{t-1} + \sum_{i=1}^{p} \beta i \, \Delta Y_{t-I} + \varepsilon_t \qquad (4.3.1.7)$$

$$\Delta Y_t = \alpha_0 + \gamma Y_{t-1} + \sum_{i=1}^{p} \beta i \, \Delta Y_{t-I} + \varepsilon_t \qquad (4.3.1.8)$$

$$\Delta Y_t = \alpha_0 + \gamma Y_{t-1} + \alpha_2 t + \sum_{i=1}^{p} \beta i \, \Delta Y_{t-I} + \varepsilon_t \qquad (4.3.1.9)$$

As in the simple Dickey-Fuller test, α_0 and α_2 represents the deterministic elements.

It should be mentioned that the specification of the lag length p is very important issue for the Augmented Dickey-Fuller test (ADF). According to Zivot and Wang (2003) if p is too large then the power of the test will suffer, while if p is too small then the remaining serial correlation in the errors will bias the test. Enders (1995) suggests to start with a relatively long lag length and choose the appropriate lag length by examining the Schwarz Information Criterion (SIC). A useful formula for determining the maximum lag length p is suggested by Schwert (1989): $P= [12^* (T/100)^{1/4}]$ where T is the number of observations.

In the present study the stationarity of the series is investigated by applying the ADF test, which is based on the value of t-statistics for the coefficient of the lagged dependent variable. The maximum lag length is determined following Schwert (1989) and the optimal lag length is chosen based on SIC. In order to reject or not the null hypothesis the calculated t value will be compared with the critical value. If the variables are not stationary, which is the most common case for macroeconomic variables, they can be made stationary by taking the first difference ($\Delta Y_t = Y_t - Y_{t-1}$).

It is interesting to mention that most tests of DF type are sensitive to the way they are conducted. For example, if the true model is a random walk, but the test is based on estimating a random walk with intercept, the conclusion will be wrong (Gujarati, 2003). In order to avoid this problem, this study follows Doldado et al. (1990) by estimating the model including an intercept and trend and checking the appropriateness of each form. In particular, if the intercept or trend are found to be statistically insignificant, it is necessary to exclude the insignificant terms and re-estimate the model.

Moreover, the DF tests tend to accept the hypothesis of a unit root test and this is because the power of these tests depends on the span of the data and not on the size of the sample. According to Gujarati (2003), a unit root test based on 30 observations over a span of 30 years may have more power than a test based on 100 observations over a span of 100 days. For this reason, annual data is more appropriate than quarterly data for the present study.

Furthermore, this study applies an alternative unit root test developed by Phillips and Perron (1988), which proposes a semi-parametric correction of serial correlation and time-dependent heteroskedasticity. In particular, the Phillips-Perron test (PP) is a generalization of the DF procedure that allows the error terms to be weakly dependent and heterogeneously distributed (Enders,1995). This test involves the following equations:

$$Y_t = \alpha^*_0 + \alpha^*_1 y_{t-1} + \mu_t \quad (4.3.1.10)$$

$$Y_t = \alpha^*_0 + \alpha^*_1 y_{t-1} + \alpha^*_2 (t - T/2) + \mu_t \quad (4.3.1.11)$$

Where T is the number of observations and the error term μ_t is such that $E\mu_t = 0$, but there is no requirement that the error term is serially uncorrelated. The Phillips-Perron t-statistics are modifications of the ADF t-statistics that take into account the less restrictive nature of the error process (Enders, 1995, Asteriou and Hall, 2007). The PP test is performed by following the method suggested by Doldado et al. (1990) regarding the inclusion of constant and trend. In addition, MacKinnon (1991) critical values are also applicable to PP test.

According to Verbeek (2012:294) “Not all series for which we cannot reject the unit root hypothesis are necessarily integrated of order one”. For this reason this research also applies the test proposed by Kwiatkowski, Phillips, Schmidt and Shin (1992), where the null hypothesis is a stationary process. The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) statistic is based on the residuals from the OLS regression of y_t on the exogenous variables x_t (constant and time trend):

$$Y_t = \delta x_t' + u_t \qquad (4.3.1.12)$$

The KPSS statistic is defined as: KPSS = $\sum_t S(t)^2 / (T^2 f_0)$

Where f_0 is an estimator of the residual spectrum at frequency zero and S(t) is a cumulative residual function: S(t) = $\sum_{r=1}^{t} \hat{u}_r$, based on the residuals $\hat{u}_t$ from the equation $Y_t = \delta x_t' + u_t$. The lag length is selected automatically by Newey-West Bandwidth using Bartlett Kernel estimation method and if the KPSS statistic is greater than the critical value, the null hypothesis of stationarity is rejected.

It should be mentioned that, if there are structural breaks in the data, the ADF, PP and KPSS test statistics are biased toward the non-rejection of a unit root. As a result, a structural break is identified as evidence of non-stationarity, even if the series is stationary within each of the periods before and after the break. For this reason, the unit root test with a structural break proposed by Saikkonen and Lutkepohl (2002) is applied to this research in order to evaluate the time series properties. As Enders (1995:243) notes, "In performing unit root test, special care must be taken if it is suspected that structural change has occurred".

In the Saikkonen and Lutkepohl unit root test (SL), the deterministic part is estimated by generalized least squares (GLS) method and subtracted from the original series. The resulting series are tested for unit root following an ADF type test and the lag length is chosen based on order selection criteria. The critical values, in order to reject or not the null hypothesis of a unit root are tabulated in Lanne et al. (2002). If the shift date is unknown, Lanne et al. (2003) note that the break date has to be determined from the given time series[3]. In this reseach, the SL test involves the following models:

$$Y_t = \mu_o + \mu_1 t + \delta d_{1t} + u_t, \quad (4.3.1.13)$$

$$Y_t = \mu_o + \delta d_{1t} + u_t, \quad (4.3.1.14)$$

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

4.3.2 Cointegration Test

Moreover, in order to perform the Granger causality test, it is important to investigate if the variables are cointegrated (Granger, 1988). For this reason, after testing for stationarity of our variables, the cointegration test will be performed and specifically the Johansen cointegration test (Johansen, 1988). The Johansen cointegration test is considered to have better properties than the other cointegration tests, such as the two-step Engle-Granger Cointegration technique (Engle and Granger, 1987). As Gonzalo (1994) notes, Johansen's cointegration test satisfies the three elements in a cointegration system, "first the existence of unit roots, second the multivariate aspect, and third the dynamics. Not taking these elements into account may create problem is estimation" (Gonzalo, 1994:223).

According to Hjalmarsson and Österholm (2007:4), “Johansen’s methodology takes its starting point in the vector autoregression (VAR) of order p” given by:

$$X_t = \mu + A_1 X_{t-1} + \ldots + A_p X_{t-p} + \varepsilon_t \qquad (4.3.2.1)$$

Where X_t is a n x 1 vector of variables that are I(1), μ is a n x 1 vector of constants, while ε_t is a n x 1 vector of random errors. Subtracting X_{t-1} from each side of this equation and letting I be an n x n identity matrix, this VAR can be re-written as:

$$\Delta X_t = \mu + \Pi X_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \varepsilon_t \qquad (4.3.2.2)$$

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

Γ and Π are the coefficient matrices, ΠX_{t-1} is the error-correction term, while the coefficient matrix Π provides information about the long-run relationships between the variables (Lim et al., 2010). If the coefficient matrix Π is equal to zero, there is no cointegration. If Π has full rank r=n, X_t is stationary. In the case where the coefficient matrix Π has rank r<n, but not equal to zero, this means that there is cointegration and r is the number of cointegrating relationships. It is important to note that in a VAR model with n variables, there can be at most r =n-1 cointegrating relationships. In this case, Π can be expressed as Π = αβ’ where α and β are n x r matrices. The elements of the matrix α are known as the adjustment matrix parameters in the vector error correction model and the matrix β is the cointegrating matrix (Lim et al., 2010;

Hjalmarsson and Österholm, 2007).

The Johansen's cointegration test can be applied using the maximum eigenvalue and trace test statistics in order to find the number of cointegrating vectors. The trace test is shown in the following equation:

$$J_{trace} = -T \sum_{i=r+1}^{n} \ln(1 - \lambda i) \qquad (4.3.2.3)$$

Where T is the sample size and λ is the eigenvalue. The trace test, tests the null hypothesis of at most r cointegrating vectors against the alternative hypothesis of n cointegrating vectors. If the statistic is greater than the critical value, the null hypothesis of at most r cointegrating vectors is rejected (Ahking, 2002)

The maximum eigenvalue test is:

$$J_{max} = -T \ln(1 - \lambda r) \qquad (4.3.2.4)$$

The maximum eigenvalue, tests the hypothesis of r cointegrating vectors against the alternative of r+1 cointegrating vectors. If the statistic is greater than the critical value, the null hypothesis of exactly r cointegrating vectors is rejected (Ahking, 2002). The critical values for Trace and Eigenvalue tests depend on whether a trend or constant are included in the VAR model. As noted by Cheung and Lai (1993:326), "between Johansen's two LR tests, Trace tests shows more robustness to both skewness and excess kurtosis in innovations than the maximum eigenvalue test". For this reason this research uses the Trace statistic.

It is important to note that the inclusion of too few lags in the cointegration test could lead to rejection of the null hypothesis, while too many lags could decrease the power of the test (Verbeek, 2012). For this reason, the lag length for the system is determined by minimizing the Schwarz Information Criterion (SIC) and Akaike Information Criterion (AIC). In addition to the selection of the optimal lag length, the inclusion of time trend should be considered when testing for cointegration. In order to determine the best model, the Pantula's principle is used, developed by Pantula (1989)[4].

Although Johansen cointegration is considered to have better properties, Hargreaves (1994) notes that this test performs better if the sample size includes 100 or more observations. In addition, Reinsel and Ahn (1992) and Cheung and Lai (1993) note that in models with small samples, Johansen's tests are biased toward rejecting the null hypothesis of no cointegration too often. In order to remedy this problem, the Trace statistics is adjusted by using the correction factor (T- n*p)/T proposed by Reinsel and Ahn (1992), where T is the sample size, while n and p is the number of the variables and the optimal lag length respectively.

4.3.3 Vector Autoregressive Model

The VAR model, which is developed by Sims (1980), can be used to investigate whether exports affect the economic growth of UAE, by including the optimal lag length of each variable in each equation (Gujarati, 2003).

The proposed VAR models are the following:

MODEL 1: Y=f (K, X, IMP)

$$LY_t = \alpha_{10} + \sum_{j=1}^{p} \beta_{1j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{1j} LK_{t-j} + \sum_{j=1}^{p} \delta_{1j} LX_{t-j} +$$

$$+ \sum_{j=1}^{p} \zeta_{1j} LIMP_{t-j} + \varepsilon_{1t} \qquad (4.3.3.1)$$

$$LK_t = \alpha_{20} + \sum_{j=1}^{p} \beta_{2j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{2j} LK_{t-j} + \sum_{j=1}^{p} \delta_{2j} LX_{t-j} +$$

$$+ \sum_{j=1}^{p} \zeta_{2j} LIMP_{t-j} + \varepsilon_{2t} \qquad (4.3.3.2)$$

$$LX_t = \alpha_{30} + \sum_{j=1}^{p} \beta_{3j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{3j} LK_{t-j} + \sum_{j=1}^{p} \delta_{3j} LX_{t-j} +$$

$$+ \sum_{j=1}^{p} \zeta_{3j} LIMP_{t-j} + \varepsilon_{3t} \qquad (4.3.3.3)$$

$$LIMP_t = \alpha_{40} + \sum_{j=1}^{p} \beta_{4j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{4j} LK_{t-j} + \sum_{j=1}^{p} \delta_{4j} LX_{t-j} +$$

$$+ \sum_{j=1}^{p} \zeta_{4j} LIMP_{t-j} + \varepsilon_{4t} \qquad (4.3.3.4)$$

MODEL 2: Y=f (K, HC, X, IMP)

$$LY_t = \alpha_{10} + \sum_{j=1}^{p} \beta_{1j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{1j} LK_{t-j} + \sum_{j=1}^{p} \delta_{1j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{1j} LX_{t-j} +$$

$$+ \sum_{j=1}^{p} \theta_{1j} LIMP_{t-j} + \varepsilon_{1t} \qquad (4.3.3.5)$$

$$LK_t = \alpha_{20} + \sum_{j=1}^{p} \beta_{2j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{2j} LK_{t-j} + \sum_{j=1}^{p} \delta_{2j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{2j} LX_{t-j} +$$

$$+ \sum_{j=1}^{p} \theta_{2j} LIMP_{t-j} + \varepsilon_{2t} \qquad (4.3.3.6)$$

$$LHC_t = \alpha_{30} + \sum_{j=1}^{p} \beta_{3j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{3j} LK_{t-j} + \sum_{j=1}^{p} \delta_{3j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{3j} LX_{t-j} +$$

$$+ \sum_{j=1}^{p} \theta_{3j} LIMP_{t-j} + \varepsilon_{3t} \qquad (4.3.3.7)$$

$$LX_t = \alpha_{40} + \sum_{j=1}^{p} \beta_{4j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{4j} LK_{t-j} + \sum_{j=1}^{p} \delta_{4j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{4j} LX_{t-j} + + \sum_{j=1}^{p} \theta_{4j} LIMP_{t-j} + \varepsilon_{4t} \quad (4.3.3.8)$$

$$LIMP_t = \alpha_{50} + \sum_{j=1}^{p} \beta_{5j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{5j} LK_{t-j} + \sum_{j=1}^{p} \delta_{5j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{5j} LX_{t-j} + + \sum_{j=1}^{p} \theta_{5j} LIMP_{t-j} + \varepsilon_{5t} \quad (4.3.3.9)$$

MODEL 3: Y=f (K, HC, PX, MX, IMP)

$$LY_t = \alpha_{10} + \sum_{j=1}^{p} \beta_{1j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{1j} LK_{t-j} + \sum_{j=1}^{p} \delta_{1j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{1j} LPX_{t-j} + + \sum_{j=1}^{p} \theta_{1j} LMX_{t-j} + \sum_{j=1}^{p} \mu_{1j} LIMP_{t-j} + \varepsilon_{1t} \quad (4.3.3.10)$$

$$LK_t = \alpha_{20} + \sum_{j=1}^{p} \beta_{2j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{2j} LK_{t-j} + \sum_{j=1}^{p} \delta_{2j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{2j} LPX_{t-j} + + \sum_{j=1}^{p} \theta_{2j} LMX_{t-j} + \sum_{j=1}^{p} \mu_{2j} LIMP_{t-j} + \varepsilon_{2t} \quad (4.3.3.11)$$

$$LHC_t = \alpha_{30} + \sum_{j=1}^{p} \beta_{3j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{3j} LK_{t-j} + \sum_{j=1}^{p} \delta_{3j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{3j} LPX_{t-j} + + \sum_{j=1}^{p} \theta_{3j} LMX_{t-j} + \sum_{j=1}^{p} \mu_{3j} LIMP_{t-j} + \varepsilon_{3t} \quad (4.3.3.12)$$

$$LPX_t = \alpha_{40} + \sum_{j=1}^{p} \beta_{4j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{4j} LK_{t-j} + \sum_{j=1}^{p} \delta_{4j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{4j} LPX_{t-j} + + \sum_{j=1}^{p} \theta_{4j} LMX_{t-j} + \sum_{j=1}^{p} \mu_{4j} LIMP_{t-j} + \varepsilon_{4t} \quad (4.3.3.13)$$

$$LMX_t = \alpha_{50} + \sum_{j=1}^{p} \beta_{5j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{5j} LK_{t-j} + \sum_{j=1}^{p} \delta_{5j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{5j} LPX_{t-j} + + \sum_{j=1}^{p} \theta_{5j} LMX_{t-j} + \sum_{j=1}^{p} \mu_{5j} LIMP_{t-j} + \varepsilon_{5t} \quad (4.3.3.14)$$

$$LIMP_t = \alpha_{60} + \sum_{j=1}^{p} \beta_{6j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{6j} LK_{t-j} + \sum_{j=1}^{p} \delta_{6j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{6j} LPX_{t-j} + + \sum_{j=1}^{p} \theta_{6j} LMX_{t-j} + \sum_{j=1}^{p} \mu_{6j} LIMP_{t-j} + \varepsilon_{6t} \quad (4.3.3.15)$$

MODEL 4: Y=f (K, HC, FX, IMP)

$$LY_t = \alpha_{10} + \sum_{j=1}^{p} \beta_{1j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{1j} LK_{t-j} + \sum_{j=1}^{p} \delta_{1j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{1j} LFX_{t-j} + + \sum_{j=1}^{p} \theta_{1j} LIMP_{t-j} + \varepsilon_{1t} \quad (4.3.3.16)$$

$$LK_t = \alpha_{20} + \sum_{j=1}^{p} \beta_{2j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{2j} LK_{t-j} + \sum_{j=1}^{p} \delta_{2j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{2j} LFX_{t-j} + + \sum_{j=1}^{p} \theta_{2j} LIMP_{t-j} + \varepsilon_{2t} \quad (4.3.3.17)$$

$$LHC_t = \alpha_{30} + \sum_{j=1}^{p} \beta_{3j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{3j} LK_{t-j} + \sum_{j=1}^{p} \delta_{3j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{3j} LFX_{t-j} + + \sum_{j=1}^{p} \theta_{3j} LIMP_{t-j} + \varepsilon_{3t} \quad (4.3.3.18)$$

$$LFX_t = \alpha_{40} + \sum_{j=1}^{p} \beta_{4j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{4j} LK_{t-j} + \sum_{j=1}^{p} \delta_{4j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{4j} LFX_{t-j} + + \sum_{j=1}^{p} \theta_{4j} LIMP_{t-j} + \varepsilon_{4t} \quad (4.3.3.19)$$

$$LIMP_t = \alpha_{50} + \sum_{j=1}^{p} \beta_{5j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{5j} LK_{t-j} + \sum_{j=1}^{p} \delta_{5j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{5j} LFX_{t-j} + + \sum_{j=1}^{p} \theta_{5j} LIMP_{t-j} + \varepsilon_{5t} \quad (4.3.3.20)$$

MODEL 5: Y=f (K, HC, NOILX, REX, IMP)

$$LY_t = \alpha_{10} + \sum_{j=1}^{p} \beta_{1j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{1j} LK_{t-j} + \sum_{j=1}^{p} \delta_{1j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{1j} LNOILX_{t-j} +$$

$$+ \sum_{j=1}^{p} \theta_{1j} LREX_{t-j} + \sum_{j=1}^{p} \mu_{1j} LIMP_{t-j} + \varepsilon_{1t} \quad (4.3.3.21)$$

$$LK_t = \alpha_{20} + \sum_{j=1}^{p} \beta_{2j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{2j} LK_{t-j} + \sum_{j=1}^{p} \delta_{2j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{2j} LNOILX_{t-j} +$$

$$+ \sum_{j=1}^{p} \theta_{2j} LREX_{t-j} + \sum_{j=1}^{p} \mu_{2j} LIMP_{t-j} + \varepsilon_{2t} \quad (4.3.3.22)$$

$$LHC_t = \alpha_{30} + \sum_{j=1}^{p} \beta_{3j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{3j} LK_{t-j} + \sum_{j=1}^{p} \delta_{3j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{3j} LNOILX_{t-j} +$$

$$+ \sum_{j=1}^{p} \theta_{3j} LREX_{t-j} + \sum_{j=1}^{p} \mu_{3j} LIMP_{t-j} + \varepsilon_{3t} \quad (4.3.3.23)$$

$$LNOILX_t = \alpha_{40} + \sum_{j=1}^{p} \beta_{4j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{4j} LK_{t-j} + \sum_{j=1}^{p} \delta_{4j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{4j} LNOILX_{t-j} +$$

$$+ \sum_{j=1}^{p} \theta_{4j} LREX_{t-j} + \sum_{j=1}^{p} \mu_{4j} LIMP_{t-j} + \varepsilon_{4t} \quad (4.3.3.24)$$

$$LREX_t = \alpha_{50} + \sum_{j=1}^{p} \beta_{5j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{5j} LK_{t-j} + \sum_{j=1}^{p} \delta_{5j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{5j} LNOILX_{t-j}$$

$$+ \sum_{j=1}^{p} \theta_{5j} LREX_{t-j} + \sum_{j=1}^{p} \mu_{5j} LIMP_{t-j} + \varepsilon_{5t} \quad (4.3.3.25)$$

$$LIMP_t = \alpha_{60} + \sum_{j=1}^{p} \beta_{6j} LY_{t-j} + \sum_{j=1}^{p} \gamma_{6j} LK_{t-j} + \sum_{j=1}^{p} \delta_{6j} LHC_{t-j} + \sum_{j=1}^{p} \zeta_{6j} LNOILX_{t-j} +$$

$$+ \sum_{j=1}^{p} \theta_{6j} LREX_{t-j} + \sum_{j=1}^{p} \mu_{6j} LIMP_{t-j} + \varepsilon_{6t} \quad (4.3.3.26)$$

Where LY_t, LK_t, LHC_t, LX_t, LPX_t, LMX_t, $LNOILX_t$, $LREX_t$ and $LIMP_t$ represent the variables of the proposed models, presented in section 4.1. In the VAR model, all variables are treated as endogenous, while no current variables appear on the right-hand side of the equations. In addition, exogenous variables can be included in the VAR model, such as structural breaks. It is noticeable that the exogenous variables can be added to the VAR model without adding equations to the system. In this research, a dummy is included when it is necessary for the stability of the model.

Before estimating the VAR equations it is important to determine the appropriate lag length (Gujarati, 2003). According to Gujarati (2003), the inclusion of too many lagged terms can cause multicollinearity problem and also can consume degrees of freedom. In addition, specification errors can be caused if too few lags are included in the model. As mentioned earlier, the Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) will be used for the selection of the optimal lag length for the models. Two or more models will be compared and the model with the lowest AIC and SIC will be chosen for the VAR estimation.

One of the advantages of VAR is that all variables are endogenous and it is not necessary to determine which variables are exogenous and which are endogenous as in Simultaneous Equations Model (Gujarati, 2003). Although in a dynamic Simultaneous Equations Model each variable is affected by the current values of the other endogenous variables, the forecast obtained by VAR sometimes are considered to be better than those from Simultaneous Equation models (Chan and Chung, 1995; Gujarati, 2003). In addition, according to Gujarati (2003:853), "the VAR model is a-theoretic, because it uses less prior information" comparing with Simultaneous-Equation models, where the inclusion and exclusion of variables is very important for the identification of the model (Gujarati, 2003).

4.3.4 Vector Error Correction Model

As it mentioned earlier, before estimating the VAR model, the cointegration test will be performed in order to investigate the existence of a long-run relationship between the variables. If the variables are cointegrated, restricted VAR models will be used, instead of the VAR models presented in section 4.3.3, in order to test for short-run causality. A restricted VAR or Vector Error Correction Model (VECM) has a form of:

$$\Delta Y_t = \alpha_{10} + \sum_{j=1}^{p} \beta_{1j} \Delta Y_{t-j} + \sum_{j=1}^{p} \gamma_{1j} \Delta X_{t-j} - \lambda_y u_{t-1} + \varepsilon_{1t} \qquad (4.3.4.1)$$

$$\Delta X_t = = \alpha_{20} + \sum_{j=1}^{p} \beta_{2j} \Delta Y_{t-j} + \sum_{j=1}^{p} \gamma_{2j} \Delta X_{t-j} - \lambda_x u_{t-1} + \varepsilon_{2t} \qquad (4.3.4.2)$$

Where u_{t-1} is the error from the cointegrating equation: $u_{t-1} = y_{t-1} - \alpha_0 - \alpha_1 X_{t-1}$, while the parameters λ_y and λ_x measure how Y and X react to deviations from long-run equilibrium. As Gujarati (2003:825) notes, the absolute value of the coefficient of the error correction term "decides how quickly the equilibrium is restored". In this study, if our variables are cointegrated, the causality can be tested by estimating the following VECM models:

MODEL 1: Y=f (K, X, IMP)

$$\Delta LY_t = \sum_{j=1}^{p} \beta_{1j} \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{1j} \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{1j} \Delta LX_{t-j} + \sum_{j=1}^{p} \theta_{1j} \Delta LIMP_{t-j} - -\lambda_y ECT_{t-1} + \varepsilon_{1t} \qquad (4.3.4.3)$$

$$\Delta LK_t = \sum_{j=1}^{p} \beta_{2j} \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{2j} \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{2j} \Delta LX_{t-j} + \sum_{j=1}^{p} \theta_{2j} \Delta LIMP_{t-j} -$$

$-\lambda_k ECT_{t-1} + \varepsilon_{2t}$ (4.3.4.4)

$\Delta LX_t = \sum_{j=1}^{p} \beta_{4j}\, \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{4j}\, \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{4j}\, \Delta LX_{t-j} + \sum_{j=1}^{p} \theta_{4j}\, \Delta LIMP_{t-j}$ -

$-\lambda_x ECT_{t-1} + \varepsilon_{4t}$ (4.3.4.5)

$\Delta LIMP_t = \sum_{j=1}^{p} \beta_{5j}\, \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{5j}\, \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{5j}\, \Delta LX_{t-j} + \sum_{j=1}^{p} \theta_{5j}\, \Delta LIMP_{t-j}$ -

$-\lambda_{imp} ECT_{t-1} + \varepsilon_{5t}$ (4.3.4.6)

<u>MODEL 2: Y=f (K, HC, X, IMP)</u>

$\Delta LY_t = \sum_{j=1}^{p} \beta_{1j}\, \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{1j}\, \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{1j}\, \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{1j}\, \Delta LX_{t-j}$ +

$+ \sum_{j=1}^{p} \theta_{1j}\, \Delta LIMP_{t-j} - \lambda_y ECT_{t-1} + \varepsilon_{1t}$ (4.3.4.7)

$\Delta LK_t = \sum_{j=1}^{p} \beta_{2j}\, \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{2j}\, \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{2j}\, \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{2j}\, \Delta LX_{t-j}$ +

$+ \sum_{j=1}^{p} \theta_{2j}\, \Delta LIMP_{t-j} - \lambda_k ECT_{t-1} + \varepsilon_{2t}$ (4.3.4.8)

$\Delta LHC_t = \sum_{j=1}^{p} \beta_{3j}\, \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{3j}\, \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{3j}\, \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{3j}\, \Delta LX_{t-j}$ +

$+ \sum_{j=1}^{p} \theta_{3j}\, \Delta LIMP_{t-j} - \lambda_{hc} ECT_{t-1} + \varepsilon_{3t}$ (4.3.4.9)

$\Delta LX_t = \sum_{j=1}^{p} \beta_{4j}\, \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{4j}\, \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{4j}\, \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{4j}\, \Delta LX_{t-j}$ +

$+ \sum_{j=1}^{p} \theta_{4j}\, \Delta LIMP_{t-j} - \lambda_x ECT_{t-1} + \varepsilon_{4t}$ (4.3.4.10)

$\Delta LIMP_t = \sum_{j=1}^{p} \beta_{5j}\, \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{5j}\, \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{5j}\, \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{5j}\, \Delta LX_{t-j}$ +

$+ \sum_{j=1}^{p} \theta_{5j}\, \Delta LIMP_{t-j} - \lambda_{imp} ECT_{t-1} + \varepsilon_{5t}$ (4.3.4.11)

MODEL 3: Y=f (K, HC, PX, MX, IMP)

$$\Delta LY_t = \sum_{j=1}^{p} \beta_{1j}\, \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{1j}\, \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{1j}\, \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{1j}\, \Delta LPX_{t-j} +$$

$$+ \sum_{j=1}^{p} \theta_{1j}\, \Delta LMX_{t-j} + \sum_{j=1}^{p} \mu_{1j}\, \Delta LIMP_{t-j} - \lambda_y ECT_{t-1} + \varepsilon_{1t} \qquad (4.3.4.12)$$

$$\Delta LK_t = \sum_{j=1}^{p} \beta_{2j}\, \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{2j}\, \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{2j}\, \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{2j}\, \Delta LPX_{t-j} +$$

$$+ \sum_{j=1}^{p} \theta_{2j}\, \Delta LMX_{t-j} + \sum_{j=1}^{p} \mu_{2j}\, \Delta LIMP_{t-j} - \lambda_k ECT_{t-1} + \varepsilon_{2t} \qquad (4.3.4.13)$$

$$\Delta LHC_t = \sum_{j=1}^{p} \beta_{3j}\, \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{3j}\, \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{3j}\, \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{3j}\, \Delta LPX_{t-j} +$$

$$+ \sum_{j=1}^{p} \theta_{3j}\, \Delta LMX_{t-j} + \sum_{j=1}^{p} \mu_{3j}\, \Delta LIMP_{t-j} - \lambda_{hc} ECT_{t-1} + \varepsilon_{3t} \qquad (4.3.4.14)$$

$$\Delta LPX_t = \sum_{j=1}^{p} \beta_{4j}\, \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{4j}\, \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{4j}\, \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{4j}\, \Delta LPX_{t-j} +$$

$$+ \sum_{j=1}^{p} \theta_{4j}\, \Delta LMX_{t-j} + \sum_{j=1}^{p} \mu_{4j}\, \Delta LIMP_{t-j} - \lambda_{px} ECT_{t-1} + \varepsilon_{4t} \qquad (4.3.4.15)$$

$$\Delta LMX_t = \sum_{j=1}^{p} \beta_{5j}\, \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{5j}\, \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{5j}\, \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{5j}\, \Delta LPX_{t-j} +$$

$$+ \sum_{j=1}^{p} \theta_{5j}\, \Delta LMX_{t-j} + \sum_{j=1}^{p} \mu_{5j}\, \Delta LIMP_{t-j} - \lambda_{mx} ECT_{t-1} + \varepsilon_{5t} \qquad (4.3.4.16)$$

$$\Delta LIMP_t = \sum_{j=1}^{p} \beta_{6j}\, \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{6j}\, \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{6j}\, \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{6j}\, \Delta LPX_{t-j} +$$

$$+ \sum_{j=1}^{p} \theta_{6j}\, \Delta LMX_{t-j} + \sum_{j=1}^{p} \mu_{6j}\, \Delta LIMP_{t-j} - \lambda_{imp} ECT_{t-1} + \varepsilon_{6t} \qquad (4.3.4.17)$$

MODEL 4: Y=f (K, HC, FX, IMP)

$$\Delta LY_t = \sum_{j=1}^{p} \beta_{1j} \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{1j} \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{1j} \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{1j} \Delta LFX_{t-j} + \sum_{j=1}^{p} \theta_{1j} \Delta LIMP_{t-j} - \lambda_y ECT_{t-1} + \varepsilon_{1t} \quad (4.3.4.18)$$

$$\Delta LK_t = \sum_{j=1}^{p} \beta_{2j} \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{2j} \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{2j} \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{2j} \Delta LFX_{t-j} + \sum_{j=1}^{p} \theta_{2j} \Delta LIMP_{t-j} - \lambda_k ECT_{t-1} + \varepsilon_{2t} \quad (4.3.4.19)$$

$$\Delta LHC_t = \sum_{j=1}^{p} \beta_{3j} \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{3j} \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{3j} \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{3j} \Delta LFX_{t-j} + \sum_{j=1}^{p} \theta_{3j} \Delta LIMP_{t-j} - \lambda_{hc} ECT_{t-1} + \varepsilon_{3t} \quad (4.3.4.20)$$

$$\Delta LFX_t = \sum_{j=1}^{p} \beta_{4j} \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{4j} \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{4j} \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{4j} \Delta LFX_{t-j} + \sum_{j=1}^{p} \theta_{4j} \Delta LIMP_{t-j} - \lambda_{fx} ECT_{t-1} + \varepsilon_{4t} \quad (4.3.4.21)$$

$$\Delta LIMP_t = \sum_{j=1}^{p} \beta_{5j} \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{5j} \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{5j} \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{5j} \Delta LFX_{t-j} + \sum_{j=1}^{p} \theta_{5j} \Delta LIMP_{t-j} - \lambda_{imp} ECT_{t-1} + \varepsilon_{5t} \quad (4.3.4.22)$$

MODEL 5: Y=f (K, HC, NOILX, REX, IMP)

$$\Delta LY_t = \sum_{j=1}^{p} \beta_{1j} \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{1j} \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{1j} \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{1j} \Delta LNOILX_{t-j} + \sum_{j=1}^{p} \theta_{1j} \Delta LREX_{t-j} + \sum_{j=1}^{p} \mu_{1j} \Delta LIMP_{t-j} - \lambda_y ECT_{t-1} + \varepsilon_{1t} \quad (4.3.4.23)$$

$$\Delta LK_t = \sum_{j=1}^{p} \beta_{2j} \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{2j} \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{2j} \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{2j} \Delta LNOILX_{t-j} +$$

$$+ \sum_{j=1}^{p} \theta_{2j}\, \Delta LREX_{t-j} + \sum_{j=1}^{p} \mu_{2j}\, \Delta LIMP_{t-j} - \lambda_{k} ECT_{t-1} + \varepsilon_{2t} \qquad (4.3.4.24)$$

$$\Delta LHC_t = \sum_{j=1}^{p} \beta_{3j}\, \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{3j}\, \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{3j} \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{3j} \Delta LNOILX_{t-j} +$$

$$+ \sum_{j=1}^{p} \theta_{3j}\, \Delta LREX_{t-j} + \sum_{j=1}^{p} \mu_{3j}\, \Delta LIMP_{t-j} - \lambda_{hc} ECT_{t-1} + \varepsilon_{3t} \qquad (4.3.4.25)$$

$$\Delta LNOILX_t = \sum_{j=1}^{p} \beta_{4j}\, \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{4j}\, \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{4j}\, \Delta LHC_{t-j} +$$

$$+ \sum_{j=1}^{p} \zeta_{4j}\, \Delta LNOILX_{t-j} + \sum_{j=1}^{p} \theta_{4j}\, \Delta LREX_{t-j} + \sum_{j=1}^{p} \mu_{4j}\, \Delta LIMP_{t-j}$$

$$- \lambda_{noilx} ECT_{t-1} + \varepsilon_{4t} \qquad (4.3.4.26)$$

$$\Delta LREX_t = \sum_{j=1}^{p} \beta_{5j}\, \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{5j} \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{5j} \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{5j} \Delta LNOILX_{t-j} +$$

$$+ \sum_{j=1}^{p} \theta_{5j}\, \Delta LREX_{t-j} + \sum_{j=1}^{p} \mu_{5j}\, \Delta LIMP_{t-j} - \lambda_{rex} ECT_{t-1} + \varepsilon_{5t} \qquad (4.3.4.27)$$

$$\Delta LIMP_t = \sum_{j=1}^{p} \beta_{6j}\, \Delta LY_{t-j} + \sum_{j=1}^{p} \gamma_{6j} \Delta LK_{t-j} + \sum_{j=1}^{p} \delta_{6j} \Delta LHC_{t-j} + \sum_{j=1}^{p} \zeta_{6j} \Delta LNOILX_{t-j} +$$

$$+ \sum_{j=1}^{p} \theta_{6j}\, \Delta LREX_{t-j} + \sum_{j=1}^{p} \mu_{6j}\, \Delta LIMP_{t-j} - \lambda_{imp} ECT_{t-1} + \varepsilon_{6t} \qquad (4.3.4.28)$$

Where Δ is the difference operator, β_{ij}, γ_{ij}, δ_{ij}, ζ_{ij}, θ_{ij}, μ_{ij} and λ_{ij} are the regression coefficients and ECT_{t-1} is the error correction term derived from the cointegration equation.

Once the models have been estimated, diagnostic tests are conducted in order to determine whether the models are well specified and stable. In particular, these tests include the Jarque-Bera Normality test (see Jarque and Bera, 1980, 1987), the Portmanteau (see Lütkepohl, 1991) and Breusch-Godfrey LM test (see Johansen, 1995) for the existence of autocorrelation, the White

Heteroskedasticity test (see White (1980), the Multivariate ARCH test (Engle, 1982) and the AR roots stability test (see Lütkepohl, 1991)

In addition, this research applies the cumulative sum of recursive residuals (CUSUM) and the CUSUM of squares (CUSUMQ) tests proposed by Brown et al. (1975) in order to assess the parameter constancy of the ECM estimates. In particular, the CUSUM test detects systematic changes, while CUSUM of squares provides useful information when the departure from constancy of the parameters is haphazard (Brown et al., 1975). In particular, the CUSUM test proposed by Brown et al. (1975) is based on the statistic:

$$W_t = \sum_{k+1}^{t} w_t / s \quad t= k+1,\ldots..T \tag{4.3.4.29}$$

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

$$w_t = (y_t - x_t'b_{t-1})/ (1+ x'_t (X_{t-1}'X_{t-1})^{-1} x_t)^{1/2} \tag{4.3.4.30}$$

Where the numerator $y_t - x'_t b_{t-1}$ is the forecast error, b_{t-1} is the estimated coefficient vector up to period t-1 and x_t' is the row vector of observations on the regressors in period t. The X_{t-1} denotes the $(t-1)\times k$ matrix of the regressors from period 1 to period t-1.

If the b vector changes, W_t will tend to diverge from the zero mean value line, while if b vector remains constant, $E(W_t)=0$. The test shows parameter instability if the cumulative sum of the recursive residuals lies outside the area between the two 5% significance lines, the distance between which increases with t.

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

$$S_t = (\sum_{k+1}^{t} w_t^2) \,/\, (\sum_{k+1}^{T} w_t^2) \qquad (4.3.4.31)$$

where t = k+1,….., T

The expected value of S_t, under the null hypothesis of b_t's constancy is $E(S_t)=(t-k)/(T-k)$, which goes from zero at t=k to unity at t=T. In this test the S_t are plotted together with the 5% significance lines and, as in CUSUM test, movement outside the 5% significance lines indicates instability in the equation during the sample period.

4.3.5 Granger Causality Test

After testing the variables for stationarity and cointegration and estimating the VAR model including all variables under consideration, this study conducts the Granger causality test (Granger, 1969; Granger, 1988). The purpose of Granger causality test is not only to find the relationship between independent and dependent variable, but also to figure out the direction of the causality between them. In other words, if a causal relationship exists between the variables, this enables us to predict their future values. The Granger test involves the following two regression equations to test the causality between two variables:

$$Y_t = \alpha_{10} + \sum_{i=1}^{n} \alpha i\, X_{t-i} + \sum_{j=1}^{n} \beta j Y_{t-j} + u_{1t} \qquad (4.3.5.1)$$

$$X_t = \alpha_{20} + \sum_{i=1}^{n} \gamma i\, X_{t-i} + \sum_{j=1}^{n} \delta j Y_{t-j} + u_{2t} \qquad (4.3.5.2)$$

Where Y_t and X_t are the variables into consideration, while u_{1t} and u_{2t} are the random errors, which are uncorrelated (Gujarati, 2003). The first equation shows that Y_t is related to past values of X_t and past values of itself, while the second equation shows that X_t is related to past values of Y_t and past values of itself. The causality from X_t to Y_t can be examined by conducting the chi-square test and the null hypothesis "X_t does not Granger cause Y_t (H_0: $\sum_{i=1}^{n} \alpha i$ =0) is tested against the alternative hypothesis "X_t Granger causes Y_t (H_A: $\sum_{i=1}^{n} \alpha i$ ≠0). To examine the causality from Y_t to X_t the null hypothesis "Y_t does not Granger cause X_t" (H_0:$\sum_{j=1}^{n} \delta j$=0) is tested against the alternative hypothesis "Y_t Granger causes X_t" (H_A: $\sum_{j=1}^{n} \delta j$≠0). In particular, we can have four possible outcomes after testing for causality:

1) Unidirectional causality from X to Y. In this case, the estimated coefficients on the lagged X, $\sum_{i=1}^{n} \boldsymbol{\alpha i}$, are statistically different from zero ($\sum_{i=1}^{n} \boldsymbol{\alpha i}$ ≠0), while the estimated coefficients on the lagged Y, $\sum_{j=1}^{n} \boldsymbol{\delta j}$, are not statistically different from zero as a group ($\sum_{j=1}^{n} \boldsymbol{\delta j}$=0) (Gujarati, 2003).

2) Unidirectional causality from Y to X. In this case, the estimated coefficients on the lagged X, $\sum_{i=1}^{n} \boldsymbol{\alpha i},$ are not statistically different from

zero ($\sum_{i=1}^{n} \boldsymbol{\alpha i}$ =0), while the lagged Y coefficients, $\sum_{j=1}^{n} \boldsymbol{\delta j}$, are different from zero ($\sum_{j=1}^{n} \boldsymbol{\delta j} \neq 0$). (Gujarati, 2003).

3) Bidirectional causality, where the estimated coefficients on the lagged Y and X are statistically significant ($\sum_{i=1}^{n} \boldsymbol{\alpha i} \neq 0$, $\sum_{j=1}^{n} \boldsymbol{\delta j} \neq 0$). (Gujarati, 2003).

4) No causality is indicated if the estimated coefficients on the lagged Y and X are not statistically different from zero in both regression equations ($\sum_{i=1}^{n} \boldsymbol{\alpha i}$ =0, $\sum_{j=1}^{n} \boldsymbol{\delta j}$=0). (Gujarati, 2003).

In this research, if the variables Y and X represent the economic growth and exports respectively, then there are four possible scenarios after testing our equations: a) a unidirectional causality from exports to economic growth (ELG) (Ghatak et al., 1997; Ramos, 2001; Yanikkaya, 2003; Awokuse, 2003; Abu Al-Foul, 2004; Shirazi and Manap, 2004; Abu-Stait, 2005; Siliverstovs and Herzer, 2006; Ferreira, 2009; Gbaiye et al., 2013), b) a bidirectional causal relationship (ELG-GLE) between exports and economic growth (Awokuse, 2007; Elbeydi et al., 2010; El-Sakka and Al-Mutairi, 2000; Abu-Qarn and Abu-Bader, 2004), c) a unidirectional causal relationship from economic growth to exports (GLE) (Panas and Vamvoukas, 2002; Abou-Stait, 2005; Love and Chandra, 2005) or d) no causal link between exports and economic growth (Jung and Marshall, 1985; Kwan and Cotsomitis, 1991; El-Sakka and Al-Mutairi, 2000; Tang, 2006).

If all the variables are integrated of order one and cointegrated, the Granger causality test will be based on VECM framework:

$$\Delta Y_t = \alpha_{10} + \sum_{j=1}^{p} \beta_{1j} \Delta Y_{t-j} + \sum_{j=1}^{p} \gamma_{1j} \Delta X_{t-j} - \lambda_y ECT_{t-1} + u_{1t} \qquad (4.3.5.3)$$

$$\Delta X_t = \alpha_{20} + \sum_{j=1}^{p} \beta_{2j} \Delta Y_{t-j} + \sum_{j=1}^{p} \gamma_{2j} \Delta X_{t-j} - \lambda_x ECT_{t-1} + u_{2t} \qquad (4.3.5.4)$$

In the above VECM framework, ΔY_t and ΔX_t , are influenced by both short-term difference lagged variables (ΔY_{t-j} and ΔX_{t-j}) and long-term error correction terms (*ECT_{t-1}*). The short-run causality from X_t to Y_t and from Y_t to X_t is determined by the joint significance of the coefficients of the lagged difference variables γ_{1j} and β_{1j} respectively. In addition, if the coefficients λ_y or λ_x of the error correction terms are significant ($\lambda_y \neq 0$, $\lambda_x \neq 0$), a long-run causality runs from the explanatory variables to the dependent variable. It should be noted that in multivariate causality tests, it is not possible to indicate which explanatory variable causes the dependent variable. Therefore, if the error correction coefficient is significantly different from zero, the causality runs interactively, through the error correction term, from the explanatory variables to the dependent variable.

4.3.6 Toda-Yamamoto Granger Causality test

As described above, the causality test based on ECMs requires pretesting for the cointegrating rank. According to Clarke and Mirza (2006:207), “the practice of pretesting for cointegration can result in severe overrejections of the non-causal null", while type I and II error may occur when testing for cointegration. In addition, as noted by Toda and Phillips (1993) the Granger causality tests in ECM's are complex and suffer from nuisance parameter dependency asymptotically in some cases. In contrast, the Granger causality test proposed by Toda and Yamamoto (1995) does not require testing for cointegration, avoiding the possible pretest biases. For this reason, this research applies the modified version of the Granger causality test (MWALD) proposed by Toda and Yamamoto (1995). In the present research, the Toda and Yamamoto Granger causality test (T-Y) involves the following models:

MODEL 1: Y=f (K, X, IMP)

$$LY_t = \alpha_{10} + \sum_{j=1}^{p+dmax} \beta_{1j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{1j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{1j} LX_{t-j} + \\ + \sum_{j=1}^{p+dmax} \zeta_{1j} LIMP_{t-j} + \varepsilon_{1t} \quad (4.3.6.1)$$

$$LK_t = \alpha_{20} + \sum_{j=1}^{p+dmax} \beta_{2j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{2j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{2j} LX_{t-j} + \\ + \sum_{j=1}^{p+dmax} \zeta_{2j} LIMP_{t-j} + \varepsilon_{2t} \quad (4.3.6.2)$$

$$LX_t = \alpha_{30} + \sum_{j=1}^{p+dmax} \beta_{3j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{3j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{3j} LX_{t-j} + \\ + \sum_{j=1}^{p+dmax} \zeta_{3j} LIMP_{t-j} + \varepsilon_{3t} \quad (4.3.6.3)$$

$$LIMP_t = \alpha_{40} + \sum_{j=1}^{p+dmax} \beta_{4j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{4j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{4j} LX_{t-j} + + \sum_{j=1}^{p+dmax} \zeta_{4j} LIMP_{t-j} + \varepsilon_{4t} \quad (4.3.6.4)$$

MODEL 2: Y=f (K, HC, X, IMP)

$$LY_t = \alpha_{10} + \sum_{j=1}^{p+dmax} \beta_{1j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{1j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{1j} LHC_{t-j} + + \sum_{j=1}^{p+dmax} \zeta_{1j} LX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{1j} LIMP_{t-j} + \varepsilon_{1t} \quad (4.3.6.5)$$

$$LK_t = \alpha_{20} + \sum_{j=1}^{p+dmax} \beta_{2j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{2j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{2j} LHC_{t-j} + + \sum_{j=1}^{p+dmax} \zeta_{2j} LX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{2j} LIMP_{t-j} + \varepsilon_{2t} \quad (4.3.6.6)$$

$$LHC_t = \alpha_{30} + \sum_{j=1}^{p+dmax} \beta_{3j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{3j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{3j} LHC_{t-j} + + \sum_{j=1}^{p+dmax} \zeta_{3j} LX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{3j} LIMP_{t-j} + \varepsilon_{3t} \quad (4.3.6.7)$$

$$LX_t = \alpha_{40} + \sum_{j=1}^{p+dmax} \beta_{4j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{4j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{4j} LHC_{t-j} + + \sum_{j=1}^{p+dmax} \zeta_{4j} LX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{4j} LIMP_{t-j} + \varepsilon_{4t} \quad (4.3.6.8)$$

$$LIMP_t = \alpha_{50} + \sum_{j=1}^{p+dmax} \beta_{5j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{5j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{5j} LHC_{t-j} + + \sum_{j=1}^{p+dmax} \zeta_{5j} LX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{5j} LIMP_{t-j} + \varepsilon_{5t} \quad (4.3.6.9)$$

MODEL 3: Y=f (K, HC, PX, MX, IMP)

$$LY_t = \alpha_{10} + \sum_{j=1}^{p+dmax} \beta_{1j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{1j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{1j} LHC_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \zeta_{1j} LPX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{1j} LMX_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \mu_{1j}\ LIMP_{t-j} + \varepsilon_{1t} \qquad (4.3.6.10)$$

$$LK_t = \alpha_{20} + \sum_{j=1}^{p+dmax} \beta_{2j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{2j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{2j} LHC_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \zeta_{2j} LPX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{2j}\ LMX_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \mu_{2j}\ LIMP_{t-j} + \varepsilon_{2t} \qquad (4.3.6.11)$$

$$LHC_t = \alpha_{30} + \sum_{j=1}^{p+dmax} \beta_{3j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{3j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{3j} LHC_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \zeta_{3j} LPX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{3j}\ LMX_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \mu_{3j}\ LIMP_{t-j} + \varepsilon_{3t} \qquad (4.3.6.12)$$

$$LPX_t = \alpha_{40} + \sum_{j=1}^{p+dmax} \beta_{4j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{4j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{4j} LHC_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \zeta_{4j} LPX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{4j}\ LMX_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \mu_{4j}\ LIMP_{t-j} + \varepsilon_{4t} \qquad (4.3.6.13)$$

$$LMX_t = \alpha_{50} + \sum_{j=1}^{p+dmax} \beta_{5j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{5j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{5j} LHC_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \zeta_{5j} LPX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{5j}\ LMX_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \mu_{5j}\ LIMP_{t-j} + \varepsilon_{5t} \qquad (4.3.6.14)$$

$$LIMP_t = \alpha_{60} + \sum_{j=1}^{p+dmax} \beta_{6j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{6j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{6j} LHC_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \zeta_{6j} LPX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{6j} LMX_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \mu_{6j} LIMP_{t-j} + \varepsilon_{6t} \quad (4.3.6.15)$$

MODEL 4: Y=f (K, HC, FX, IMP)

$$LY_t = \alpha_{10} + \sum_{j=1}^{p+dmax} \beta_{1j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{1j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{1j} LHC_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \zeta_{1j} LFX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{1j} LIMP_{t-j} + \varepsilon_{1t} \quad (4.3.6.16)$$

$$LK_t = \alpha_{20} + \sum_{j=1}^{p+dmax} \beta_{2j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{2j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{2j} LHC_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \zeta_{2j} LFX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{2j} LIMP_{t-j} + \varepsilon_{2t} \quad (4.3.6.17)$$

$$LHC_t = \alpha_{30} + \sum_{j=1}^{p+dmax} \beta_{3j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{3j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{3j} LHC_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \zeta_{3j} LFX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{3j} LIMP_{t-j} + \varepsilon_{3t} \quad (4.3.6.18)$$

$$LFX_t = \alpha_{40} + \sum_{j=1}^{p+dmax} \beta_{4j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{4j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{4j} LHC_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \zeta_{4j} LFX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{4j} LIMP_{t-j} + \varepsilon_{4t} \quad (4.3.6.19)$$

$$LIMP_t = \alpha_{50} + \sum_{j=1}^{p+dmax} \beta_{5j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{5j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{5j} LHC_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \zeta_{5j} LFX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{5j} LIMP_{t-j} + \varepsilon_{5t} \quad (4.3.6.20)$$

MODEL 5: Y=f (K, HC, NOILX, REX, IMP)

$$LY_t = \alpha_{10} + \sum_{j=1}^{p+dmax} \beta_{1j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{1j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{1j} LHC_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \zeta_{1j} LNOILX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{1j} LREX_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \mu_{1j} LIMP_{t-j} + \varepsilon_{1t} \quad (4.3.6.21)$$

$$LK_t = \alpha_{20} + \sum_{j=1}^{p+dmax} \beta_{2j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{2j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{2j} LHC_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \zeta_{2j} LNOILX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{2j} LREX_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \mu_{2j} LIMP_{t-j} + \varepsilon_{2t} \quad (4.3.6.22)$$

$$LHC_t = \alpha_{30} + \sum_{j=1}^{p+dmax} \beta_{3j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{3j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{3j} LHC_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \zeta_{3j} LNOILX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{3j} LREX_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \mu_{3j} LIMP_{t-j} + \varepsilon_{3t} \quad (4.3.6.23)$$

$$LNOILX_t = \alpha_{40} + \sum_{j=1}^{p+dmax} \beta_{4j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{4j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{4j} LHC_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \zeta_{4j} LNOILX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{4j} LREX_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \mu_{4j} LIMP_{t-j} + \varepsilon_{4t} \quad (4.3.6.24)$$

$$LREX_t = \alpha_{50} + \sum_{j=1}^{p+dmax} \beta_{5j} LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{5j} LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{5j} LHC_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \zeta_{5j} LNOILX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{5j} LREX_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \mu_{5j} LIMP_{t-j} + \varepsilon_{5t} \quad (4.3.6.25)$$

$$LIMP_t = \alpha_{60} + \sum_{j=1}^{p+dmax} \beta_{6j}\, LY_{t-j} + \sum_{j=1}^{p+dmax} \gamma_{6j}\, LK_{t-j} + \sum_{j=1}^{p+dmax} \delta_{6j}\, LHC_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \zeta_{6j}\, LNOILX_{t-j} + \sum_{j=1}^{p+dmax} \theta_{6j}\, LREX_{t-j} +$$

$$+ \sum_{j=1}^{p+dmax} \mu_{6j}\, LIMP_{t-j} + \varepsilon_{6t} \qquad (4.3.6.26)$$

Where p is the optimal lag length, selected by minimising the value of Schwartz Information Criterion (SIC) and Akaike Information criterion (AIC), while dmax is the maximum order of integration of the variables in the model. In particular, the selected lag length (p) is augmented by the maximum order of integration (dmax) and the chi-square test is applied to the first p VAR coefficients.

CHAPTER 5. EMPIRICAL RESULTS: THE CAUSAL RELATIONSHIP BETWEEN MERCHANDISE EXPORTS AND ECONOMIC GROWTH

5.1 Introduction

This chapter carries out an empirical analysis of the causal relatioship between merchandise exports and economic for UAE over the period 1975-2012. The analysis is based on two models: one based on an AK model and the other based on a neoclassical model, both augmented with merchandise exports and imports of goods and services. In the first model, the causality between exports and economic growth is examined assuming that the aggregate production of the economy can be expressed as a function of physical capital, imports and merchandise exports. The second model, except from the physical capital, exports and imports, includes the human capital as an input factor of production (see Chapter 4, section 4.1.1 for the outline of the theoretical models).

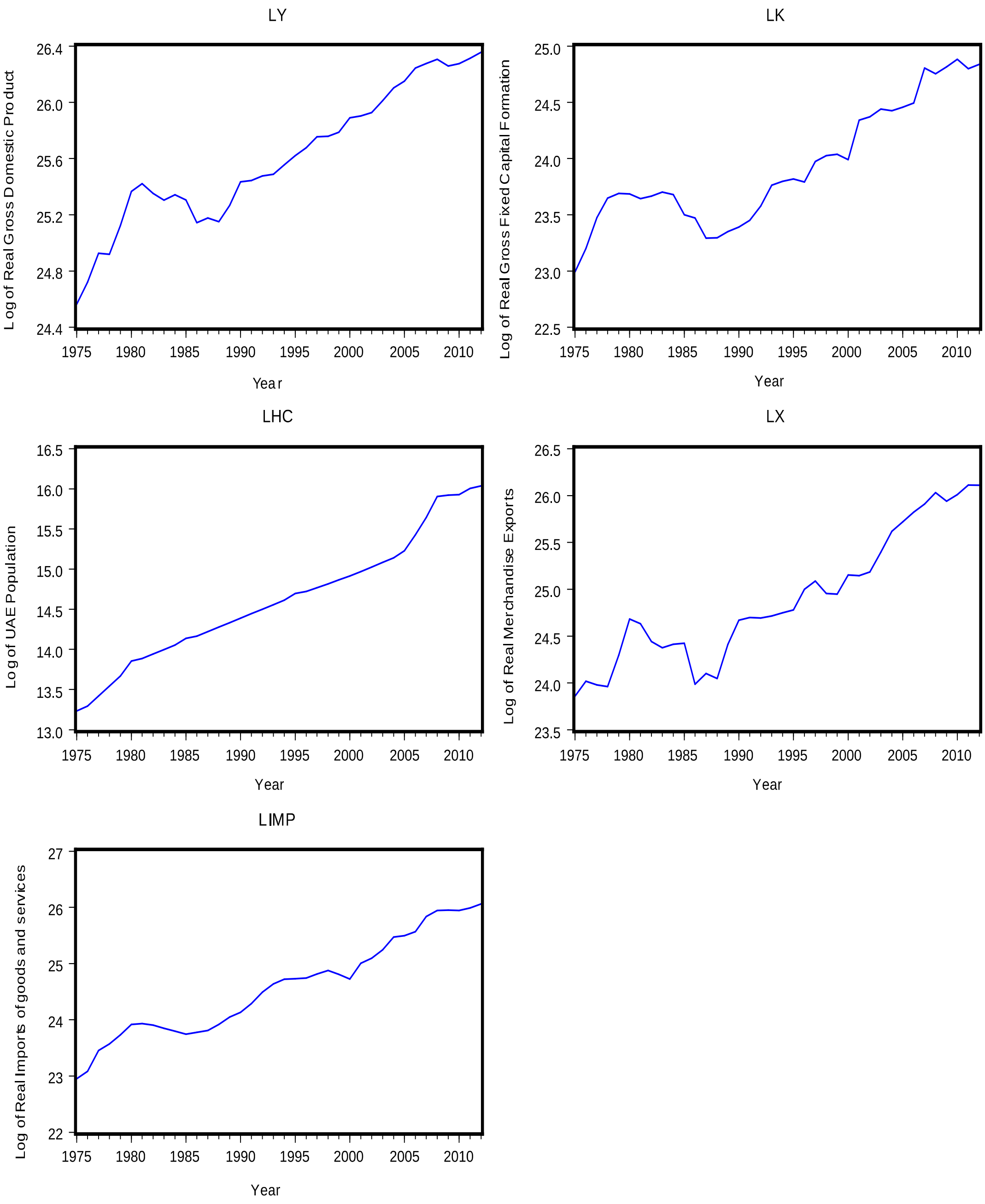
The first section of this chapter examines the time series properties of the data for UAE over the period 1975-2012. The two subsequent sections present in detail the analysis and findings pertaining to the first research question, which investigates whether merchandise exports cause economic growth or vice versa. The main findings and their consistency with previous research are presented in the last section.

5.2 Unit root tests for model 1 and model 2

Before analysing the causal relations among GDP and merchandise exports, it is important to ensure that all variables are stationary, which means that they have a constant mean and variance. The stationarity of real GDP (LY), real gross fixed capital formation (LK), population (HC), real merchandise exports (LX) and real imports of goods and services (LIMP) is initially investigated by performing visual inspection of plots and correlograms of the variables at level and first difference. Figure 5.1 shows the pattern of LY, LK, HC, LX and LIMP over the period 1975-2012.

The graphical inspection of the series indicates that all variables at level are potentially non-stationary. In particular, most of the series are upward trended after 1988, while the series of real gross fixed capital formation (LK) and real merchandise exports (LX) are more volatile than the series of real GDP (LY) and real imports (LIMP). In addition, the series of population (HC) has an upward trend and is smoother than all the other series. Therefore, the series can be considered as non-stationary.

Figure 5.1: Pattern of the logarithm of the series over the period 1975-2012



Source: Gross Domestic Product and Exports are taken from the WDI- World Bank, Gross Fixed Capital formation and Imports are taken from IFS- IMF (years 1999-2000 are taken from UAE National Bureau of Statistics and years 2010-2012 are taken from World Bank). Population is obtained from UAE National Bureau of Statistics.

The graphs are produced by using the econometric software Eviews 7

In addition to the visual inspection of plots of the variables at level, the correlograms of the variables are inspected. All variables at level have correlograms that die out slowly, while the autocorrelations of the first differences display the classic pattern of a stationary series described in chapter four, section 4.3.1. The correlograms of the series at levels and first differences are given in figure D.1, Appendix D.

Although the visual inspection of the plots and correlograms suggest that the series at level are not stationary, the stationarity of the series are formally investigated by applying the Augmented Dickey-Fuller (ADF) unit root test, Phillips-Perron (PP) test, Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test and Saikkonen and Lutkepohl (SL) test in log levels and in first differences of the logs. The software Eviews 7 is used to estimate the ADF, PP and KPSS tests, while SL unit root test is performed using JMulti statistical software.

Table 5.1 presents the results of the ADF test for the log levels and first difference of the time series. In particular, the results of the ADF test at log levels indicate that the null hypothesis of non-stationarity cannot be rejected for LY, LK, LHC, LX and LIMP at any conventional significance level. In contrast, after taking the first difference of LY, LK, LX and LIMP the null hypothesis for unit root can be rejected at the 1% level of significance, while the first-differenced series of LHC is found to be stationary at 5% significance level. Hence, the ADF test results indicate that the time series for the period 1975-2012 are integrated of order one I(1).

Table 5.1: ADF test results at logarithmic level and first difference for model 1 and model 2

	Constant with trend			**Constant**			**None**		
	ADF	**Test critical values of % level**		**ADF**	**Test critical values of % level**		**ADF**	**Test critical values of % level**	
LY[(a)]	-2.94	1%	-4.24	-1.76	1%	-3.62	3.64	1%	-2.63
	[1]	5%	-3.54	[0]	5%	-2.94	[0]	5%	-1.95
		10%	-3.20		10%	-2.61		10%	-1.61
DLY[(b)]	-4.38***	1%	-4.24	-4.43***	1%	-3.63	-3.74***	1%	-2.63
	[0]	5%	-3.54	[0]	5%	-2.95	[0]	5%	-1.95
		10%	-3.20		10%	-2.61		10%	-1.61
LK[(c)]	-1.49	1%	-4.23	-0.74	1%	-3.62	2.62	1%	-2.63
	[0]	5%	-3.54	[0]	5%	-2.94	[0]	5%	-1.95
		10%	-3.20		10%	-2.61		10%	-1.61
DLK[(c)]	-5.08***	1%	-4.24	-5.15***	1%	-3.63	-4.66***	1%	-2.63
	[0]	5%	-3.54	[0]	5%	-2.95	[0]	5%	-1.95
		10%	-3.20		10%	-2.61		10%	-1.61
LHC[(a)]	-2.44	1%	-4.24	-0.49	1%	-3.63	2.74	1%	-2.63
	[1]	5%	-3.54	[1]	5%	-2.95	[1]	5%	-1.95
		10%	-3.20		10%	-2.61		10%	-1.61
DLHC[(b)]	-3.48*	1%	-4.24	-3.55**	1%	-3.63	-1.99**	1%	-2.63
	[0]	5%	-3.54	[0]	5%	-2.95	[0]	5%	-1.95
		10%	-3.20		10%	-2.61		10%	-1.61
LX[(c)]	-1.99	1%	-4.23	-0.37	1%	-3.62	2.35	1%	-2.63
	[0]	5%	-3.54	[0]	5%	-2.94	[0]	5%	-1.95
		10%	-3.20		10%	-2.61		10%	-1.61
DLX[(c)]	-5.06***	1%	-4.24	-5.10***	1%	-3.63	-4.66***	1%	-2.63
	[0]	5%	-3.54	[0]	5%	-2.95	[0]	5%	-1.95
		10%	-3.20		10%	-2.61		10%	-1.61
LIMP[(a)]	-2.77	1%	-4.24	-0.81	1%	-3.62	4.89	1%	-2.63
	[1]	5%	-3.54	[0]	5%	-2.94	[0]	5%	-1.95
		10%	-3.20		10%	-2.61		10%	-1.61
DLIMP[(b)]	-4.05**	1%	-4.24	-4.11***	1%	-3.63	-3.03***	1%	-2.63
	[0]	5%	-3.54	[0]	5%	-2.95	[0]	5%	-1.95
		10%	-3.20		10%	-2.61		10%	-1.61

Note: Numbers in parentheses corresponding to ADF test statistics are the optimal lags, chosen based on Schwarz Information Criterion (SIC).

The maximum lag length for the ADF test is found by rounding up $P_{max} = [12^* (T/100)^{1/4}] = [12^* (38/100)^{1/4}] \cong 9$ (Schwert, 1989).

*, **, *** denote the rejection of the null hypothesis of a unit root at 10%, 5% and 1% respectively.

All the time series are tested for unit root under the ADF regressions and the letters in brackets indicate the selected model following Doldado et al. (1990):

$\Delta Y_t = \alpha_0 + \gamma Y_{t-1} + \alpha_2 t + \sum_{i=1}^{p} \beta i \, \Delta Y_{t-i} + \varepsilon_t$ (a)
$\Delta Y_t = \alpha_0 + \gamma Y_{t-1} + \sum_{i=1}^{p} \beta i \, \Delta Y_{t-i} + \varepsilon_t$ (b)
$\Delta Y_t = \gamma Y_{t-1} + \sum_{i=1}^{p} \beta i \, \Delta Y_{t-i} + \varepsilon_t$ (c)

Moreover, the Phillips-Perron test results indicate that the null hypothesis of a unit root cannot be rejected for LY, LK, LHC, LX and LIMP at any conventional significance level. Thus, the PP unit root test suggests that none of the variables at level represents a stationary process. In contrast, DLY, DLK, DLX and DLIMP are found to be stationary at 1% level of significance, while DLHC is found to be stationary at 5% significance level. Therefore, all variables are integrated of order one and PP test results are in line with the ADF results. The PP test results are presented in table 5.2.

The KPSS test results including an intercept in the equation, indicate that the null hypothesis of stationarity is rejected for LY, LK, LX and LHC at 5% significance level, while the null hypothesis for LIMP is rejected at 1% significance level. The same test is also conducted including an intercept and linear deterministic trend and the results indicate that LK, LX are non-stationary at 5% significance level, while LHC is non-stationary at 10%. In contrast, the variables LY and LIMP are found to be stationary at 5% significance level after the inclusion of linear trend in the equation. After taking the first difference of the series, all variables are found to be stationary at any conventional significance level with and without the inclusion of linear deterministic trend. The KPSS results are reported in table 5.3.

Table 5.2: PP test results at logarithmic level and first difference for model 1 and model 2

	Constant with trend			**Constant**			**None**		
	PP	**Test critical values of % level**		**PP**	**Test critical values of % level**		**PP**	**Test critical values of % level**	
LY$^{(a)}$	-2.86	1%	-4.23	-1.64	1%	-3.62	2.97	1%	-2.63
	[3]	5%	-3.54	[3]	5%	-2.94	[3]	5%	-1.95
		10%	-3.20		10%	-2.61		10%	-1.61
DLY$^{(b)}$	-4.38***	1%	-4.24	-4.41***	1%	-3.63	-3.68***	1%	-2.63
	[0]	5%	-3.54	[1]	5%	-2.95	[1]	5%	-1.95
		10%	-3.20		10%	-2.61		10%	-1.61
LK$^{(c)}$	-1.74	1%	-4.23	-0.83	1%	-3.62	2.44	1%	-2.63
	[2]	5%	-3.54	[2]	5%	-2.94	[1]	5%	-1.95
		10%	-3.20		10%	-2.61		10%	-1.61
DLK$^{(c)}$	-5.05***	1%	-4.24	-5.12***	1%	-3.63	-4.66***	1%	-2.63
	[2]	5%	-3.54	[1]	5%	-2.95	[0]	5%	-1.95
		10%	-3.20		10%	-2.61		10%	-1.61
LHC$^{(c)}$	-1.70	1%	-4.23	-0.19	1%	-3.62	6.22	1%	-2.63
	[2]	5%	-3.54	[2]	5%	-2.94	[2]	5%	-1.95
		10%	-3.20		10%	-2.61		10%	-1.61
DLHC$^{(b)}$	-3.52*	1%	-4.24	-3.58**	1%	-3.63	-3.58*	1%	-3.63
	[1]	5%	-3.54	[1]	5%	-2.95	[2]	5%	-2.95
		10%	-3.20		10%	-2.61		10%	-2.61
LX$^{(c)}$	-2.12	1%	-4.23	-0.27	1%	-3.62	2.98	1%	-2.63
	[3]	5%	-3.54	[6]	5%	-2.94	[7]	5%	-1.95
		10%	-3.20		10%	-2.61		10%	-1.61
DLX$^{(c)}$	-6.11***	1%	-4.24	-5.41***	1%	-3.63	-4.63***	1%	-2.63
	[14]	5%	-3.54	[12]	5%	-2.95	[5]	5%	-1.95
		10%	-3.20		10%	-2.61		10%	-1.61
LIMP$^{(c)}$	-2.51	1%	-4.23	-0.82	1%	-3.62	3.77	1%	-2.63
	[4]	5%	-3.54	[3]	5%	-2.94	[3]	5%	-1.95
		10%	-3.20		10%	-2.61		10%	-1.61
DLIMP$^{(b)}$	-4.05**	1%	-4.24	-4.09***	1%	-3.63	-2.94***	1%	-2.63
	[3]	5%	-3.54	[3]	5%	-2.95	[4]	5%	-1.95
		10%	-3.20		10%	-2.61		10%	-1.61

Note: Bandwidth in [ ] (Newey-West automatic) using Bartlett kernel estimation method.

*, **, *** denote the rejection of the null hypothesis of a unit root at 10%, 5% and 1% respectively.

All the time series are tested for the unit root including intercept and trend (a), intercept only (b) and no constant or trend (c). The letters in brackets indicate the selected model following Doldado et al. (1990).

Table 5.3: KPSS test results at logarithmic level and first difference for model 1 and model 2

	Constant with trend			Constant		
	KPSS	Test critical values of % level		KPSS	Test critical values of % level	
LY(a)	0.074	1%	0.216	0.737**	1%	0.739
	[4]	5%	0.146	[5]	5%	0.463
		10%	0.119		10%	0.347
DLY(b)	0.098	1%	0.216	0.129	1%	0.739
	[2]	5%	0.146	[3]	5%	0.463
		10%	0.119		10%	0.347
LK(a)	0.148**	1%	0.216	0.663**	1%	0.739
	[5]	5%	0.146	[5]	5%	0.463
		10%	0.119		10%	0.347
DLK(b)	0.114	1%	0.216	0.110	1%	0.739
	[1]	5%	0.146	[1]	5%	0.463
		10%	0.119		10%	0.347
LHC(a)	0.120*	1%	0.216	0.743**	1%	0.739
	[4]	5%	0.146	[5]	5%	0.463
		10%	0.119		10%	0.347
DLHC(b)	0.109	1%	0.216	0.112	1%	0.739
	[2]	5%	0.146	[2]	5%	0.463
		10%	0.119		10%	0.347
LX(a)	0.151**	1%	0.216	0.706**	1%	0.739
	[4]	5%	0.146	[5]	5%	0.463
		10%	0.119		10%	0.347
DLX(b)	0.108	1%	0.216	0.114	1%	0.739
	[8]	5%	0.146	[7]	5%	0.463
		10%	0.119		10%	0.347
LIMP(a)	0.096	1%	0.216	0.741***	1%	0.739
	[4]	5%	0.146	[5]	5%	0.463
		10%	0.119		10%	0.347
DLIMP(a)	0.068	1%	0.216	0.067	1%	0.739
	[3]	5%	0.146	[3]	5%	0.463
		10%	0.119		10%	0.347

Note: Bandwidth in [ ] (Newey-West automatic) using Bartlett kernel estimation method.

*, **, *** denote the rejection of the null hypothesis of a unit root at 10%, 5% and 1% respectively.

All the time series are tested for the unit root including intercept and trend (a), intercept only (b). The letters in brackets indicate the selected model following Doldado et al. (1990).

In addition, the SL unit root test with structural break is performed, as a structural break can be identified as evidence of non-stationarity. The results of the SL unit root test for the log levels and first difference of the time series are presented in table 5.4.

Table 5.4: SL test results with a structural break at logarithmic level and first difference for model 1 and model 2

	Without trend				**With trend**			
	UR	**Year**	**Test critical values of % level**		**UR**	**Year**	**Test critical values of % level**	
LY	-0.63	1980	1%	-3.48	-2.57	1986	1%	-3.55
	[0]		5%	-2.88	[3]		5%	-3.03
			10%	-2.58			10%	-2.76
DLY	-5.27***	1986	1%	-3.48	-4.66***	1986	1%	-3.55
	[0]		5%	-2.88	[0]		5%	-3.03
			10%	-2.58			10%	-2.76
LK	-0.80	2001	1%	-3.48	-1.42	2001	1%	-3.55
	[0]		5%	-2.88	[0]		5%	-3.03
			10%	-2.58			10%	-2.76
DLK	-5.36***	2001	1%	-3.48	-4.06***	2001	1%	-3.55
	[0]		5%	-2.88	[0]		5%	-3.03
			10%	-2.58			10%	-2.76
LHC	-0.52	2008	1%	-3.48	-2.33	2008	1%	-3.55
	[1]		5%	-2.88	[1]		5%	-3.03
			10%	-2.58			10%	-2.76
DLHC	-3.62***	2008	1%	-3.48	-3.55**	2008	1%	-3.55
	[0]		5%	-2.88	[1]		5%	-3.03
			10%	-2.58			10%	-2.76
LX	-0.45	1986	1%	-3.48	-2.96*	1986	1%	-3.55
	[0]		5%	-2.88	[2]		5%	-3.03
			10%	-2.58			10%	-2.76
DLX	-4.849***	1986	1%	-3.48	-4.54***	1986	1%	-3.55
	[0]		5%	-2.88	[0]		5%	-3.03
			10%	-2.58			10%	-2.76
LIMP	0.08	2001	1%	-3.48	-2.96*	2001	1%	-3.55
	[1]		5%	-2.88	[1]		5%	-3.03
			10%	-2.58			10%	-2.76
DLIMP	-4.49***	2001	1%	-3.48	-4.19***	2001	1%	-3.55

[0]	5%	-2.88	[0]	5%	-3.03
	10%	-2.58		10%	-2.76

Note: Numbers in parentheses corresponding to SL test statistics are the optimal lags, chosen based on Schwarz Information Criterion (SIC).

Critical values are tabulated in Lanne et al. (2002)

*, **, *** denote the rejection of the null hypothesis of a unit root at 10%, 5% and 1% respectively.

All the time series are tested for the unit root including intercept and trend and intercept only.

The SL test is conducted including an intercept and linear trend and also using an intercept only. Both results indicate that the variables at level are non-stationary at conventional levels of significance. The first-differenced series DLY, DLK, DLHC, DLX and DLIMP are stationary at conventional significance levels, with and without the inclusion of a trend in the equation.

Since all variables are I(1), we can apply the cointegration test to investigate the existence of a long-run relationship between the variables in each model.

5.3 Model 1: The causality between merchandise exports and economic growth: *Augmented AK Production Function*

5.3.1 Model 1: Lag Order Selection

Before testing for cointegration, the lag length for the VAR system is determined by minimizing the Schwarz Information Criterion (SIC) and Akaike Information Criterion (AIC). Given the annual frequency of the data and the sample size (T= 38), the maximum of three lags is allowed in order to allow for sufficient degrees of freedom. Table 5.5 reports that SIC suggests the use of 1 lag in the VAR system, while AIC suggests lag 2. It is known that SIC is preferable for small samples (Lutkepohl, 1991), while at the same time lag 1 is the smallest possible lag length which ensures that the residuals are multivariate normal and homoscedastic, with no evidence of serial correlation. Therefore, the VAR model is estimated with one lag of each variable.

Table 5.5: Model 1: VAR lag order selection criteria

Lag	0	1	2	3
AIC	-2.011	-8.845	-8.901*	-8.532
SC	-1.833	-7.956*	-7.302	-6.221

*Indicates lag order selected by the criterion

AIC: Akaike Information Criterion

SC: Schwarz Information Criterion

The multivariate specification tests for the VAR(1) model are presented in table E.1, Appendix E. As it can be seen from table E.1, there is no problem of serial correlation, while the residuals are multivariate normal and homoscedastic. Therefore, the selected VAR model adequately describes the data.

5.3.2 Model 1: Cointegration test

The Johansen cointegration test is conducted in order to investigate the existence of a long-run relationship between LY, LK, LX and LIMP. Table 5.6, shows that null hypothesis of no cointegration is rejected at 5% significance level, indicating the existence of one cointegrating vector. In particular, the adjusted Trace statistic for no cointegration vector is 58.93, which is greater than the critical value at 5%. Therefore, the Johansen's cointegration results suggest that real GDP, real gross fixed capital formation, real exports and real imports are cointegrated and follow a common path.

Table 5.6: Model 1: Johansen's Cointegration Test results

Hypothesized Number of Cointegrating equations	Adjusted Trace Statistic	Critical Value		
		1%	5%	10%
r=0	58.93**	60.16	53.12	49.65
r≤1	32.59	41.07	34.91	32.00
r≤2	9.13	24.60	19.96	17.85
r≤3	3.63	12.97	9.24	7.52

Note: Critical values are taken from Osterwald-Lenum (1992). The model includes a restricted constant (Model selection based on Pantula Principle)

*, ** and *** indicate rejection at 10%, 5% and 1% significance level respectively

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

$$LY_t = \underset{(3.358)}{0.548^{***}}LK_t - \underset{(3.018)}{0.621^{***}}LX_t + \underset{(4.450)}{0.638^{***}}LIMP_t + \underset{(7.789)}{12.352^{***}} \qquad (5.3.2.1)$$

From the above equation, an 1% increase in real merchandise exports leads to a 0.621% decrease in real GDP, while a 1% increase in physical capital and imports leads to a 0.548% and 0.638% increase in real GDP respectively. These results suggest that exports seem to have an inverse effect on economic growth. The negative relationship between exports and economic growth can be explained by the high share of fuel-mining exports in UAE merchandise exports. This category of exports can be subject to excessive price fluctuations (Myrdal, 1957) and does not offer knowledge spillovers and other externalities as manufactured exports (Herzer et al., 2006). In general, as Sachs and Warner (1995) notes, a higher share of primary exports is associated with lower growth. For this reason, the long-run relationship between fuel and mining exports is examined separately in chapter 7, section 7.3.

5.3.3 Model 1: Vector Error Correction Model

Since the variables are integrated of order one and cointegrated, a Vector Error Correction model (VECM) should be specified (for further details see table E.2, Appendix E). The VECM is checked for autocorrelation, normality and homoscedasticity of the residuals. The Portmanteau test is conducted in order to test for the presence of autocorrelation, the Jarque-Bera test to verify the normality of the residuals and the White test to check for heteroskedasticity. As it can be seen from table E.3, Appendix E, the White test chi-square statistic is equal to 116.057, with the corresponding p-value of 0.130, indicating that the null hypothesis of homoscedasticity cannot be rejected at any significance level. In addition the null hypothesis of no autocorrelation of residuals cannot be rejected up to lag length 12 at 5% significance level, since all corresponding p-values are greater than 5%. Moreover, the null hypothesis of multivariate normal residuals cannot be rejected at 5% significance level.

In addition, the stability of the VECM is checked by calculating the inverse roots of the characteristic AR polynomial. The analysis shows that the VEC specification imposes 3 unit roots, while the remaining roots have modulus less than one. Therefore, since there are 4 variables and one cointegrating equation in the system, the estimated VECM is stable. The stability results are presented in table E.4 and figure E.1, Appendix E.

Since the aim of this reseach is to find the direction of the causality between exports and economic growth, emphasis is placed on the estimated error correction models for ΔLY_t and ΔLX_t. The absolute t-statistics are reported in the parentheses:

$$\Delta LY_t = \underset{(0.112)}{-0.023}\,\Delta LY_{t-1} + \underset{(2.087)}{0.228^{**}}\,\Delta LK_{t-1} + \underset{(3.609)}{0.378^{***}}\,\Delta LX_{t-1} - \underset{(1.892)}{0.241^{*}}\,\Delta LIMP_{t-1} - \underset{(5.648)}{0.346^{***}}\,ECT_{t-1} \quad (5.3.3.1)$$

$$\Delta LX_t = \underset{(1.099)}{-0.542}\,\Delta LY_{t-1} + \underset{(0.972)}{0.253}\,\Delta LK_{t-1} + \underset{(2.688)}{0.673^{**}}\,\Delta LX_{t-1} - \underset{(0.827)}{0.252}\,\Delta LIMP_{t-1} - \underset{(4.262)}{0.623^{***}}\,ECT_{t-1} \quad (5.3.3.2)$$

5.3.4 Model 1: Granger Causality in VECM

The short-run Granger causality results for UAE are reported in table 5.7:

Table 5.7: Model 1: Short-run Granger causality test

	Source of causation				
	ΔLY_t	**ΔLK_t**	**ΔLX_t**	**$\Delta LIMP_t$**	**ALL**
Dependent Variable	χ^2 *(1)*	χ^2 *(1)*	χ^2 *(1)*	χ^2 *(1)*	χ^2 *(3)*
ΔLY_t	-	4.355**	13.025***	3.579*	15.930***
ΔLK_t	1.774	-	0.098	0.105	6.049
ΔLX_t	1.207	0.945	-	0.683	2.802
$\Delta LIMP_t$	0.155	0.404	1.527	-	6.102

Note: *, ** and *** indicates significance at 10%, 5% and 1% significance level respectively

df in parentheses

The diagnostic tests for the VECM model are presented in table E.2, Appendix E.

The results show that the null hypothesis of non causality from exports to economic growth is rejected at 1% significance level, indicating that there is a unidirectional causality from merchandise exports to economic growth. Therefore, the ELG hypothesis is valid in the short-run over the period 1975-2012. In addition, the results show that physical capital Granger causes economic growth at 5% significance level, while imports Granger causes economic growth at 10% significance level. In contrast, the null hypothesis of non causality from economic growth to exports cannot be rejected at any conventional significance level, indicating that GLE hypothesis is not valid in the short-run.

Moreover, the Chi-square is performed to investigate the joint significance of the explanatory variables. The results indicate that the null hypothesis of non causality from ΔLK_t, ΔLX_t and $LIMP_t$ to economic growth is rejected at 1%

significance level. Table 5.8 summarizes the short-run Granger causality results.

Table 5.8: Model 1: Short-run Granger Causality results

ΔLX_t	→	ΔLY_t
ΔLK_t	→	ΔLY_t
$\Delta LIMP_t$	→	ΔLY_t
ΔLK_t, ΔLX_t, $\Delta LIMP_t$	→	ΔLY_t

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

Table 5.9 presents the long-run causality results within ECM framework. In the estimated ECMs for economic growth and merchandise exports, the coefficients of the lagged error correction terms are significant at 1% significance level. In particular, the coefficient of the error correction term (-0.346) in equation (5.3.3.1) is negative and significant at 1% significance level, indicating that approximately 34.6% of the disequilibrium in real GDP caused by a shock in year t-1, converges back to the long-run equillibrium in year t. This result can be interpreted as a long-run causality which runs interactively through the error correction term from physical capital, exports and imports to economic growth.

In addition, the negative and significant error correction coefficient (-0.623) in equation (5.3.3.2) indicates that approximately 62.3% of the disequilibrium in real exports caused by a shock in year t-1, converges back to the long-run equillibrium in year t. This result can be interpreted as a long-run causality which runs interactively through the error correction term from economic growth, physical capital and imports to merchandise exports.

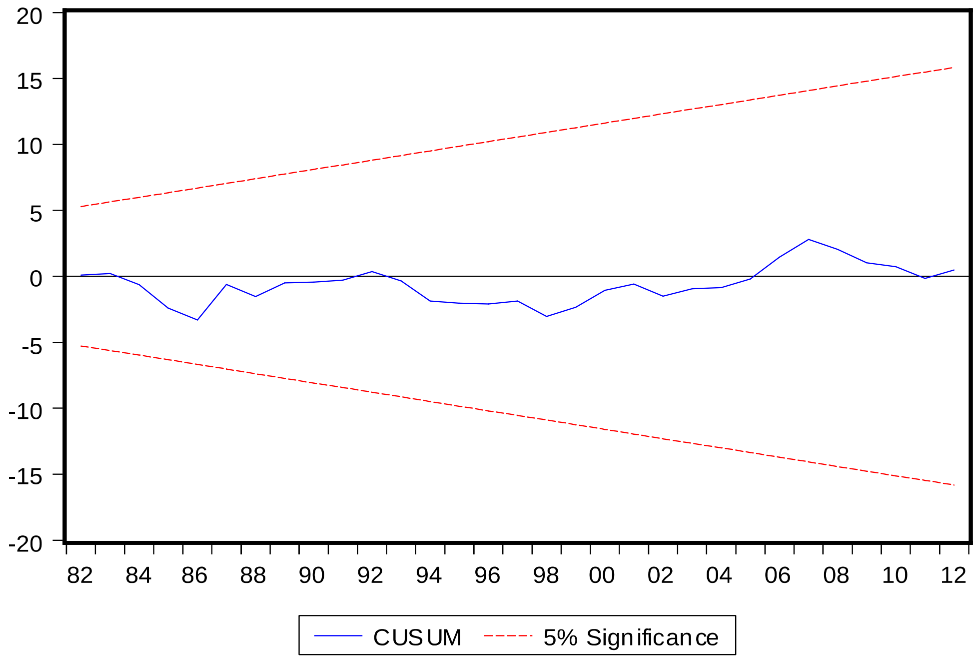
Table 5.9: Model 1: Long-run Granger Causality within ECM framework

Dependent Variables	ΔLY_t	ΔLX_t
ECT_{t-1}	-0.346***	-0.623***
t-statistic	[5.648]	[4.262]

Note: *** denote statistical significance at 1% significance level. t-statistics in [ ]

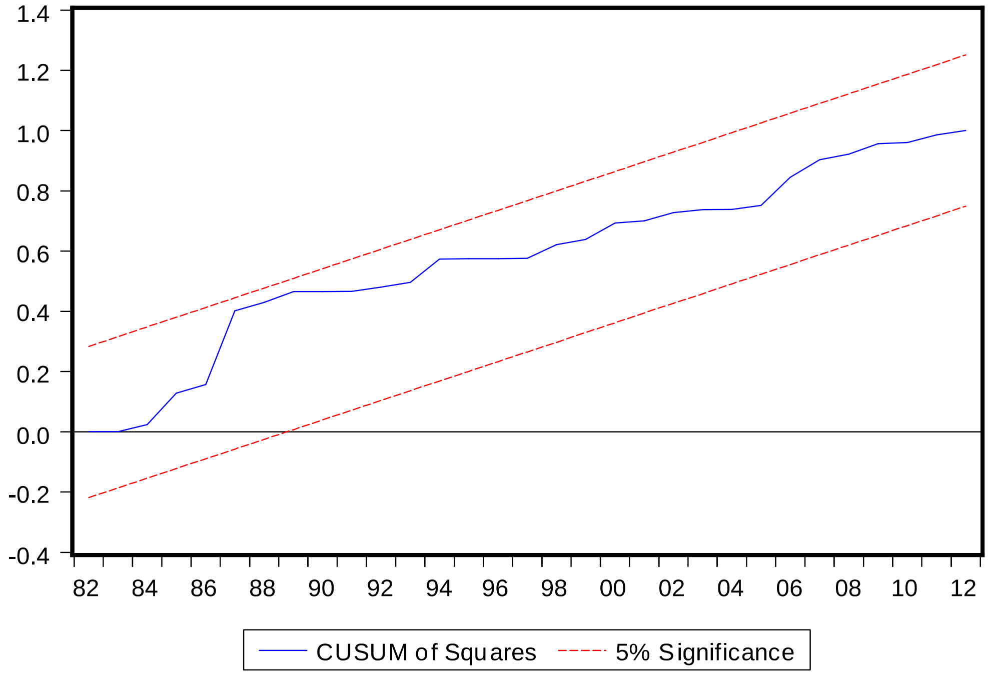
Since the aim of this reseach focuses on the relationship between exports and economic growth, emphasis is placed on the structural stability of the parameters of the estimated ECMs for ΔLY_t and ΔLX_t. The cumulative sum of recursive residuals (CUSUM) and the CUSUM of squares (CUSUMQ) are applied, in order to assess the constancy of the parameters of the equation 5.3.3.1 and the results are presented in figure 5.2 and figure 5.3.

Figure 5.2: Model 1: Plot of CUSUM for the estimated ECM for economic growth



$\Delta LY_t = -0.023\ \Delta LY_{t-1} + 0.228\ \Delta LK_{t-1} + 0.378\ \Delta LX_{t-1} - 0.241\ \Delta LIMP_{t-1} - 0.346\ ECT_{t-1}$

Figure 5.3: Model 1: Plot of CUSUMQ for the estimated ECM for economic growth

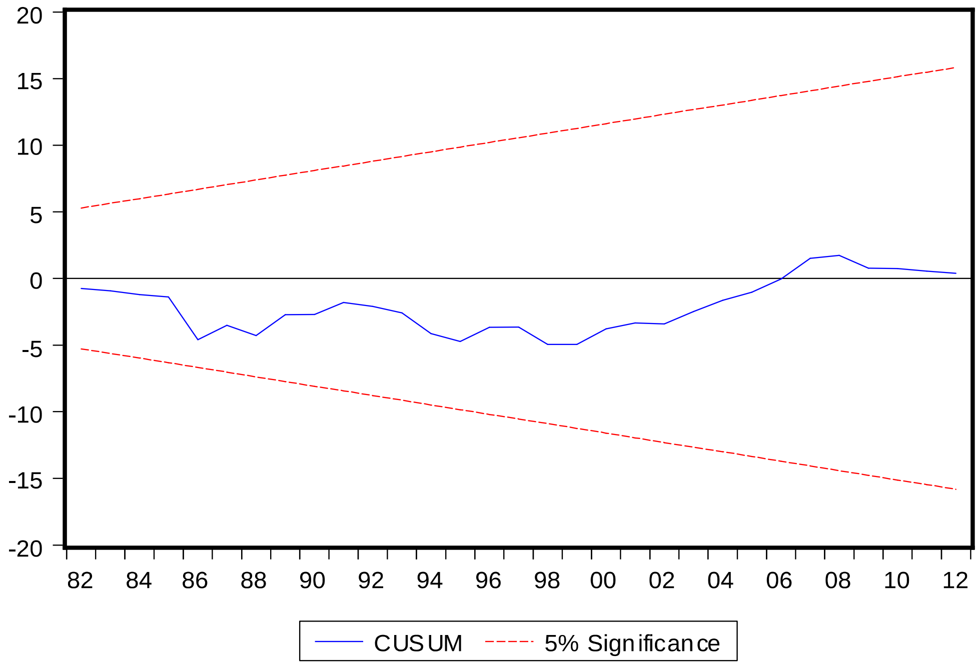


$\Delta LY_t = -0.023\ \Delta LY_{t-1} + 0.228\ \Delta LK_{t-1} + 0.378\ \Delta LX_{t-1} - 0.241\ \Delta LIMP_{t-1} - 0.346\ ECT_{t-1}$

The CUSUM plots for the estimated ECM for economic growth show that there is no movement outside the 5% critical lines of parameter stability. Therefore, the model for economic growth is stable even during the oil crises of 1986 and 2000.

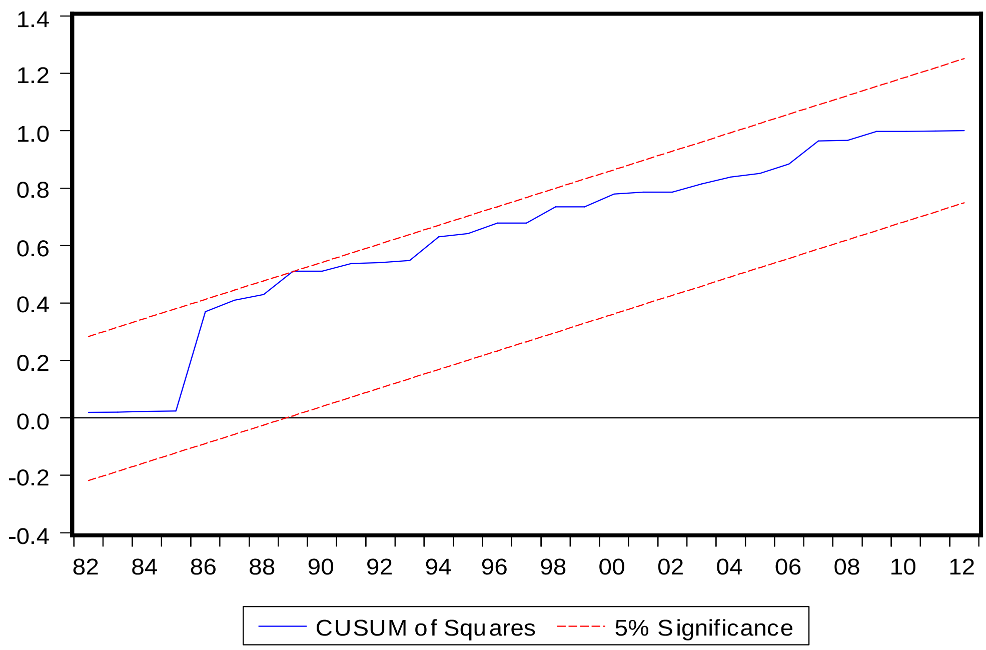
As far as the structural stability of the parameters of the ECM for exports (equation 5.3.3.2), the CUSUM plots (figures 5.4 and 5.5) show that there is no movement outside the 5% critical lines of parameter stability. Therefore, the model for exports is also stable even during the oil crises of 1986 and 2000.

Figure 5.4: Model 1: Plot of CUSUM for the estimated ECM for merchandise exports



$\Delta LX_t = -0.542\Delta LY_{t-1} + 0.253\ \Delta LK_{t-1} + 0.673\ \Delta LX_{t-1} - 0.252\ \Delta LIMP_{t-1} - 0.623\ ECT_{t-1}$

Figure 5.5: Model 1: Plot of CUSUMQ for the estimated ECM for merchandise exports



$\Delta LX_t = -0.542\Delta LY_{t-1} + 0.253\ \Delta LK_{t-1} + 0.673\ \Delta LX_{t-1} - 0.252\ \Delta LIMP_{t-1} - 0.623\ ECT_{t-1}$

5.3.5 Model 1: Toda-Yamamoto Granger causality test

In the case of UAE the maximum order of integration is d_{max} =1, while the optimal lag length, based on Schwarz Information Criterion is one. Therefore the selected lag length (p=1) is augmented by the maximum order of integration (d_{max}=1) and the Wald tests are applied to the first p VAR coefficients. The results are presented in table 5.10.

Table 5.10: Model 1: Granger Causality based on Toda-Yamamoto procedure

	Source of causation				
	LY	**LK**	**LX**	**LIMP**	**ALL**
Dependent Variable	$\chi 2\ (1)$	$\chi 2\ (1)$	$\chi 2\ (1)$	$\chi 2\ (1)$	$\chi 2\ (3)$
LY_t	-	9.706***	1.816	0.064	14.912***
LK_t	0.476	-	0.319	0.148	4.817
LX_t	0.064	5.800**	-	0.468	13.623***
$LIMP_t$	0.451	0.355	2.843*	-	4.591

Note: *, ** and *** indicates significance at 10%, 5% and 1% significance level respectively

The diagnostic tests for the select VAR(p) model prior to the application of the Toda-Yamamoto procedure are presented in table E.1, Appendix E.

df in parentheses

The Granger causality results show that the null hypothesis that LX does not Granger cause LY cannot be rejected at 5% significance level. In addition, there is no evidence to support the converse, as the null hypothesis of non-causality from LY to LX cannot be rejected at any conventional significance level. In contrast, the null hypothesis that LK does not Granger cause LY is rejected at 1% significance level, indicating that the physical capital causes economic growth in the long-run. In addition, the null hypothesis that LK does not Granger cause LX is rejected at 5% significant level. Therefore, the Toda-Yamamoto procedure does not provide evidence of either ELG or GLE hypothesis in the long-run. However, the results show that LK, LX and LIMP jointly Granger cause economic growth and also that all the variables jointly Granger cause exports. Therefore, these results are in line with the long-run Granger causality in the VECM framework.

5.4 Model 2: The causality between merchandise exports and economic growth: *Augmented Cobb-Douglas Production Function*

5.4.1 Model 2: Lag Order Selection

The lag length for the VAR system is determined by minimizing the Schwarz Information Criterion (SIC) and Akaike Information Criterion (AIC), allowing the maximum of three lags. Table 5.11 reports that both criteria suggest the use of 1 lag in the VAR system.

Table 5.11: Model 2: VAR lag order selection criteria

Lag	0	1	2	3
AIC	-3.066	-11.962*	-11.894	-11.333
SC	-2.844	-10.629*	-9.450	-7.778

*Indicates lag order selected by the criterion

AIC: Akaike Information Criterion

SC: Schwarz Information Criterion

Therefore the VAR model is estimated with one lag of each variable and the multivariate specification tests for the VAR(1) are presented in table E.5, Appendix E. As it can be seen from table E.5, there is no problem of serial correlation, while the residuals are multivariate normal and homoscedastic. Therefore, the selected VAR model adequately describes the data.

5.4.2 Model 2: Cointegration test

The Johansen cointegration test is conducted in order to investigate the existence of a long-run relationship between LY, LK, LHC, LX and LIMP. Table 5.12, shows that null hypothesis of no cointegration is rejected at 5% significance level, indicating the existence of one cointegrating vector. In particular, the adjusted Trace statistic for no cointegration vector is 76.14, which is greater than the critical value at 5%. Therefore, the Johansen's cointegration results suggest that real GDP, real gross fixed capital formation, population, real exports and real imports are cointegrated and follow a common long path.

Table 5.12: Model 2: Johansen's Cointegration Test results

Hypothesized Number of Cointegrating equations	Adjusted Trace Statistic	Critical Value		
		1%	5%	10%
r=o	76.14**	84.45	76.07	71.86
r≤1	47.93	60.16	53.12	49.65
r≤2	23.93	41.07	34.91	32.00
r≤3	10.19	24.60	19.96	17.85

Note: Critical values are taken from Osterwald-Lenum (1992). The model includes a restricted constant (Model selection based on Pantula Principle)

*, ** and *** indicate rejection at 10%, 5% and 1% significance level respectively

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

$$\underset{}{LY_t} = \underset{(2.628)}{0.372^{***}LK_t} - \underset{(1.622)}{0.271LHC_t} - \underset{(2.354)}{0.396^{**}LX_t} + \underset{(4.141)}{0.807^{***}LIMP_t} + \underset{(6.866)}{10.776^{***}} \quad (5.4.2.1)$$

From the above equation, an 1% increase in real merchandise exports leads to a 0.396% decrease in real GDP, while a 1% increase in physical capital and imports leads to a 0.372% and 0.807% increase in real GDP respectively. In addition, 1% increase in population can cause a decrease in real GDP by 0.271%. These results suggest that exports seem to have negative effect on economic growth. As mentioned earlier, the high share of fuel-mining exports in merchandise exports can explain the negative relationship between exports and economic growth in UAE merchandise exports. For this reason, the long-run relationship between fuel and mining exports is examined separately in chapter 7, section 7.3, in order to examine the separate effects of this category on economic growth.

5.4.3 Model 2: Vector Error Correction Model

Since the variables are integrated of order one and cointegrated, a VECM should be specified (for further details see table E.6, Appendix E). The VECM is checked for autocorrelation, normality and homoscedasticity of the residuals. The Portmanteau test is conducted in order to test for the presence of autocorrelation, the Jarque-Bera test to verify the normality of the residuals and the White test to check for heteroskedasticity. As it can be seen from table E.7, Appendix E, the White test chi-square statistic is equal to 188.26, with the corresponding p-value of 0.321, indicating that the null hypothesis of homoscedasticity cannot be rejected at any significance level. In addition the null hypothesis of no autocorrelation of residuals cannot be rejected up to lag length 12 at 5% significance level, since all corresponding p-values are greater than 5%. Moreover, the null hypothesis of multivariate normal residuals cannot be rejected at 5% significance level.

In addition, the stability of the VECM is checked by calculating the inverse roots of the characteristic AR polynomial. The analysis shows that the VEC specification imposes 4 unit roots, while the remaining roots have modulus less than one. Therefore, since there are 5 variables and one cointegrating equation in the system, the estimated VECM is stable. The stability results are presented in table E.8 and figure E.2, Appendix E.

Since the aim of this reseach is to find the direction of the causality between exports and economic growth, emphasis is placed on the estimated error correction models for ΔLY_t and ΔLX_t. The absolute t-statistics are reported in the parentheses:

$$\Delta LY_t = \underset{(0.695)}{-0.143}\,\Delta LY_{t-1} + \underset{(1.768)}{0.194^{*}}\,\Delta LK_{t-1} - \underset{(0.140)}{0.019}\,\Delta LHC_{t-1} + \underset{(3.769)}{0.393^{***}}\,\Delta LX_{t-1} -$$

$$- \underset{(1.851)}{0.258^{*}}\,\Delta LIMP_{t-1} - \underset{(5.858)}{0.413^{***}}\,ECT_{t-1} \qquad (5.4.3.1)$$

$$\Delta LX_t = \underset{(1.432)}{-0.743}\,\Delta LY_{t-1} + \underset{(0.733)}{0.203}\,\Delta LK_{t-1} - \underset{(0.090)}{0.031}\,\Delta LHC_{t-1} + \underset{(2.579)}{0.678^{**}}\,\Delta LX_{t-1} -$$

$$- \underset{(0.699)}{0.245}\,\Delta LIMP_{t-1} - \underset{(3.895)}{0.693^{***}}\,ECT_{t-1} \qquad (5.4.3.2)$$

5.4.4 Model 2: Granger Causality in VECM

The short-run Granger causality results for UAE are reported in the following table:

Table 5.13: Model 2: Short-run Granger Causality test

Dependent Variable	Source of causation ΔLY_t χ^2 (1)	ΔLK_t χ^2 (1)	ΔLHC_t χ^2 (1)	ΔLX_t χ^2 (1)	$\Delta LIMP_t$ χ^2 (1)	ALL χ^2 (4)
ΔLY_t	-	3.126*	0.020	14.208***	3.427*	17.441***
ΔLK_t	1.740	-	0.537	0.115	0.003	7.385
ΔLHC_t	0.200	3.187*	-	0.026	0.517	4.378
ΔLX_t	2.052	0.538	0.008	-	0.489	3.752
$\Delta LIMP_t$	0.053	0.641	1.182	1.132	-	6.953

Note: *, ** and *** indicates significance at 10%, 5% and 1% significance level respectively df in parentheses

The diagnostic tests for the VECM model are presented in table E.6, Appendix E.

The results show that the null hypothesis of non causality from exports to economic growth is rejected at 1% significance level, indicating that the ELG hypothesis is valid in the short-run over the period 1975-2012. In addition, physical capital and imports Granger cause economic growth in the short-run at 10% singificance level. In contrast, the null hypothesis of non causality from economic growth to exports cannon be rejected at any conventional significance level, indicating that the GLE hypothesis is not valid in the short-run over the period 1975-2012.

Moreover, the Chi-square test is performed to investigate the joint significance of the explanatory variables. The results indicate that the null hypothesis of non causeality from ΔLK_{t-1}, ΔLHC_{t-1}, ΔLX_{t-1} and $LIMP_{t-1}$ to economic growth is rejected at 1% significance level. Table 5.14 summarizes the Granger causality results in the short-run.

Table 5.14: Model 2: Short-run Granger Causality results

ΔLX_t	➔	ΔLY_t
ΔLK_t	➔	ΔLY_t
$\Delta LIMP_t$	➔	ΔLY_t
ΔLK_t	➔	ΔLHC_t
ΔLK_t, ΔLHC_t, ΔLX_t, $\Delta LIMP_t$	➔	ΔLY_t

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

Table 5.15 presents the long-run causality results within ECM framework. In the estimated ECMs for economic growth and exports, the coefficients of the lagged error correction terms are significant at 1% significance level. In particular, the negative and significant error correction coefficient (-0.413) in equation (5.4.3.1) indicates that approximately 41.3% of the disequilibrium in real GDP, caused by a shock in year t-1, converges back to the long-run equillibrium in year t. This result can be interpreted as a long-run causality which runs interactively through the error correction term from physical capital, human capital, exports and imports to economic growth.

In addition, the coefficient of the error correction term (-0.693) in equation (5.4.3.2) is negative and significance at 1% significance level, indicating that approximately 69.3% of the disequilibrium in real exports is corrected each year by the changes in real GDP, real physical capital, human capital and real imports to bring the system back to its long-run equilibrium. This result can be interpreted as a long-run causality which runs interactively through the error correction term from economic growth, physical capital, human capital and imports to exports.

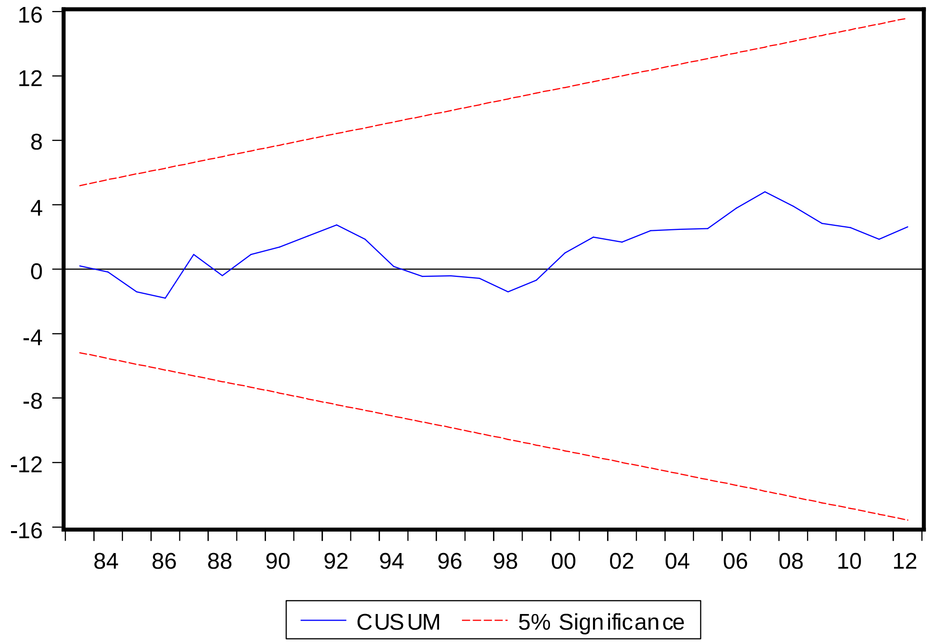
Table 5.15: Model 2: Long-run Granger Causality within ECM framework

Dependent Variables	**ΔLY_t**	**ΔLX_t**
ECT_{t-1}	-0.413***	-0.693***
t-statistic	[-5.858]	[-3.895]

Note: *** denote statistical significance at 1% significance level. t-statistics in [ ]

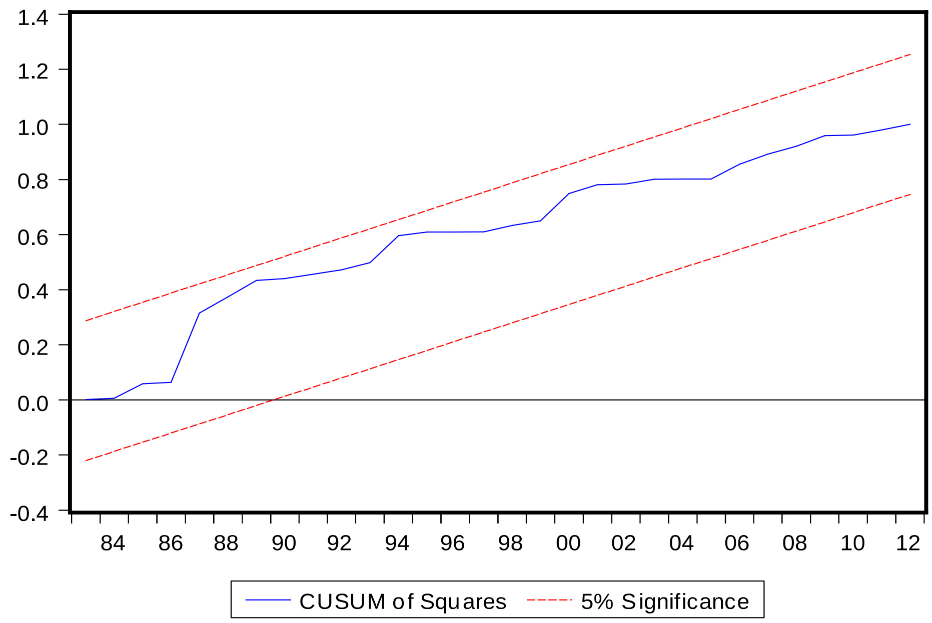
Since the aim of this research is to find the direction of the causality between exports and economic growth, emphasis is placed on the structural stability of the parameters of the estimated ECMs for ΔLY_t and ΔLX_t . The cumulative sum of recursive residuals (CUSUM) and the CUSUM of squares (CUSUMQ) are applied, in order to assess the constancy of the parameters of the equation 5.4.3.1 and the results are presented in figure 5.6 and figure 5.7.

Figure 5.6: Model 2: Plot of CUSUM for the estimated ECM for economic growth



ΔLY_t= -0.143 ΔLY_{t-1} +0.194 ΔLK_{t-1} -0.019 ΔLHC_{t-1}+0.393 ΔLX_{t-1}-0.258$\Delta LIMP_{t-1}$ -0.413 ECT_{t-1}

Figure 5.7: Model 2: Plot of CUSUMQ for the estimated ECM for economic growth

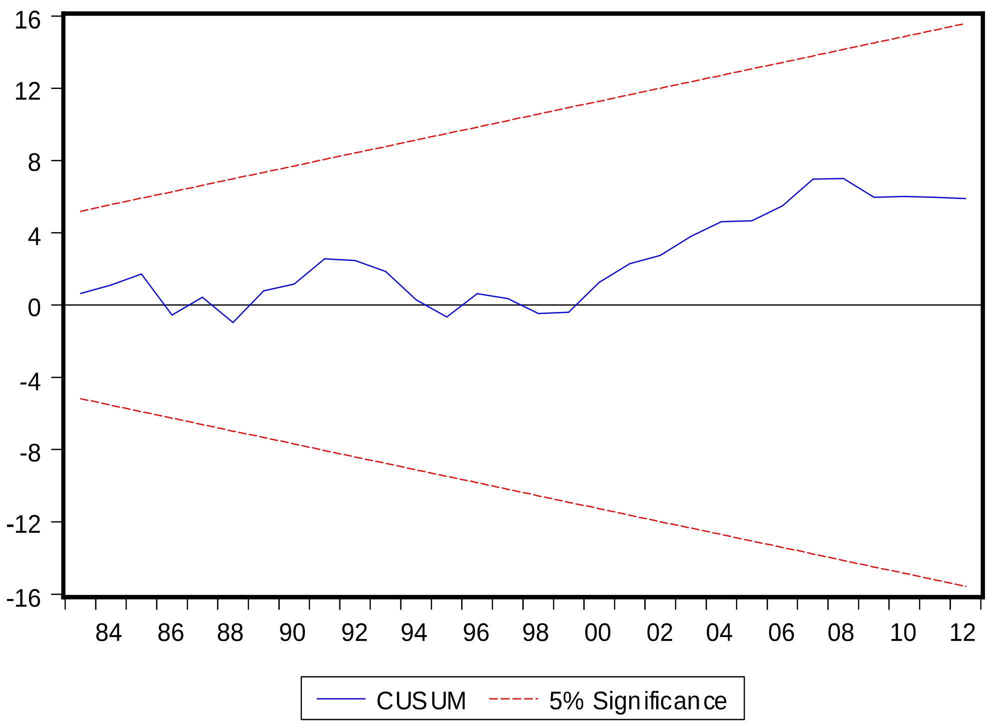


ΔLY_t= -0.143 ΔLY_{t-1} +0.194 ΔLK_{t-1} -0.019 ΔLHC_{t-1}+0.393 ΔLX_{t-1}-0.258$\Delta LIMP_{t-1}$ -0.413 ECT_{t-1}

As it can be seen from the figure 5.6 and 5.7, there is no movement outside the 5% critical lines of parameter stability. Therefore, the model for economic growth is stable even during the oil crises of 1986 and 2000.

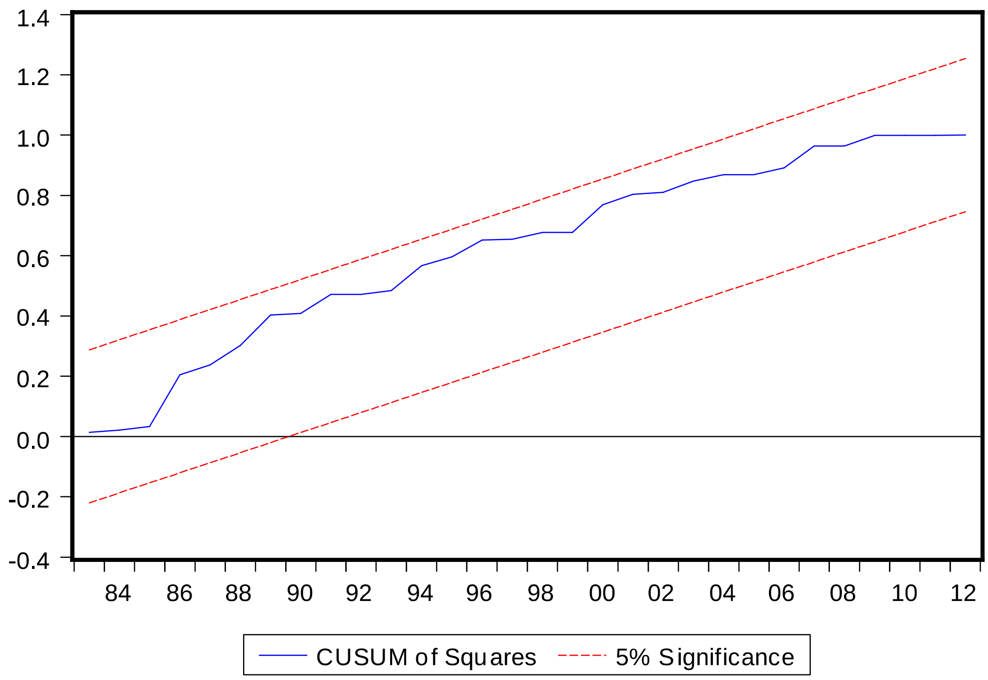
As far as the structural stability of the parameters of the ECM for exports (equation 5.4.3.2), the CUSUM plots (figure 5.8 and 5.9) show that there is no movement outside the 5% critical lines of parameter stability. Therefore, the model for exports is also stable even during the oil crises of 1986 and 2000.

Figure 5.8: Model 2: Plot of CUSUM for the estimated ECM for merchandise exports



$\Delta LX_t = -0.743\ \Delta LY_{t-1} + 0.203\ \Delta LK_{t-1} - 0.03\ \Delta LHC_{t-1} + 0.678\ \Delta LX_{t-1} - 0.245\ \Delta LIMP_{t-1} - 0.693\ ECT_{t-1}$

Figure 5.9: Model 2: Plot of CUSUMQ for the estimated ECM for merchandise exports



$\Delta LX_t = -0.743\Delta LY_{t-1} + 0.203\,\Delta LK_{t-1} - 0.031\,\Delta LHC_{t-1} + 0.678\,\Delta LX_{t-1} - 0.245\,\Delta LIMP_{t-1} - 0.693ECT_{t-1}$

5.4.5 Model 2: Toda-Yamamoto Granger causality test

In the case of UAE the maximum order of integration is d_{max} =1, while the optimal lag length, based on Schwarz Information Criterion is one. Therefore the selected lag length (p=1) is augmented by the maximum order of integration (d_{max}=1) and the Wald tests are applied to the first p VAR coefficients. The results are presented in table 5.16.

Table 5.16: Model 2: Granger Causality based on Toda-Yamamoto procedure

	Source of causation					
	LY	**LK**	**LHC**	**LX**	**LIMP**	**ALL**
Dependent Variable	***χ2 (1)***	***χ2 (1)***	***χ2 (1)***	***χ2 (1)***	***χ2 (1)***	***χ2 (4)***
LY_t	-	6.541**	0.650	2.480	0.122	14.879***
LK_t	0.366	-	0.071	0.261	0.152	4.196
LHC_t	0.016	2.475	-	0.114	0.032	3.935
LX_t	0.136	4.359**	0.014	-	0.539	12.468**
$LIMP_t$	0.042	0.938	0.227	1.857	-	5.529

Note: *, ** and *** indicates significance at 10%, 5% and 1% significance level respectively

The diagnostic tests for the select VAR(k) model prior to the application of the Toda-Yamamoto procedure are presented in table E.5, Appendix E

df in parentheses

The Granger causality results show that the null hypothesis that LX does not Granger cause LY cannot be rejected at 5% significance level. In addition, there is no evidence to support the converse, as the null hypothesis of non-causality from LY to LX cannot be rejected at any conventional significance level.

In contrast, the null hypothesis that LK does not Granger cause LY is rejected at 5% significance level, while physical capital also causes exports in the long-run at 5% significance level. Therefore, the Toda-Yamamoto procedure does not provide evidence of either ELG or GLE hypothesis in the long-run. However, the results show that LK, LHC, LX and LIMP jointly Granger cause economic growth and also that all the variables jointly Granger cause exports. Thus, the T-Y Granger causality results are consistent with the VECM approach.

5.5 Conclusions

This chapter provides evidence on the relationship between merchandise exports and economic growth over the period 1975-2012. The empirical results of both models confirm the existence of a long-run relationship between the variables under consideration, while exports are found to have a negative impact on economic growth in the long-run. These results can be explained by the high share of fuel-mining exports in UAE merchandise exports, as this export category is subject to excessive price fluctuations (Myrdal, 1957), while does not offer knowledge spillover effects (Herzer et al., 2006). Theses findings are consistent with previous studies, which argued that exports can have a negative impact on economic growth (Myrdal, 1957; Berill, 1960; Meier, 1970; Lee and Huang 2002; Kim and Lin, 2009).

In addition, the short-run Granger causality results in VECM support the existence of a causality from merchandise exports to economic growth, indicating that the ELG hypothesis is valid in the short-run for the case of UAE. This result is in line with those reported in the relevant literature (Thornton, 1996; Ghatak et al., 1997; Al-Yousif, 1997; Ramos, 2001; Yanikkaya, 2003; Awokuse, 2003; Abu Al-Foul, 2004; Shirazi and Manap, 2004; Abu-Stait, 2005; Siliverstovs and Herzer, 2006; Ferreira, 2009; Gbaiye et al., 2013). In particular, the empirical results of model 1 and model 2 are in agreement with the study by Al-Yousif (1997) and in contrast with the study by El-Sakka and Al-Mutairi (2000). Specifically Al-Yousif (1997) shows that exports have a positive short-run impact on economic growth in UAE, while El-Sakka and Al-Mutairi (2000) supports the growth-led exports hypothesis for the UAE economy. It is interesting to note that different results are due to the examined period, the choice of variables, the lag length selection and the methods used in estimation.

As far as the long-run causality is concerned, the empirical results for both models do not provide evidence to support the ELG or GLE hypothesis for UAE. This is consistent with the studies by Al-Yousif (1999) and Tang (2006), which found no long-run causality between exports and economic growth for Malaysia and China respectively. Therefore, the empirical findings of model 1 and model 2 are supportive of the ELG hypothesis, but only in the short-run.

In addition, the empirical estimations of both models show that physical capital and imports cause economic growth in the short-run, indicating that investments and imports in the form of inputs enhance economic growth over the period 1975-2012. Moreover, the Granger causality results show that all the variables, in both models, jointly cause economic growth in the short-run. In the long-run, both empirical results show that physical capital causes economic growth, as well as exports, while all the variables jointly cause economic growth and exports, confirming the importance of these factors in the models.

In sum, the main findings regarding the causal relationship between merchandise exports and economic growth are summarised below:

Model	Granger causality in the short-run	Result
Model 1	Merchandise exports → Economic growth	ELG
Model 2	Merchandise exports → Economic growth	ELG

Model	Granger causality in the long-run	Result
Model 1	No causality	No causality
Model 2	No causality	No causality

CHAPTER 6. EMPIRICAL RESULTS: THE CAUSAL RELATIONSHIP BETWEEN PRIMARY EXPORTS, MANUFACTURED EXPORTS AND ECONOMIC GROWTH

6.1 Introduction

This chapter attempts to provide a contribution to the causal analysis of exports and economic growth by disaggregated the merchandise exports into primary exports and manufatured exports for UAE. Two models, based on the neoclassical production function, are used to find the direction of the causality between disaggregated exports and economic growth over the period 1981-2012. In the first model, except from the traditional inputs of production, physical and human capital, primary exports, manucfactured exports and imports are included as additional factors of production. In the second model, an impulse dummy for the year 2000 is included as exogenous variable, in order to obtain more efficient estimates. In particular, the oil price in 2000 increased by two-fold reaching over US$30 per barrel, that is likely to have important effects on UAE economy.

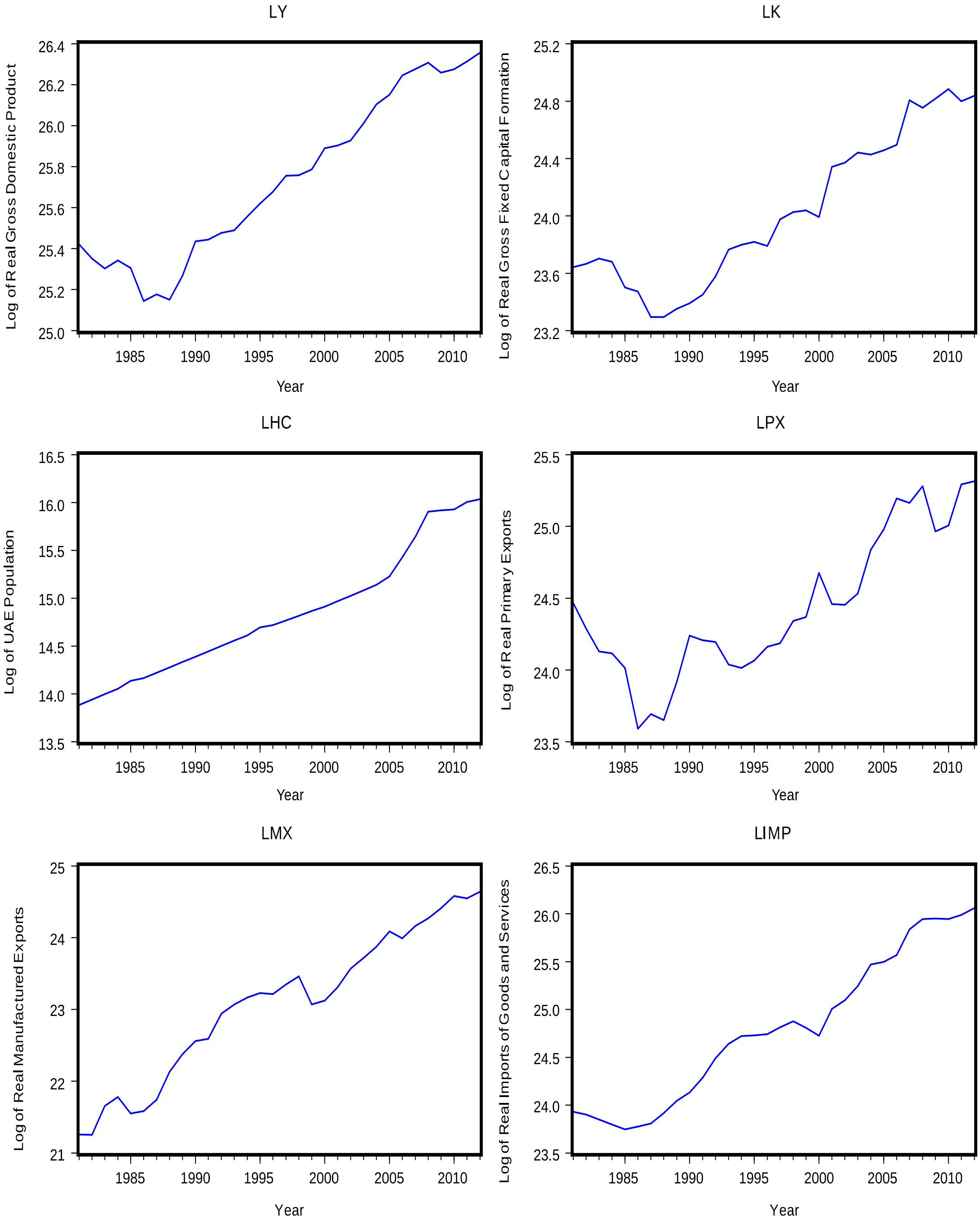
The first section of this chapter examines the time series properties of the data for UAE over the period 1981-2012. The subsequent sections present in detail the empirical analysis pertaining to the second research question, which investigates whether manufactured exports contribute more to economic growth than primary exports. Finally, the last section presents the main findings and their consistency with previous studies.

6.2 Unit root tests for model 3

Before analysing the causal relations between GDP, primary exports and manufactured exports, it is important to test the order of integration of the variables. The stationarity of real GDP (LY), real gross fixed capital formation (LK), population (HC), real primary exports (LPX), real manufactured exports (LMX) and real imports of goods and services (LIMP) are initially investigated by performing visual inspection of plots and correlograms of the variables at level and first difference. The plots of the variables are presented in figure 6.1.

The graphical inspection of the series at levels indicates that each variable has non-constant mean. In particular, the LY, LK, LIMP and LPX suffered declines approximately until 1988, while after that year are upward trended with some fluctuations. The time series of LMX follows an upward trend with some fluctuations throughout the period, while the series of HC is clearly upward trended and smoother than all the other series.

Figure 6.1: Pattern of the logarithm of the data series over the period 1981-2012



Source: Gross Domestic Product is taken from the WDI- World Bank, Gross Fixed Capital formation and Imports are taken from IFS- IMF (years 1999-2000 are taken from UAE National Bureau of Statistics and years 2010-2012 are taken from World Bank). Primary and Manufactured exports are obtained from WTO- Time Series on International Trade and population is obtained from UAE National Bureau of Statistics.

The graphs are produced by using the econometric software Eviews 7

In addition to the graphical evidence, the correlograms of the variables are inspected. All variables at level have correlograms that die out slowly, while the autocorrelations of the first differences display the classic pattern of a stationary series described in chapter four, section 4.3.1. The correlograms of the series at levels and first differences are given in figure F.1, Appendix F.

Although the visual inspection of the plots and correlograms suggest that the series are not stationary at level, the stationarity of the series are formally investigated by applying the ADF, PP, KPSS and SL unit root tests in log levels and in first differences of the logs. The software Eviews 7 is used to estimate the ADF, PP and KPSS tests, while SL is performed using JMulti statistical software.

Table 6.1 presents the results of the ADF unit root test at levels and first differences. The results of the ADF test at log levels indicate that the null hypothesis of non-stationarity cannot be rejected for all the variables at 5% significance level. In contrast, after taking the first difference of LY, LK, LPX, LMX and LIMP, the null hypothesis of unit root can be rejected at 1% level of significance, while the first-differenced series of LHC is found to be stationary at 5% significance level. Hence, the ADF test results indicate that the time series for the period 1981-2012 are integrated of order one I(1).

Table 6.1: ADF test results at logarithmic level and first difference for model 3

	Constant with trend	Constant	None

	ADF	Test critical values of % level		ADF	Test critical values of % level		ADF	Test critical values of % level	
LY(a)	-3.45*	1%	-4.29	0.67	1%	-3.66	2.69	1%	-2.64
	[0]	5%	-3.56	[0]	5%	-2.96	[0]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
DLY(b)	-3.45*	1%	-4.31	-4.32***	1%	-3.67	-3.54***	1%	-2.64
	[1]	5%	-3.57	[0]	5%	-2.96	[0]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
LK(a)	-2.36	1%	-4.29	0.28	1%	-3.66	1.94	1%	-2.64
	[0]	5%	-3.56	[0]	5%	-2.96	[0]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
DLK(c)	-5.54***	1%	-4.30	-5.32***	1%	-3.67	-4.84***	1%	-2.64
	[0]	5%	-3.57	[0]	5%	-2.96	[0]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
LHC(a)	-2.02	1%	-4.30	0.26	1%	-3.67	2.36	1%	-2.64
	[1]	5%	-3.57	[1]	5%	-2.96	[1]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
DLHC(b)	-3.07	1%	-4.30	-3.04**	1%	-3.67	-1.81*	1%	-2.64
	[0]	5%	-3.57	[0]	5%	-2.96	[0]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
LPX(a)	-3.09	1%	-4.29	-0.18	1%	-3.66	0.84	1%	-2.64
	[0]	5%	-3.56	[0]	5%	-2.96	[0]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
DLPX(c)	-5.17***	1%	-4.30	-4.98***	1%	-3.67	-4.90***	1%	-2.64
	[0]	5%	-3.57	[0]	5%	-2.96	[0]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
LMX(a)	-2.16	1%	-4.29	0.90	1%	-3.66	3.72	1%	-2.64
	[0]	5%	-3.56	[0]	5%	-2.96	[0]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
DLMX(b)	-5.07***	1%	-4.30	-5.08***	1%	-3.67	-3.67***	1%	-2.64
	[0]	5%	-3.57	[0]	5%	-2.96	[0]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
LIMP(a)	-2.91	1%	-4.29	0.79	1%	-3.66	4.05	1%	-2.64
	[0]	5%	-3.56	[0]	5%	-2.96	[0]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
DLIMP(b)	-3.82**	1%	-4.30	-3.81***	1%	-3.67	-2.76***	1%	-2.64
	[0]	5%	-3.57	[0]	5%	-2.96	[0]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61

Note: Numbers in parentheses corresponding to ADF test statistics are the optimal lags, chosen based on Schwarz Information Criterion (SIC).

*, **, *** denote the rejection of the null hypothesis of a unit root at 10%, 5% and 1% respectively.

All the time series are tested for the unit root under the ADF regression and the letters in brackets indicate the selected model following Doldado et al. (1990):

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

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

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

The Phillips-Perron test results (table 6.2 and table 6.3) indicate that that the null hypothesis of a unit root cannot be rejected for LY, LK, LHC, LPX, LMX and LIMP at 5% significance level. In contrast, DLY, DLK, DLIMP, DLPX and DLMX are found to be stationary at 1% level of significance, while DLHC is found to be stationary at 5% significance level. Therefore, the PP test results are in line with the ADF results.

Table 6.2: PP test results at logarithmic level for model 3

	Constant with trend			Constant			None		
	ADF	Test critical values of % level		ADF	Test critical values of % level		ADF	Test critical values of % level	
LY(a)	-3.41* [3]	1% 5% 10%	-4.29 -3.56 -3.22	0.46 [2]	1% 5% 10%	-3.66 -2.96 -2.62	2.31 [2]	1% 5% 10%	-2.64 -1.95 -1.61
LK(a)	-2.36 [6]	1% 5% 10%	-4.29 -3.56 -3.22	0.28 [0]	1% 5% 10%	-3.66 -2.96 -2.62	1.95 [1]	1% 5% 10%	-2.64 -1.95 -1.61
LHC(c)	-1.22 [1]	1% 5% 10%	-4.29 -3.56 -3.22	1.28 [0]	1% 5% 10%	-3.66 -2.96 -2.62	5.84 [1]	1% 5% 10%	-2.64 -1.95 -1.61
LPX(a)	-3.09 [2]	1% 5% 10%	-4.29 -3.56 -3.22	-0.33 [2]	1% 5% 10%	-3.66 -2.96 -2.62	0.78 [2]	1% 5% 10%	-2.64 -1.95 -1.61
LMX(a)	-2.25 [2]	1% 5% 10%	-4.29 -3.56 -3.22	-0.95 [7]	1% 5% 10%	-3.66 -2.96 -2.62	4.64 [7]	1% 5% 10%	-2.64 -1.95 -1.61
LIMP(a)	-2.92 [2]	1% 5% 10%	-4.29 -3.56 -3.22	0.49 [3]	1% 5% 10%	-3.66 -2.96 -2.62	3.20 [3]	1% 5% 10%	-2.64 -1.95 -1.61

Note: Numbers in parentheses corresponding to PP test statistics are the optimal lags, chosen based on Schwarz Information Criterion (SIC). Bandwidth in [ ] (Newey-West automatic) using Bartlett kernel estimation method.

*, **, *** denote the rejection of the null hypothesis of a unit root at 10%, 5% and 1% respectively. All the time series are tested for the unit root including intercept and trend (a), intercept only (b) and no constant or trend (c). The letters in brackets indicate the selected model following Doldado et al. (1990).

Table 6.3: PP test results at first difference for model 3

	Constant with trend			Constant			None		
	PP	Test critical values of % level		PP	Test critical values of % level		PP	Test critical values of % level	
DLY(b)	-4.33***	1%	-4.30	-4.30***	1%	-3.67	-3.58***	1%	-2.64
	[1]	5%	-3.57	[1]	5%	-2.96	[3]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
DLK(c)	-5.54***	1%	-4.30	-5.32***	1%	-3.67	-4.88***	1%	-2.64
	[1]	5%	-3.57	[1]	5%	-2.96	[2]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
DLHC(b)	-3.07	1%	-4.30	-3.04**	1%	-3.67	-1.69*	1%	-2.64
	[3]	5%	-3.57	[3]	5%	-2.96	[3]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
DLPX(c)	-5.49***	1%	-4.30	-4.97***	1%	-3.67	-4.89***	1%	-2.64
	[6]	5%	-3.57	[4]	5%	-2.96	[3]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
DLMX(b)	-5.95***	1%	-4.30	-5.29***	1%	-3.67	-3.66***	1%	-2.64
	[11]	5%	-3.57	[9]	5%	-2.96	[1]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
DLIMP(b)	-3.74**	1%	-4.30	-3.72***	1%	-3.67	-2.70***	1%	-2.64
	[2]	5%	-3.57	[2]	5%	-2.96	[3]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61

Note: Numbers in parentheses corresponding to PP test statistics are the optimal lags, chosen based on Schwarz Information Criterion (SIC). Bandwidth in [ ] (Newey-West automatic) using Bartlett kernel estimation method.

*, **, *** denote the rejection of the null hypothesis of a unit root at 10%, 5% and 1% respectively. All the time series are tested for the unit root including intercept and trend (a), intercept only (b) and no constant or trend (c). The letters in brackets indicate the selected model following Doldado et al. (1990).

The KPSS test results including an intercept, indicate that the null hypothesis of stationarity is rejected for all the variables at 5% significance level. The same test is also conducted including an intercept and linear deterministic trend and the results indicate that LK, LHC and LPX are non-stationary at 5%

significance level, while LY is non-stationary at 10% significance level. In contrast, the variables LIMP and LMX are found to be stationary at 5% significance level. The KPSS test results at level are presented in table 6.4.

Table 6.4: KPSS test results at logarithmic level for model 3

	Constant with trend			**Constant no trend**		
	KPSS	**Test critical values of % level**		**KPSS**	**Test critical values of % level**	
LY[(a)]	0.13*	1%	0.22	0.60**	1%	0.74
	[4]	5%	0.15	[5]	5%	0.46
		10%	0.12		10%	0.35
LK[(a)]	0.15**	1%	0.22	0.58**	1%	0.74
	[4]	5%	0.15	[5]	5%	0.46
		10%	0.12		10%	0.35
LHC[(a)]	0.16**	1%	0.22	0.73**	1%	0.74
	[4]	5%	0.15	[4]	5%	0.46
		10%	0.12		10%	0.35
LPX[(a)]	0.17**	1%	0.216	0.61**	1%	0.74
	[3]	5%	0.146	[4]	5%	0.46
		10%	0.119		10%	0.35
LMX[(a)]	0.11	1%	0.22	0.73**	1%	0.74
	[4]	5%	0.15	[4]	5%	0.46
		10%	0.12		10%	0.35
LIMP[(a)]	0.10	1%	0.22	0.72**	1%	0.74
	[3]	5%	0.15	[4]	5%	0.46
		10%	0.12		10%	0.35

Note: Numbers in parentheses corresponding to KPSS test statistics are the optimal lags, chosen based on Schwarz Information Criterion (SIC). Bandwidth in [ ] (Newey-West automatic) using Bartlett kernel

*, **, *** denote the rejection of the null hypothesis of a unit root at 10%, 5% and 1% respectively.

All the time series are tested for the unit root including intercept and trend (a) and intercept only(b). The letters in brackets indicate the selected model following Doldado et al. (1990).

After taking the first difference of the time series, DLY, DLK, DLHC, DLPX, DLMX and DLIMP are found to be stationary at 1% significance level with and without the inclusion of linear deterministic trend. The KPSS test results at first difference are presented in table 6.5.

Table 6.5: KPSS test results at first difference for model 3

	Constant with trend			**Constant no trend**		
	KPSS	**Test critical values of % level**		**KPSS**	**Test critical values of % level**	
DLY(b)	0.15*	1%	0.22	0.30	1%	0.74
	[2]	5%	0.15	[2]	5%	0.46
		10%	0.12		10%	0.35
DLK(b)	0.11	1%	0.22	0.29	1%	0.74
	[2]	5%	0.15	[1]	5%	0.46
		10%	0.12		10%	0.35
DLHC(b)	0.10	1%	0.22	0.22	1%	0.74
	[0]	5%	0.15	[2]	5%	0.46
		10%	0.12		10%	0.35
DLPX(b)	0.12	1%	0.22	0.28	1%	0.74
	[5]	5%	0.15	[2]	5%	0.46
		10%	0.12		10%	0.35
DLMX(b)	0.11	1%	0.22	0.13	1%	0.74
	[8]	5%	0.15	[7]	5%	0.46
		10%	0.12		10%	0.35
DLIMP(b)	0.09	1%	0.22	0.19	1%	0.74
	[3]	5%	0.15	[3]	5%	0.46
		10%	0.12		10%	0.35

Note: Numbers in parentheses corresponding to KPSS test statistics are the optimal lags, chosen based on Schwarz Information Criterion (SIC). Bandwidth in [ ] (Newey-West automatic) using Bartlett kernel

*, **, *** Denote the rejection of the null hypothesis of a unit root at 10%, 5% and 1% respectively.

All the time series are tested for the unit root including intercept and trend (a) and intercept only(b). The letters in brackets indicate the selected model following Doldado et al. (1990).

However, when testing for the existence of unit root, a structural break can be identified as evidence of non-stationarity. For this reason, the SL test with a structural break is applied to this research in order to evaluate the time series properties. The SL with a structural break test results for the log levels and first difference of the time series are presented in tables 6.6 and 6.7. The test is conducted including an intercept and linear trend and also including an intercept only. Both results indicate that the variables at level are non-stationary at conventional levels of significance. The first-differenced series of LY, LK, LHC, LPX, LMX and LIMP are stationary at 1% significance level. Since all variables are I(1)[5], we can apply the cointegration test to investigate the existence of a long-run relationship between the variables.

Table 6.6: SL test results with structural break at logarithmic level for model 3

	Without trend				**With trend**			
	UR	**Year**	**Test critical values of % level**		**UR**	**Year**	**Test critical values of % level**	
LY	0.77 [0]	1990	1% 5% 10%	-3.48 -2.88 -2.58	-1.09 [0]	1986	1% 5% 10%	-3.55 -3.03 -2.76
LK	0.11 [0]	2001	1% 5% 10%	-3.48 -2.88 -2.58	-1.45 [0]	2001	1% 5% 10%	-3.55 -3.03 -2.76
LHC	0.05 [1]	2008	1% 5% 10%	-3.48 -2.88 -2.58	-2.64 [1]	2008	1% 5% 10%	-3.55 -3.03 -2.76
LIMP	0.50 [0]	2001	1% 5% 10%	-3.48 -2.88 -2.58	-1.24 [0]	2001	1% 5% 10%	-3.55 -3.03 -2.76
LPX	-0.18 [0]	1986	1% 5% 10%	-3.48 -2.88 -2.58	-1.83 [0]	1986	1% 5% 10%	-3.55 -3.03 -2.76
LMX	-0.97 [0]	1988	1% 5% 10%	-3.48 -2.88 -2.58	-2.79* [0]	1999	1% 5% 10%	-3.55 -3.03 -2.76

Note: Numbers in parentheses corresponding to UR test statistics are the optimal lags, chosen based on Schwarz Information Criterion (SIC).

Critical values are tabulated in Lanne et al. (2002)

*, **, *** denote the rejection of the null hypothesis of a unit root at 10%, 5% and 1% respectively.

All the time series are tested for the unit root including intercept and trend and intercept only

Table 6.7: SL test results with structural break at first difference for model 3

	Without trend				**With trend**			
	UR	**Year**	**Test critical values of % level**		**UR**	**Year**	**Test critical values of % level**	
DLY	-5.14***	1986	1%	-3.48	-4.50***	1990	1%	-3.55
	[0]		5%	-2.88	[0]		5%	-3.03
			10%	-2.58			10%	-2.76
DLK	-4.85***	2001	1%	-3.48	-4.95***	2001	1%	-3.55
	[0]		5%	-2.88	[0]		5%	-3.03
			10%	-2.58			10%	-2.76
DLHC	-3.75***	2008	1%	-3.48	-3.46**	2008	1%	-3.55
	[1]		5%	-2.88	[1]		5%	-3.03
			10%	-2.58			10%	-2.76
DLIMP	-7.41***	2001	1%	-3.48	-6.92***	2001	1%	-3.55
	[7]		5%	-2.88	[7]		5%	-3.03
			10%	-2.58			10%	-2.76
DLPX	-5.58***	1986	1%	-3.48	-5.23***	1986	1%	-3.55
	[0]		5%	-2.88	[0]		5%	-3.03
			10%	-2.58			10%	-2.76
DLMX	-5.39***	1999	1%	-3.48	-5.14***	1999	1%	-3.55
	[0]		5%	-2.88	[0]		5%	-3.03
			10%	-2.58			10%	-2.76

Note: Numbers in parentheses corresponding to UR test statistics are the optimal lags, chosen based on Schwarz Information Criterion (SIC).

Critical values are tabulated in Lanne et al. (2002)

*, **, *** denote the rejection of the null hypothesis of a unit root at 10%, 5% and 1% respectively.

All the time series are tested for the unit root including intercept and trend and intercept only

6.3 Model 3.α: The causality between primary exports, manufactured exports and economic growth

6.3.1 Model 3.α: Lag Order Selection

The lag length for the VAR system is determined by minimizing the Schwarz Information Criterion (SIC) and Akaike Information Criterion (AIC). Given the annual frequency of the data, the sample size (T= 32) and the number of explanatory variables, the maximum of two lags is allowed in order to allow for sufficient degrees of freedom. Table 6.8 reports that SIC suggests the use of 1 lag in the VAR system, while AIC suggests lag 2. As lag 1 is the smallest possible lag length which ensures that the residuals are multivariate normal, homoscedastic and uncorrelated, the VAR model is estimated with one lag. The multivariate specification tests for the VAR(1) model are presented in table G.1, Appendix G and as it can be seen, the selected VAR model adequately describes the data.

Table 6.8: Model 3.α: VAR lag order selection criteria

Lag	0	1	2
AIC	-5.089	-14.405	-14.623*
SC	-4.809	-12.443*	-10.980

*Indicates lag order selected by the criterion

AIC: Akaike Information Criterion

SC: Schwarz Information Criterion

6.3.2 Model 3.α: Cointegration test

The Johansen cointegration test is conducted in order to investigate the existence of a long-run relationship between LY, LK, LHC, LPX, LMX and LIMP. Table 6.9, shows that null hypothesis of no cointegration is rejected at 1% significance level, indicating the existence of one cointegrating vector. In particular, the adjusted Trace statistic for no cointegration vector is 118.32, which is greater than the critical value at 1%. Therefore, the Johansen's cointegration results suggest that real GDP, real gross fixed capital formation, population, real primary exports, real manufactured exports and real imports are cointegrated and follow a common long path.

Table 6.9: Model 3.α: Johansen's Cointegration Test results

Hypothesized Number of Cointegrating equations	Adjusted Trace Statistic	Critical Value		
		1%	5%	10%
r=0	118.32***	111.01	102.14	97.18
r≤1	69.61	84.45	76.07	71.86
r≤2	42.86	60.16	53.12	49.65
r≤3	24.14	41.07	34.91	32.00

Note: Critical values are taken from Osterwald-Lenum (1992). The model includes a restricted constant (Model selection based on Pantula Principle)

*, ** and *** indicate rejection at 10%, 5% and 1% significance level respectively

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

$$LY_t = \underset{(7.417)}{1.107^{***}}LK_t - \underset{(1.710)}{0.220^{*}}LHC_t + \underset{(2.516)}{0.297^{***}}LPX_t + \underset{(10.980)}{1.580^{***}}LMX_t - \underset{(7.990)}{2.156^{***}}LIMP_t + \underset{(8.578)}{11.995^{***}} \quad (6.3.2.1)$$

From the above equation, a 1% increase in real primary exports leads to a 0.297% increase in real GDP, while a 1% increase in manufactured exports rises real GDP by 1.580%. In addition, real GDP increases by 1.107% in response to a 1% increase in physical capital. In contrast, 1% increase in population and imports can lead to a decrease in real GDP by 0.22% and 2.156% respectively. These results suggest that manufactured exports seem to enhance economic growth through knowledge spillover effects and other externalities.

6.3.3 Model 3.α: Vector Error Correction Model

Since the variables are integrated of order one and cointegrated, a VECM should be specified (for further details see table G.2, Appendix G). The VECM is checked for autocorrelation, normality and homoscedasticity of the residuals. As it can be seen from table G.3 at Appendix G, the null hypothesis of no autocorrelation of residuals cannot be rejected up to lag length 12 at 5% significance level, since all corresponding p-values are greater than 5%. In addition, the White test chi-square statistic is equal to 299.677, with the corresponding p-value of 0.397, indicating that the null hypothesis of homoscedasticity cannot be rejected at any significance level. As far the normality of the residuals is concerned, the p-value is greater than 5%, indicating that null hypothesis of multivariate normal residuals cannot be rejected.

In addition, the stability of the VECM is checked by calculating the inverse roots of the characteristic AR polynomial. The analysis shows that the VEC specification imposes 5 unit roots, while the remaining roots have modulus less than one. Therefore, since there are 6 variables and one cointegrating equation in the system, the estimated VECM is stable. The stability results are presented in table G.4 and figure G.1, Appendix G.

Since the aim of this reseach is to find the direction of the causality between exports and economic growth, emphasis is placed on the estimated error correction models for ΔLY_t and ΔLPX_t. The absolute t-statistics are reported in the parentheses:

$$\Delta LY_t = \underset{(0.240)}{0.093}\,\Delta LY_{t-1} + \underset{(0.610)}{0.105}\,\Delta LK_{t-1} + \underset{(0.100)}{0.022}\,\Delta LHC_{t-1} + \underset{(0.346)}{0.050}\,\Delta LPX_{t-1} + \underset{(1.327)}{0.101}\,LMX_{t-1} + \underset{(0.332)}{0.059}\,\Delta LIMP_{t-1} - \underset{(0.569)}{0.038}\,ECT_{t-1} \qquad (6.3.3.1)$$

$$\Delta LPX_t = -\underset{(0.093)}{0.105}\,\Delta LY_{t-1} + \underset{(1.024)}{0.512}\,\Delta LK_{t-1} - \underset{(0.760)}{0.488}\,\Delta LHC_{t-1} + \underset{(0.543)}{0.227}\,\Delta LPX_{t-1} + \underset{(0.677)}{0.149}\,LMX_{t-1} + \underset{(0.217)}{0.112}\,\Delta LIMP_{t-1} - \underset{(0.325)}{0.062}\,ECT_{t-1} \qquad (6.3.3.2)$$

6.3.4 Model 3.α: Granger Causality in VECM

The Granger causality results for UAE are reported in table 6.10.

Table 6.10: Model 3.α Short-run Granger causality test

Dependent Variable	Source of causation						
	ΔLY_t	ΔLK_t	ΔLHC_t	ΔLPX_t	ΔLMX_t	$\Delta LIMP_t$	ALL
	X^2 *(1)*	X^2 *(1)*	X^2 *(1)*	X^2 *(1)*	X^2 *(1)*	X^2 *(1)*	X^2 *(5)*
ΔLY_t	-	0.372	0.010	0.120	1.762	0.110	6.666
ΔLK_t	0.508	-	0.008	0.551	0.121	0.066	9.864*
ΔLHC_t	0.031	2.338	-	0.185	1.101	0.332	4.928
ΔLPX_t	0.009	1.048	0.578	-	0.459	0.047	3.899
ΔLMX_t	7.741***	0.719	5.892**	2.270	-	5.273**	18.06***
$\Delta LIMP_t$	2.287	0.575	0.462	0.276	0.526	-	9.285*

Note: *, ** and *** indicates significance at 10%, 5% and 1% significance level respectively

df in parentheses

The diagnostic tests for the VECM model are presented in table G.2, Appendix G.

The short-run Granger causality results show that there is no causal effect from primary exports or manufactured exports on economic growth. In particular, the null hypothesis of non causality from primary exports or manufactured exports to economic growth cannot be rejected at conventional significance levels. Therefore, the ELG hypothesis is not valid in the short-run over the period 1981-2012.

In contrast, the null hypothesis of non causality from economic growth to manufactured exports can be rejected at 1% significance level, indicating that there is a unidirectional causality from economic growth to manufactured exports. In addition, the results show that there is a unidirectional causality from human capital to manufactured exports and from imports to manufactured exports.

In addition, the Chi-square test is performed to investigate the joint significance of the explanatory variables. The results indicate that the null hypothesis of non causality from ΔLK_t, ΔLHC_t, ΔLPX_t, ΔLMX_t and $LIMP_t$ to economic growth cannot be rejected at 5% significance level. In contrast, the results show that all the variables in the model jointly cause manufactured exports at 1% significance level. Moreover, all the variables jointly cause imports and physical capital at 10% significance level. Table 6.11 summarizes the short-run Granger causality results.

Table 6.11: Model 3.α: Short-run Granger Causality results

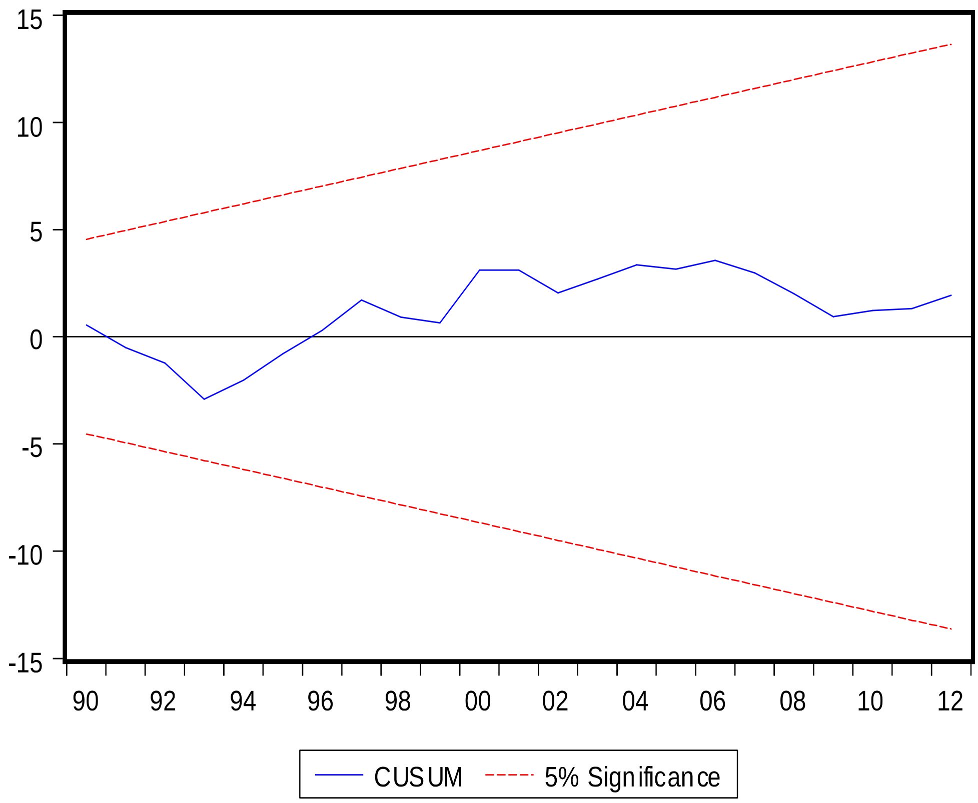
ΔLY_t	➔	ΔLMX_t
ΔLHC_t	➔	ΔLMX_t
$\Delta LIMP_t$	➔	ΔLMX_t
ΔLY_t, ΔLK_t, ΔLHC_t, LPX_t, $\Delta LIMP_t$	➔	ΔLMX_t
ΔLY_t, ΔLK_t, ΔLHC_t, LPX_t, $\Delta LIMP_t$	➔	ΔLK_t
ΔLY_t, ΔLK_t, ΔLHC_t, LPX_t, $\Delta LIMP_t$	➔	$\Delta LIMP_t$

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

Since the aim of this reseach focuses on the relationship between exports and economic growth, emphasis is placed on the stability of the parameters of the estimated error correction models for economic growth and disagreggated exports. The constancy of the parameters of the ECM for economic growth is assesed by applying the CUSUM and CUSUM of squares and the results are presented in figure 6.2 and figure 6.3.

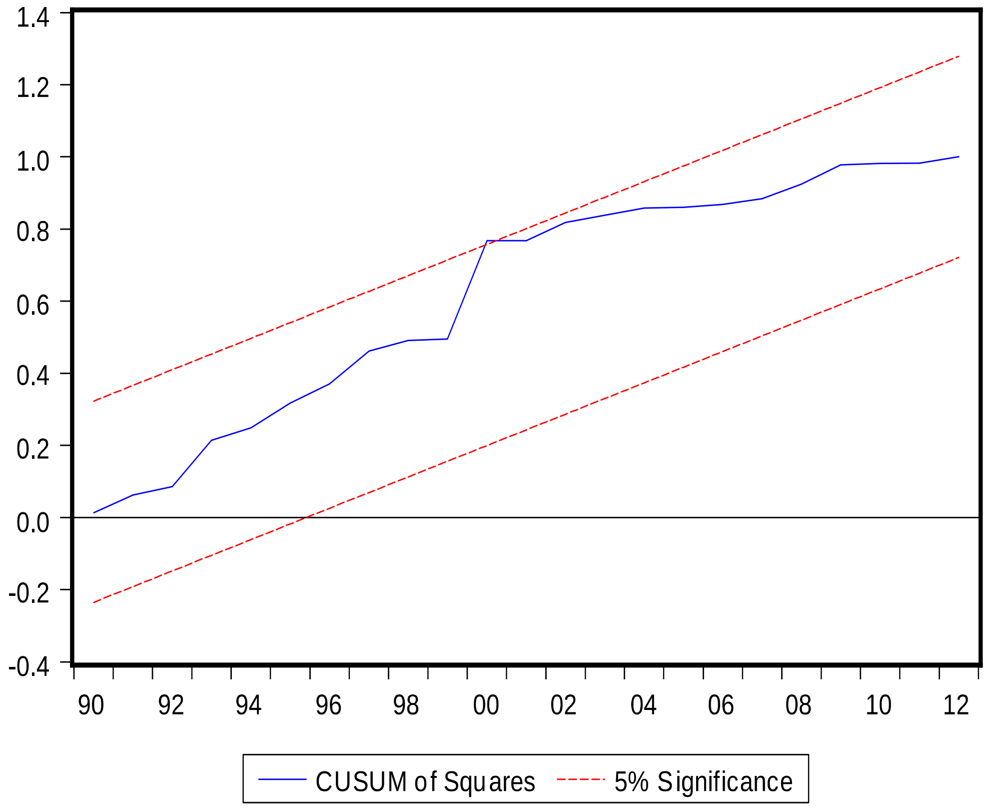
Although the CUSUM plot (figure 6.2) indicates a stable model, it is clear that after 2000 the parameters become more unstable. In addition, the CUSUM of squares plot (figure 6.3) shows evidence of some structural instability around 2000[6]. In order to obtain more efficient estimations, the VECM will be re-estimated in the section 6.4, including an impulse dummy, which takes value of 1 in 2000 and zero otherwise.

Figure 6.2: Model 3.α: Plot of CUSUM for the estimated ECM for economic growth



ΔLY_t= 0.093 ΔLY_{t-1} +0.105 ΔLK_{t-1} +0.022 ΔLHC_{t-1} +0.050 ΔLPX_{t-1} + 0.101 LMX_{t-1} + 0.059 $\Delta LIMP_{t-1}$ - 0.038 ECT_{t-1}

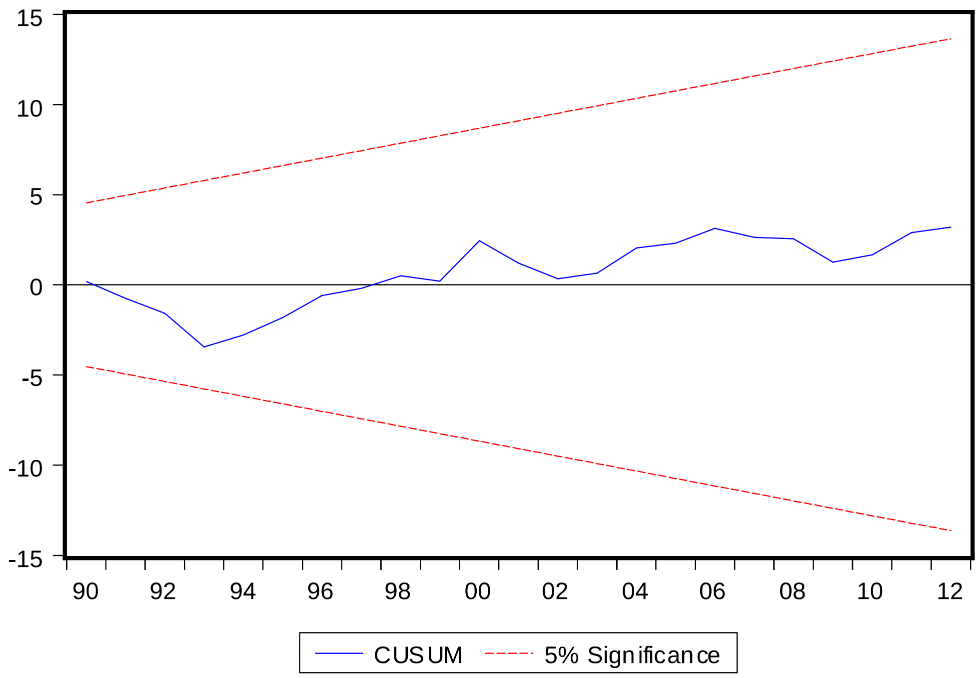
Figure 6.3: Model 3.α: Plot of CUSUMQ for the estimated ECM for economic growth



$\Delta LY_t = 0.093\ \Delta LY_{t-1} + 0.105\ \Delta LK_{t-1} + 0.022\ \Delta LHC_{t-1}\ + 0.050\ \Delta LPX_{t-1} + 0.101\ LMX_{t-1} + 0.059\ \Delta LIMP_{t-1} - 0.038\ ECT_{t-1}$

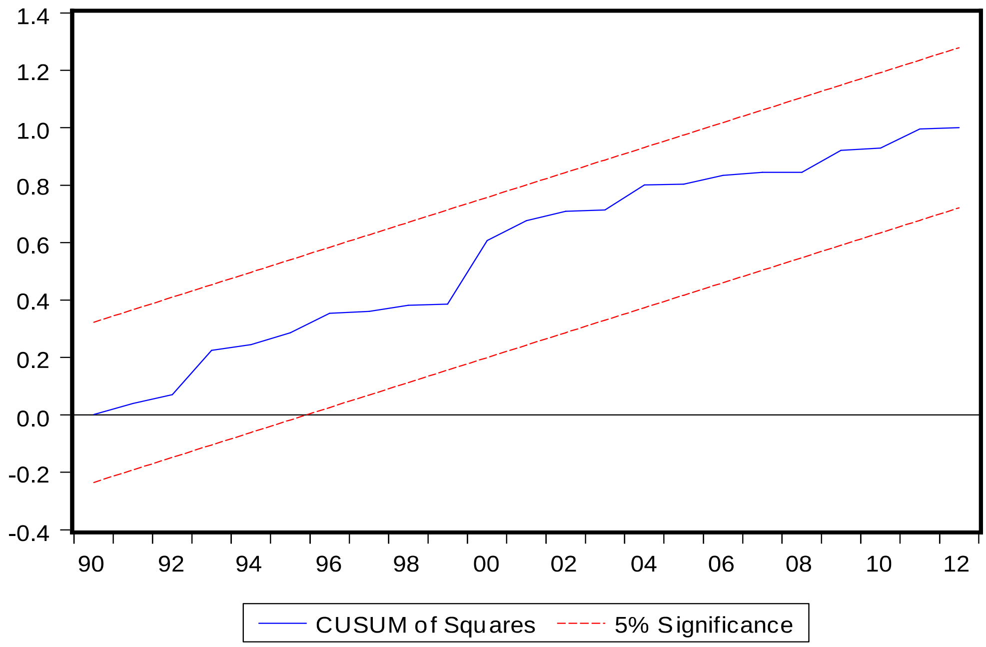
As far as the structural stability of the ECMs for disaggregated exports are concerned, the CUSUM plots (figures 6.4- 6.7) show that there is no movement outside the 5% critical lines of parameter stability. Therefore, the models for disaggregated exports are stable even during the oil crises of 1986 and 2000.

Figure 6.4: Model 3.α: Plot of CUSUM for the estimated ECM for primary exports



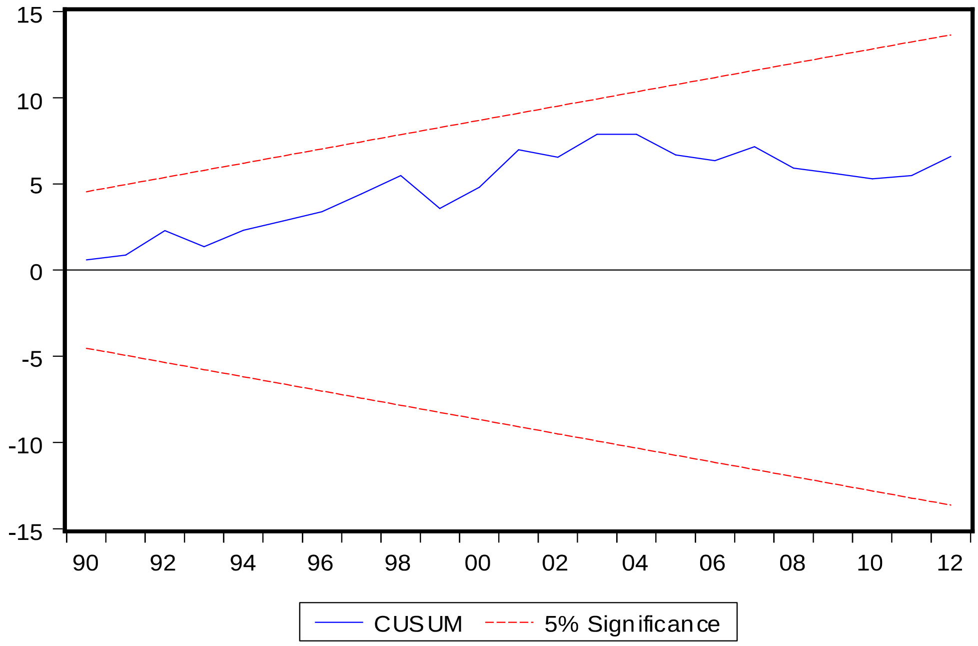
$$\Delta LPX_t = -0.105\Delta LY_{t-1} + 0.512\Delta LK_{t-1} - 0.488\Delta LHC_{t-1} + 0.227\Delta LPX_{t-1} + 0.149LMX_{t-1} + 0.112\Delta LIMP_{t-1} - 0.062\ ECT_{t-1}$$

Figure 6.5: Model 3.α: Plot of CUSUMQ for the estimated ECM for primary exports



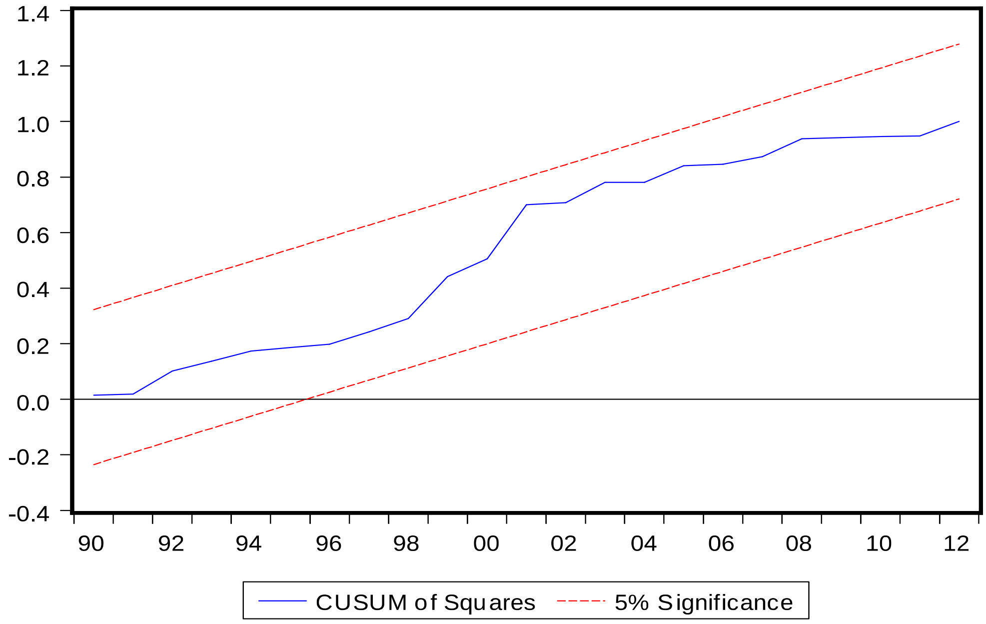
$$\Delta LPX_t = -0.105\Delta LY_{t-1} + 0.512\Delta LK_{t-1} - 0.488\Delta LHC_{t-1} + 0.227\Delta LPX_{t-1} + 0.149LMX_{t-1} + 0.112\Delta LIMP_{t-1} - 0.062\ ECT_{t-1}$$

Figure 6.6: Model 3.α: Plot of CUSUM for the estimated ECM for manufactured exports



ΔLMX_t= 1.898 ΔLY_{t-1} - 0.257ΔLK_{t-1} -0.944ΔLHC_{t-1}-0.382ΔLPX_{t-1} +0.263LMX_{t-1} + 0.715$\Delta LIMP_{t-1}$ + 0.658 ECT_{t-1}

Figure 6.7: Model 3.α: Plot of CUSUMQ for the estimated ECM for manufactured exports



ΔLMX_t= 1.898 ΔLY_{t-1} - 0.257ΔLK_{t-1} -0.944ΔLHC_{t-1}-0.382ΔLPX_{t-1} +0.263LMX_{t-1} + 0.715$\Delta LIMP_{t-1}$ + 0.658 ECT_{t-1}

6.3.5 Model 3.α: Toda-Yamamoto Granger causality test

In the case of UAE the maximum order of integration is d_{max} =1, while the optimal lag length, based on Schwarz Information Criterion, is one. Therefore the selected lag length (p=1) is augmented by the maximum order of integration (d_{max}=1) and the Wald tests are applied to the first p VAR coefficients. The results are presented in table 6.12.

Table 6.12: Model 3.α: Granger Causality based on Toda-Yamamoto procedure

	Source of causation						
	LY_t	**LK_t**	**LHC_t**	**LPX_t**	**LMX_t**	**$LIMP_t$**	**ALL**
Dependent Variable	X^2 *(1)*	X^2 *(1)*	X^2 *(1)*	X^2 *(1)*	X^2 *(1)*	X^2 *(1)*	X^2 *(5)*
LY_t	-	1.845	0.359	1.134	0.127	0.010	4.475
LK_t	4.016**	-	0.085	0.451	0.408	0.007	10.275*
LHC_t	0.127	0.685	-	0.604	0.116	0.035	2.040
LPX_t	1.034	4.619**	0.906	-	0.322	0.059	7.335
LMX_t	10.682***	9.448***	1.856	5.823**	-	21.188***	30.352***
$LIMP_t$	4.726**	4.016**	0.258	1.461	1.529	-	12.713**

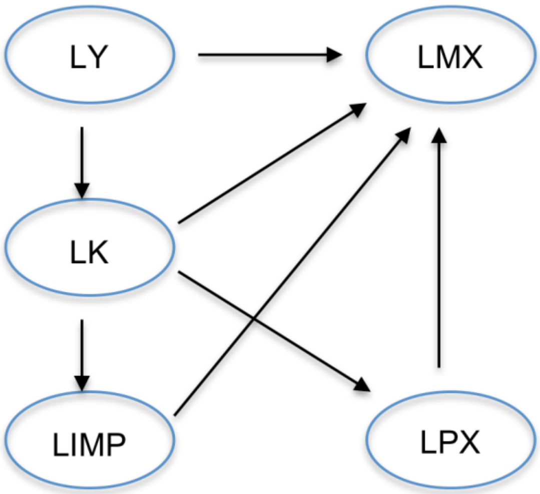
Note: *, ** and *** indicates significance at 10%, 5% and 1% significance level respectively

The diagnostic tests for the select VAR(p) model prior to the application of the Toda-Yamamoto procedure are presented in table G.1, Appendix G.

The results of the T-Y causality test show that there is no evidence to support the ELG hypothesis in the long-run, as the null hypothesis that LMX or LPX does not Granger cause LY cannot be rejected at any conventional significance level. In contrast, the results suggest that a direct long-run causality exists, running from economic growth to manufactured exports. In particular, the null hypothesis that LY does not Granger cause LMX can be rejected at 1% significance level, indicating that the GLE is valid for the case of UAE during 1981-2012. This result shows that economic growth can cause an increase in manufactured exports, by increasing the national production, the capacity to import essential materials for domestic production and improving the existing technology. At the same time a significant causality runs from primary exports to manufactured exports at 5% level, indicating that primary exports are still essential for the expansion of manufactured exports. Moreover, manufactured exports are also affected directly by physical capital and imports of goods and services at 1% significance level, indicating that investments on advanced technology and imports in the form of inputs contribute to the expansion of manufactured exports.

It should be noted that the long-run causal relationship between economic growth and manufactured exports is also affected indirectly by physical capital accumulation and imports. In particular, LY Granger causes LK at 5% significance level, LK Granger causes LIMP at 5% significance level and LIMP Granger causes LMX at 1% significance level. At the same time, economic growth indirectly causes primary exports through physical capital. In particular, LY causes LK at 5% significance level and LK causes PX at 5% significance level. In addition, the results show that LY, LK, LHC, LPX and LIMP jointly Granger cause LMX in the long-run at 1% significance level, while all variables in the model jointly cause LK and LIMP and 10% and 5% significance level. The following figure summarizes the long-run causal relationships between the variables in the model.

Figure 6.8: Model 3.α: Long-run Causal relationships



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

6.4 Model 3.β: The causality between primary exports, manufactured exports and economic growth

6.4.1 Model 3.β: Lag Order Selection

Although the CUSUM plot of the growth model in the previous section, indicates stability of the coefficients' estimates over the period 1981-2012, the CUSUM of squares plot shows evidence of some structural instability around 2000. In the second half of 2000, due to the production cuts by OPEC, the oil price increased approximately by 200% comparing with the 1999 level, reaching over US$30 per barrel[7]. For this reason, an impulse dummy is included for the year 2000.

The lag length for the cointegration test is determined by minimizing the Schwarz Information Criterion (SIC) and Akaike Information Criterion (AIC). Table 6.13 reports that SIC suggests the use of 1 lag in the VAR system, while AIC suggests lag 2. It is known that SIC is preferable for small samples (Lutkepohl, 1991) and therefore, lag 1 is used in this model.

Table 6.13: Model 3.β: VAR lag order selection criteria

Lag	0	1	2
AIC	-5.125	-14.550	-14.790*
SC	-4.565	-12.309*	-10.866

*Indicates lag order selected by the criterion

AIC: Akaike Information Criterion

SC: Schwarz Information Criterion

The diagnostic tests reveal that the residuals are multivariate normal and homoscedastic and there is no evidence of serial correlation. Therefore, the selected VAR model adequately describes the data. The multivariate specification tests are presented in table G.5, Appendix G.

6.4.2 Model 3.β: Cointegration test

The Johansen cointegration test is conducted in order to investigate the existence of a long-run relationship between the variables. Table 6.14 shows that the null hypothesis of no cointegration is rejected at 1% significance level, indicating the existence of one cointegrating vector. In particular, the adjusted Trace statistic for no cointegration vector is 119.32, which is greater than the critical value at 1%. Therefore, the Johansen's cointegration results suggest that real GDP, real gross fixed capital formation, population, real primary exports, real manufactured exports and real imports are cointegrated and follow a common long path.

Table 6.14: Model 3.β: Johansen's Cointegration test results

Hypothesized Number of Cointegrating equations	**Adjusted Trace Statistic**		**Critical Value**	
		1%	**5%**	**10%**
r=0	119.32***	111.01	102.14	97.18
r≤1	70.57	84.45	76.07	71.86
r≤2	43.74	60.16	53.12	49.65
r≤3	21.55	41.07	34.91	32.00

Note: Critical values are taken from Osterwald-Lenum (1992). The model includes an restricted constant (Model selection based on Pantula Principle)

*, ** and *** indicate rejection at 10%, 5% and 1% significance level respectively

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

$$LY_t = \underset{(7.267)}{1.151^{***}} LK_t - \underset{(1.561)}{0.214} LHC_t + \underset{(2.477)}{0.319^{**}} LPX_t + \underset{(10.849)}{1.665^{***}} LMX_t$$

$$-\underset{(8.037)}{2.309^{***}} LIMP_t + \underset{(8.043)}{12.184^{***}} \qquad (6.4.2.1)$$

From the above equation, a 1% increase in real primary exports leads to a 0.319% increase in real GDP, while a 1% increase in manufactured exports rises real GDP by 1.665%. In addition, real GDP increases by 1.151% in response to a 1% increase in physical capital. In contrast, 1% increase in population and imports can lead to a decrease in real GDP by 0.214% and 2.309% respectively. Similarly with the cointegration results of the model 3.*α*, manufactured exports seem to contribute more than primary exports to economic growth, through knowledge spillover effects and other externalities.

6.4.3 Model 3.β: Vector Error Correction Model

Since the variables are integrated of order one and cointegrated, a VECM is specified (for further details see table G.6, Appendix G). The VECM is checked for autocorrelation, normality and homoscedasticity of the residuals. As it can be seen from table G.7 at Appendix G, the null hypothesis of no autocorrelation of residuals cannot be rejected up to lag length 12 at 5% significance level, since all corresponding p-values are greater than 5%. In addition, the White test chi-square statistic is equal to 301.511, with the corresponding p-value of 0.698, indicating that the null hypothesis of homoscedasticity cannot be rejected at any significance level. As far the normality of the residuals is concerned, the p-value 0.982 is greater than 5%, indicating that null hypothesis of multivariate normal residuals cannot be rejected.

In addition, the stability of the VECM is checked by calculating the inverse roots of the characteristic AR polynomial. The analysis shows that the VEC specification imposes 5 unit roots, while the remaining roots have modulus less than one. Therefore, since there are 6 variables and one cointegrating equation in the system, the estimated VECM is stable. The stability results are presented in table G.8 and figure G.2, Appendix G.

Since the aim of this reseach is to find the direction of the causality between exports and economic growth, emphasis is placed on the estimated error correction models for ΔLY_t and ΔLPX_t. The absolute t-statistics are reported in the parentheses:

$$\Delta LY_t = \underset{(0.232)}{-0.076}\,\Delta LY_{t-1} + \underset{(0.242)}{0.035}\,\Delta LK_{t-1} - \underset{(0.371)}{0.069}\,\Delta LHC_{t-1} + \underset{(0.688)}{0.083}\,\Delta LPX_{t-1} +$$

$$+ \underset{(2.778)}{0.193^{**}}\,LMX_{t-1} + \underset{(0.837)}{0.125}\,\Delta LIMP_{t-1} + \underset{(3.314)}{0.200^{***}}\,DUM00 - \underset{(0.918)}{0.049}\,ECT_{t-1} \qquad (6.4.3.1)$$

$$\Delta LPX_t = \underset{(0.566)}{-0.558}\,\Delta LY_{t-1} + \underset{(0.747)}{0.325}\,\Delta LK_{t-1} - \underset{(1.333)}{0.739}\,\Delta LHC_{t-1} + \underset{(0.879)}{0.318}\,\Delta LPX_{t-1} +$$

$$+ \underset{(1.923)}{0.401^{*}}\,LMX_{t-1} + \underset{(0.645)}{0.289}\,\Delta LIMP_{t-1} + \underset{(2.994)}{0.542^{***}}\,DUM00 - \underset{(0.573)}{0.091}\,ECT_{t-1} \qquad (6.4.3.2)$$

6.4.4 Model 3.β: Granger Causality test in VECM

The Granger causality results are reported in table 6.15.

Table 6.15: Model 3.β Short-run Granger causality test

	Source of causation						
	ΔLY_t	ΔLK_t	ΔLHC_t	ΔLPX_t	ΔLMX_t	$\Delta LIMP_t$	ALL
Dependent Variable	χ^2 *(1)*	χ^2 *(1)*	χ^2 *(1)*	χ^2 *(1)*	χ^2 *(1)*	χ^2 *(1)*	χ^2 *(5)*
ΔLY_t	-	0.059	0.137	0.473	7.715***	0.701	16.640***
ΔLK_t	0.680	-	0.057	0.433	0.000	0.129	10.111*
ΔLHC_t	0.007	1.940	-	0.207	1.335	0.237	4.877
ΔLPX_t	0.321	0.558	1.776	-	3.699*	0.416	9.051
ΔLMX_t	6.977***	0.960	5.703**	2.100	-	5.284**	16.748***
$\Delta LIMP_t$	2.493	0.437	0.694	0.356	0.111	-	9.446*

Note: *, ** and *** indicates significance at 10%, 5% and 1% significance level respectively

The diagnostic tests for the VECM model are presented in table G.6, Appendix G.

df in parenthesess

The short-run Granger causality results show that the causality runs from manufactured exports to economic growth at 1% significance level. In addition, the null hypothesis of non causality from economic to manufactured exports can be rejected at 1% significance level, indicating that a bi-directional causality exists between manufactured exports and economic growth over the period 1981-2012. In contrast, no causality exists between primary exports and economic growth over the examined period. Moreover, the results show that there is a unidirectional causality from manufactured exports to primary exports and from human capital and imports to manufactured exports. Thus, given that manufactured exports cause economic growth, human capital and imports indirectly cause economic growth. The short-run Granger causality results for UAE are reported in the following table.

In addition, the Chi-square test is performed to investigate the joint significance of the explanatory variables. As it can be seen from table 6.16, the results indicate that the null hypothesis of non causality from ΔLK_t, ΔLHC_t, ΔLPX_t, ΔLMX_t and $LIMP_t$ to economic growth can be rejected at 1% significance level. In addition, the results show that all the variables in the model jointly cause manufactured exports at 1% significance level. Moreover, all the variables jointly cause imports and physical capital at 10% significance level. Table 6.16 summarizes the short-run Granger causality results.

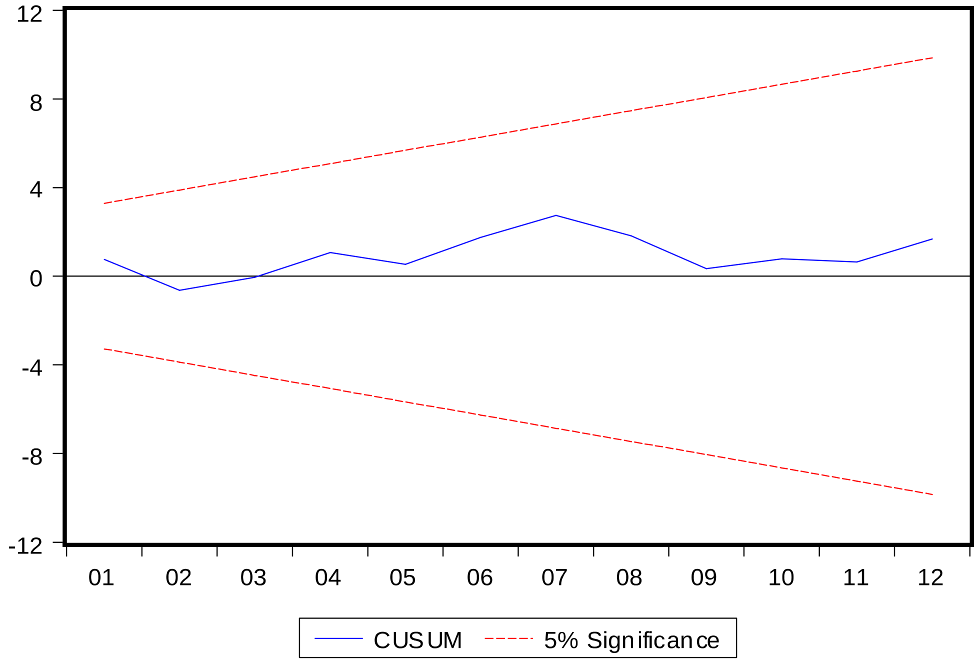
Table 6.16: Model 3.β: Short-run Granger Causality test results

ΔLY_t	➔	ΔLMX_t
ΔLMX_t	➔	ΔLY_t
ΔLMX_t	➔	ΔLPX_t
ΔLHC_t	➔	ΔLMX_t
$\Delta LIMP_t$	➔	ΔLMX_t
ΔLY_t, ΔLK_t, ΔLHC_t, LPX_t, $\Delta LIMP_t$	➔	ΔLMX_t
ΔLK_t, ΔLHC_t, LPX_t, ΔMX_t, $\Delta LIMP_t$	➔	ΔLY_t
ΔLY_t, ΔLK_t, ΔLHC_t, LPX_t, $\Delta LIMP_t$	➔	ΔLK_t
ΔLY_t, ΔLK_t, ΔLHC_t, LPX_t, $\Delta LIMP_t$	➔	$\Delta LIMP_t$

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

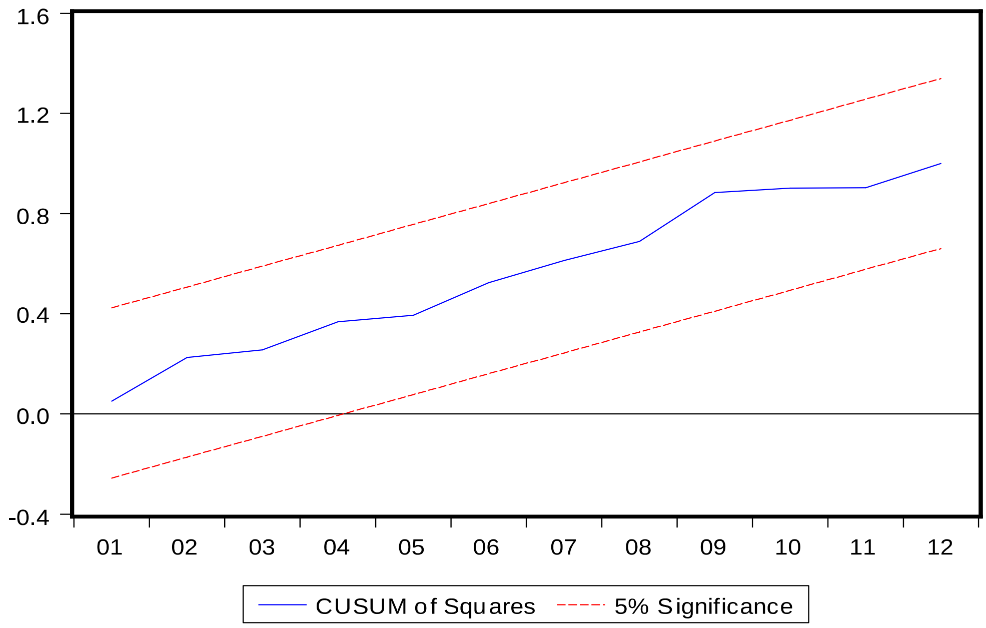
Since the aim of this reseach focuses on the relationship between exports and economic growth, emphasis is placed on the stability of the parameters of estimated error correction models for economic growth and disaggregated exports. The constancy of the parameters of the ECM for economic growth is assesed by applying the CUSUM and CUSUM of squares. The results are presented in figure 6.9 and figure 6.10.

Figure 6.9: Model 3.β: Plot of CUSUM for the estimated ECM for economic growth



ΔLY_t= -0.076 ΔLY_{t-1} + 0.035 ΔLK_{t-1} - 0.069 ΔLHC_{t-1} + 0.083ΔLPX_{t-1} + 0.193 LMX_{t-1} + 0.125 $\Delta LIMP_{t-1}$ + 0.200 DUM00 - 0.049 ECT_{t-1}

Figure 6.10: Model 3.β: Plot of CUSUMQ for the estimated ECM for economic growth

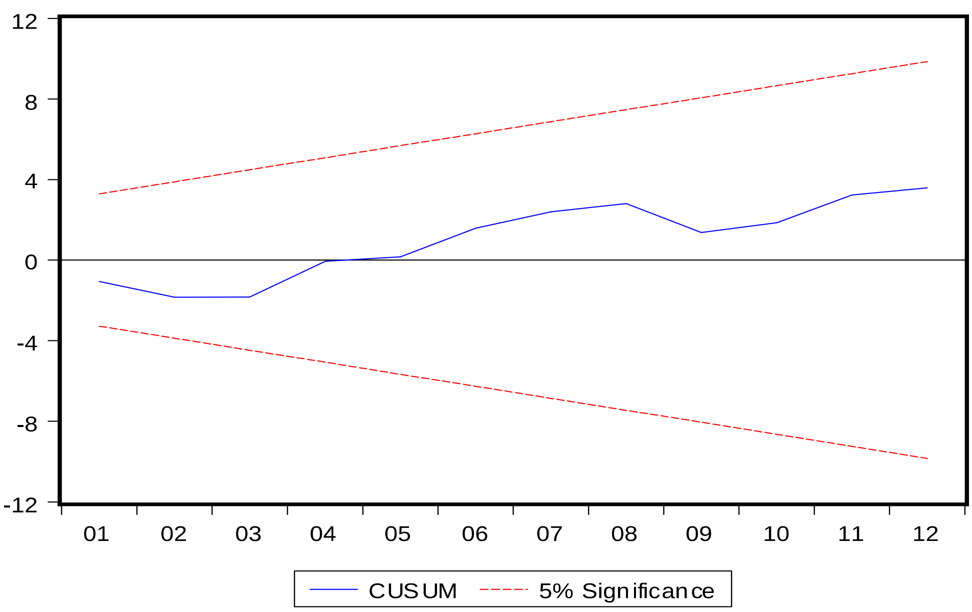


ΔLY_t= -0.076 ΔLY_{t-1} + 0.035 ΔLK_{t-1} - 0.069 ΔLHC_{t-1} + 0.083ΔLPX_{t-1} + 0.193 LMX_{t-1} + 0.125 $\Delta LIMP_{t-1}$ + 0.200 DUM00 - 0.049 ECT_{t-1}

As it can be seen from the CUSUM plot (figure 6.9), there is no movement outside the 5% critical lines, indicating that the model is stable. Moreover, the cumulative sum of squares (figure 6.10) is within the 5% critical lines, suggesting parameter stability. Therefore, the estimated model for economic growth including the impulse dummy DUM00 is stable and there is no reason to test for the presence of a second structural break.

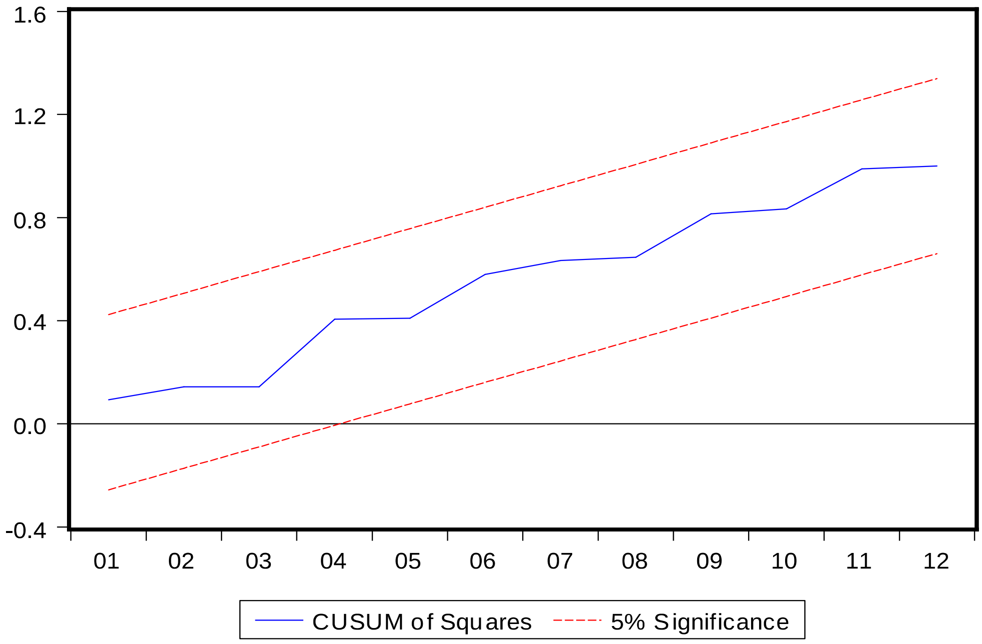
In addition, the CUSUM plots (figures 6.11- 6.14) for the structural stability of the ECMs for disaggregated exports show that there is no movement outside the 5% critical lines of parameter stability. Therefore, there is no reason to test for the presence of a second structural break.

Figure 6.11: Model 3.β Plot of CUSUM for the estimated ECM for primary exports



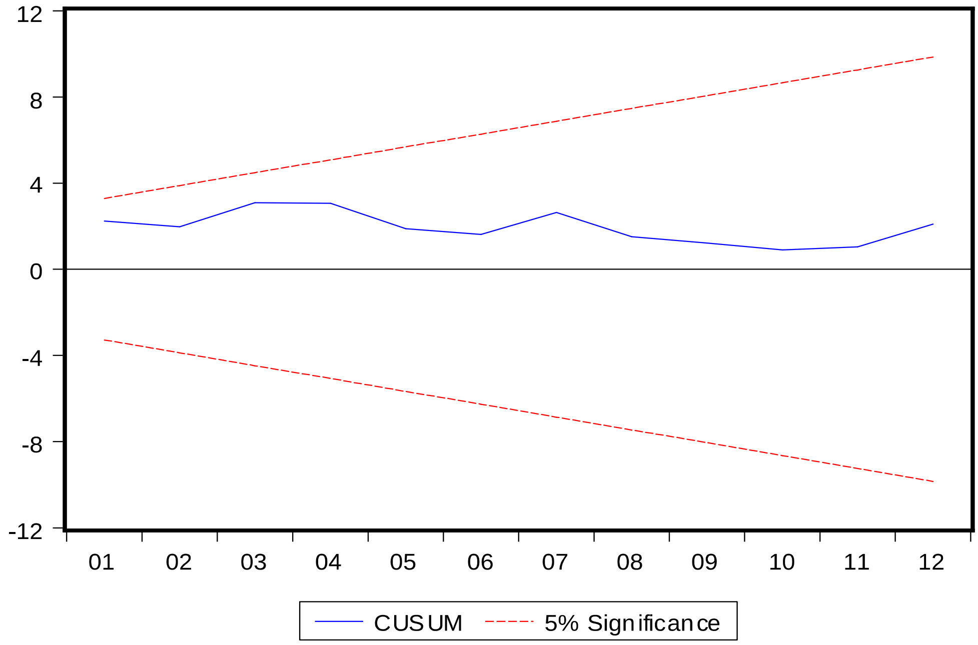
$\Delta LPX_t = -0.558\ \Delta LY_{t-1} + 0.325\ \Delta LK_{t-1} - 0.739\ \Delta LHC_{t-1} + 0.318\ \Delta LPX_{t-1} + 0.401\ LMX_{t-1} + 0.289\ \Delta LIMP_{t-1} + 0.542\ DUM00 - 0.091\ ECT_{t-1}$

Figure 6.12: Model 3.β: Plot of CUSUMQ for the estimated ECM for primary exports



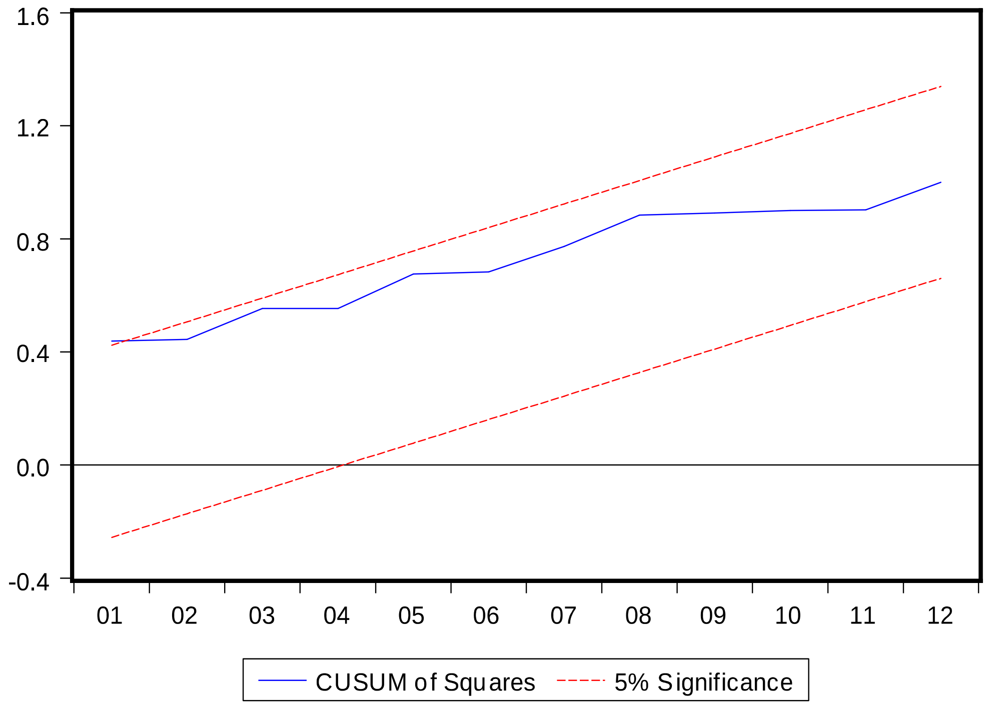
ΔLPX_t= -0.558 ΔLY_{t-1} + 0.325 ΔLK_{t-1} - 0.739 ΔLHC_{t-1} + 0.318 ΔLPX_{t-1} + 0.401 LMX_{t-1} + 0.289 $\Delta LIMP_{t-1}$ + 0.542 DUM00 - 0.091 ECT_{t-1}

Figure 6.13: Model 3.β: Plot of CUSUM for the estimated ECM for manufactured exports



ΔLMX_t= 1.862 ΔLY_{t-1} - 0.305 ΔLK_{t-1} -0.948 ΔLHC_{t-1} - 0.375 ΔLPX_{t-1} + 0.318 LMX_{t-1} + 0.737 $\Delta LIMP_{t-1}$ + 0.103 DUM00 + 0.622 ECT_{t-1}

Figure 6.14: Model 3.β: Plot of CUSUMQ for the estimated ECM for manufactured exports



ΔLMX_t= 1.862 ΔLY_{t-1} - 0.305 ΔLK_{t-1} -0.948 ΔLHC_{t-1} - 0.375 ΔLPX_{t-1} + 0.318 LMX_{t-1} + 0.737 $\Delta LIMP_{t-1}$ + 0.103 DUM00 + 0.622 ECT_{t-1}

6.4.5 Model 3.β: Toda-Yamamoto Granger causality test

In the case of UAE the maximum order of integration is d_{max} =1, while the optimal lag length, based on Schwarz Information Criterion, is one. Therefore the selected lag length (p=1) is augmented by the maximum order of integration (d_{max}=1) and the Wald tests are applied to the first p VAR coefficients. The results are presented in table 6.17.

Table 6.17: Model 3.β: Granger Causality based on Toda-Yamamoto procedure

Dependent Variable	Source of causation LY_t χ^2 *(1)*	 LK_t χ^2 *(1)*	 LHC_t χ^2 *(1)*	 LPX_t χ^2 *(1)*	 LMX_t χ^2 *(1)*	 $LIMP_t$ χ^2 *(1)*	 ALL χ^2 *(5)*
LY_t	-	0.628	0.388	0.828	1.729	0.120	7.824
LK_t	3.554*	-	0.089	0.325	0.038	0.029	8.275
LHC_t	0.127	0.642	-	0.583	0.054	0.038	1.758
LPX_t	0.773	2.614	0.999	-	0.164	0.241	9.323*
LMX_t	10.327***	8.887***	1.750	5.692**	-	20.309***	28.693***
$LIMP_t$	4.223**	2.513	0.246	1.160	0.308	-	9.276*

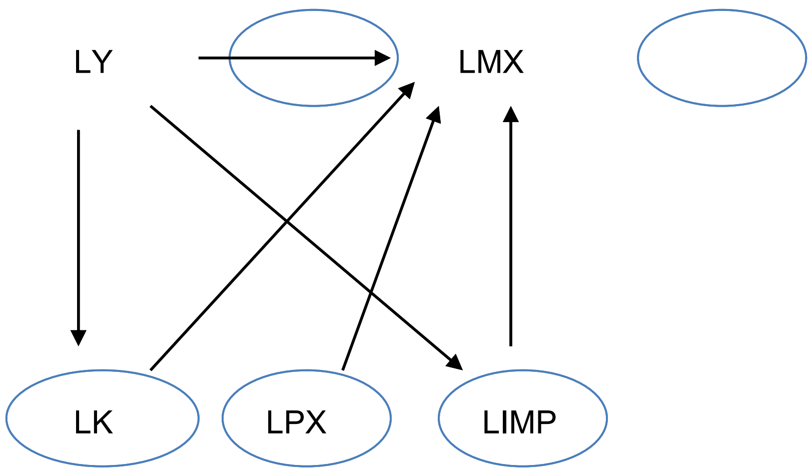
Note: *, ** and *** indicates significance at 10%, 5% and 1% significance level respectively. df in parentheses. The diagnostic tests for the select VAR(p) model prior to the application of the Toda-Yamamoto procedure are presented in table G.5, Appendix G.

The results of the T-Y causality test show that there is no evidence to support the ELG hypothesis in the long-run. The null hypothesis that LPX does not Granger cause LY and the null hypothesis that LMX does not Granger cause LY cannot be rejected at any conventional significance level. In contrast, the results suggest that a direct long-run causality exists, running from economic growth to manufactured exports. In particular, the null hypothesis that LY does not Granger cause LMX can be rejected at 1% significance level, indicating that the GLE is valid for the case of UAE during 1981-2012.

This result shows that economic growth can cause an increase in manufactured exports, by increasing the national production, the capacity to import essential materials for domestic production and improving the existing technology. At the same time a significant causality runs from primary exports to manufactured exports at 5% level, indicating that primary exports are still essential for the expansion of manufactured exports. Moreover, manufactured exports are also affected directly by physical capital and imports of goods and services at 1% significance level, indicating that investments on advanced technology and imports in the form of inputs contribute to the expansion of manufactured exports.

It should be noted that the long-run causal relationship between economic growth and manufactured exports is also affected indirectly by physical capital accumulation and imports. In particular, LY Granger causes LK at 10% significance level and LK Granger causes LMX at 1% significance level. At the same time, LY Granger causes LIMP at 5% significance level and LIMP Granger causes LMX at 1% significance level. In addition, the results show that LY, LK, LHC, LPX and LIMP jointly Granger cause LMX in the long-run at 1% significance level, while all variables in the model jointly cause LPX and LIMP at 10% significance level. In contrast with the results of the previous model, where the impulse dummy variable DUM00 is not included, economic growth does not indirectly cause primary exports through physical capital. The following figure summarizes the long-run causal relationships between the variables in the model.

Figure 6.15: Model 3.β Long-run Causal relationships



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

6.5 Conclusions

This chapter provides evidence on the causal relationship between primary exports, manufactured exports and economic growth over the period 1981-2012. The model with disaggregated exports is estimated with and without the inclusion of an impulse dummy variable for the year 2000, in order to obtain more efficient results. The cointegration results for both models confirm the existence of a long-run relationship between the variables under consideration. Disaggregating merchandise exports into primary and manufactured exports, the analysis reveals that manufactured exports contribute more to economic growth than primary exports in the long-run. Theses findings are consistent with previous studies, which argued that manufactured exports offer knowledge spillover effects and other externalities, enhancing economic growth (e.g. Fosu, 1990; Ghatak et al., 1997; Abu-Qarn and Abu-Bader, 2004; Herzer et al., 2006; Siliverstovs and Herzer, 2006; Siliverstovs and Herzer, 2007).

The short-run causality analysis based on disaggregated exports without the inclusion of the dummy exogenous variable (model 3.α) reveals that economic growth causes manufactured exports both in the short-run and long-run over the period 1981-2012. This result shows that economic growth can cause an increase in manufactured exports, by increasing the national production, the capacity to import essential materials for domestic production and improving the existing technology. This finding is in line with those reported in the relevant literature (El-Sakka and Al-Mutairi, 2000; Panas and Vamvoukas, 2002; Love and Chandra, 2005; Mishra, 2011). In particular, this result is similar with that of El-Sakka and Al-Mutairi (2000), which supports the GLE for UAE over the period 1972-1996. However, the study by El-Sakka and Al-Mutairi is based on bivariate Granger causality tests, using total exports and not disaggregated exports.

The empirical results of model 3.α also provides evidence that primary exports do not cause economic growth in UAE in both short-run and long-run. However, economic growth indirectly causes primary exports through physical capital in the long-run. Hence, these results indicate that manufactured exports contribute more to economic growth than primary exports in UAE, reinforcing the view that aggregate measures may mask the different causal effects of subcategories of exports (Ghatak et al., 1997; Abu-Qarn and Abu-Bader, 2004; Siliverstovs and Herzer, 2006, Herzer et al. 2006; Kilavuz and Altay Topcu, 2012). However, a significant causality runs from primary exports to manufactured exports in the long-run, indicating that primary exports are still essential for the expansion of manufactured exports.

After the inclusion of the dummy variable for the year 2000 (model 3.β), the analysis confirms the existence of a short-run bidirectional causality between manufactured exports and economic growth, which is consistent with previous studies (e.g Kwan and Cotsomitis, 1991; Awokuse, 2007; Narayan et al., 2007; Elbeydi et al., 2010). In the long-run, the growth-led exports hypothesis and the unidirectional causality from primary exports to manufactured exports remain valid after the inclusion of the dummy variable. In contrast with the results of the model 3.α, economic growth does not indirectly cause primary exports through physical capital.

Finally, the empirical results of models 3.α and model 3.β indicate that all the variables under consideration jointly cause manufactured exports in both short-run and long-run for UAE, confirming the importance of these factors for the manufactured exports sector.

In sum, the main findings regarding the causal relationship between disaggregated exports and economic growth are summarised below:

Model	**Granger causality in the short-run**	**Result**
Model 3.α	Economic growth $\longrightarrow$ Manufactured Exports	GLE
Model 3.β	Economic growth $\longleftrightarrow$ Manufactured Exports	ELG-GLE

Model	**Granger causality in the long-run**	**Result**
Model 3.α	Economic growth $\longrightarrow$ Manufactured Exports	GLE
Model 3.β	Economic growth $\longrightarrow$ Manufactured Exports	GLE

CHAPTER 7. EMPIRICAL RESULTS: THE CAUSAL EFFECT OF TRADITIONAL EXPORTS AND DIVERSIFIED EXPORTS ON ECONOMIC GROWTH

7.1 Introduction

This chapter examines the causal effects of traditional UAE exports and diversified exports on economic growth over the period 1981-2012. Two models, based on an augmented neoclassical production function, are used to find the direction of the causality between traditional exports-economic growth and diversified exports-economic growth. The first model, investigates the causal effects of traditional exports, consisting of fuel and mining exports, on economic growth, while the second model examines the existence of causality between non-oil exports, re-exports and economic growth. In addition, an impulse dummy time variable is also included where appropriate for the stability of the model.

The first section of this chapter examines the time series properties of the data for UAE over the period 1981-2012. The subsequent sections present in detail the empirical analysis pertaining to the third and fourth research question, which investigate whether abundant fuel-mining exports and diversified exports cause economic growth. Finally, the last section presents the main findings and their consistency with previous studies.

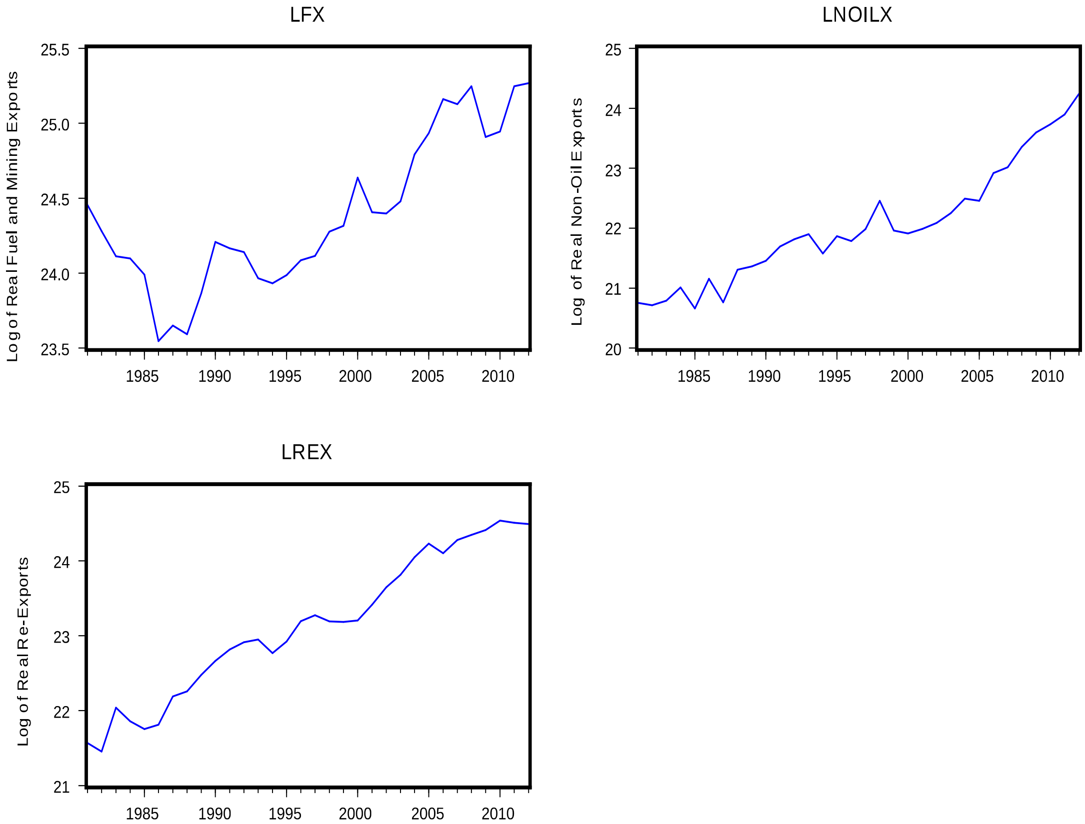
7.2 Unit root tests for model 4 and model 5

Before testing for causality between GDP, fuel-mining exports, non-oil exports and re-exports, the order of integration of the variables is examined. The time-series properties of real GDP (LY), real gross fixed capital formation (LK), population (HC) and real imports of goods and services (LIMP) over the period 1981-2012 are examined and presented in chapter six, section 6.2. In the present section, the time-series properties of real fuel-mining exports (LFX), real non-oil exports (LNOILX) and real re-exports (LREX) are initially investigated by performing visual inspection of plots and correlograms of the variables at level and first difference.

The graphical inspection of the series at levels indicates that each variable has non-constant mean (figure 7.1). In particular, LFX suffered declines approximately until 1988, while after that year is upward trended with some fluctuations. In addition, the series of LNOILX and LREX follow an upward trend with some fluctuations throughout the period.

In addition to the graphical evidence, the correlograms of the variables are inspected. All variables at level have correlograms that die out slowly, while the autocorrelations of the first differences display the classic pattern of a stationary series described in chapter four, section 4.3.1. The correlograms of the series at levels and first differences are given in figure F.1, Appendix F.

Figure 7.1: Pattern of the logarithm of the data series of fuel-mining exports, non-oil exports and re-exports over the period 1981-2012



Source: Fuel-mining exports are taken from the WTO-Time Series on International Trade. Non-Oil exports and Re-exports are taken from the UAE National Bureau of Statistics.

The graphs are produced by using the econometric software eviews7

Although the visual inspection of the plots and correlograms at level suggest that the series are not stationary, the stationarity of the series are formally investigated by applying the ADF, PP, KPSS and SL unit root tests in log levels and in first differences of the logs.

Table 7.1 presents the results of the ADF unit root test at levels and first differences. The results of the ADF test at log levels indicate that the null hypothesis of non-stationarity cannot be rejected for all the variables at any conventional significance level. After taking the first difference of LFX, LNOILX and LREX, the null hypothesis for unit root can be rejected at 1% level of significance. Hence, the ADF test results indicate that the time series for the period 1981-2012 are integrated of order one I(1).

Table 7.1: ADF test results at logarithmic level and first difference for model 4 and model 5

	Constant with trend			**Constant**			**None**		
	ADF	**Test critical values of % level**		**ADF**	**Test critical values of % level**		**ADF**	**Test critical values of % level**	
LFX[(a)]	-3.02	1%	-4.29	-0.28	1%	-3.66	0.76	1%	-2.64
	[0]	5%	-3.56	[0]	5%	-2.96	[0]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
DLFX[(c)]	-5.17***	1%	-4.30	-4.97***	1%	-3.67	-4.92***	1%	-2.64
	[0]	5%	-3.57	[0]	5%	-2.96	[0]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
LNOILX[(a)]	-1.94	1%	-4.29	0.55	1%	-3.66	2.49	1%	-2.64
	[0]	5%	-3.56	[0]	5%	-2.96	[0]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
DLNOILX[(b)]	-9.22***	1%	-4.30	-8.75***	1%	-3.67	-6.66***	1%	-2.64
	[0]	5%	-3.57	[0]	5%	-2.96	[0]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
LREX[(a)]	-3.06	1%	-4.30	-0.85	1%	-3.66	3.12	1%	-2.64
	[1]	5%	-3.57	[0]	5%	-2.96	[0]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
DLREX[(b)]	-6.39***	1%	-4.30	-6.38***	1%	-3.67	-4.66***	1%	-2.64
	[0]	5%	-3.57	[0]	5%	-2.96	[0]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61

Note: Numbers in parentheses corresponding to ADF test statistics are the optimal lags, chosen based on Schwarz Information Criterion (SIC).

*, **, *** denote the rejection of the null hypothesis of a unit root at 10%, 5% and 1% respectively.

All the time series are tested for the unit root under the ADF regression and the letters in brackets indicate the selected model following Doldado et al. (1990):

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

The Phillips-Perron test results (table 7.2) indicate that the null hypothesis of a unit root cannot be rejected for LFX, LNOILX and LREX at 5% significance level. In contrast DLFX, DLNOILX and DLREX are found to be stationary at 1% level of significance. Therefore, the PP test results are in line with the ADF results.

Table 7.2: PP test results at logarithmic level and first difference for model 4 and model 5

	Constant with trend			Constant			None		
	ADF	**Test critical values of % level**		**ADF**	**Test critical values of % level**		**ADF**	**Test critical values of % level**	
LFX(a)	-3.49*	1%	-4.29	-0.44	1%	-3.66	0.71	1%	-2.64
	[11]	5%	-3.56	[2]	5%	-2.96	[2]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
DLFX(c)	-5.50***	1%	-4.30	-4.97***	1%	-3.67	-4.91***	1%	-2.64
	[6]	5%	-3.57	[4]	5%	-2.96	[3]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
LNOILX(a)	-1.86	1%	-4.29	1.36	1%	-3.66	2.49	1%	-2.64
	[3]	5%	-3.56	[2]	5%	-2.96	[0]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
DLNOILX(b)	-9.22***	1%	-4.30	-8.55***	1%	-3.67	6.61***	1%	-2.64
	[0]	5%	-3.57	[2]	5%	-2.96	[4]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
LREX(a)	-3.06	1%	-4.29	-1.06	1%	-3.66	7.61	1%	-2.64
	[3]	5%	-3.56	[13]	5%	-2.96	[16]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61
DLREX(b)	-10.86***	1%	-4.30	-8.63***	1%	-3.67	-4.70	1%	-2.64
	[19]	5%	-3.57	[16]	5%	-2.96	[2]	5%	-1.95
		10%	-3.22		10%	-2.62		10%	-1.61

Note: Bandwidth in [ ] (Newey-West automatic) using Bartlett kernel estimation method.

*, **, *** denote the rejection of the null hypothesis of a unit root at 10%, 5% and 1% respectively. All the time series are tested for the unit root including intercept and trend (a), intercept only (b) and no constant or trend (c). The letters in brackets indicate the selected model following Doldado et al. (1990).

The KPSS test results including an intercept, indicate that the null hypothesis of stationarity is rejected for all the variables at 5% significance level. The same test is also conducted including an intercept and linear deterministic trend and the results indicate that LFX and NOILX are non-stationary at 5% and 10% significance level respectively. In contrast, the variable LREX is found to be stationary at 5% significance level. The first-differenced series DLFX and

DLNOILX are found to be stationary at 1% significance level with and without the inclusion of linear deterministic trend. In the case of DLREX, when the test is conducted including an intercept and deterministic trend, the null hypothesis of stationarity is rejected at 1% significance level. However, the coefficient of the deterministic linear trend is not significant. The KPSS test results are presented in table 7.3.

Table 7.3: KPSS test results at logarithmic level and first difference for model 4 and model 5

	Constant with trend			**Constant no trend**		
	KPSS	**Test critical values of % level**		**KPSS**	**Test critical values of % level**	
LFX[(a)]	0.17**	1%	0.22	0.60**	1%	0.74
	[3]	5%	0.15	[4]	5%	0.46
		10%	0.12		10%	0.35
DLFX[(b)]	0.14*	1%	0.22	0.28	1%	0.74
	[6]	5%	0.15	[2]	5%	0.46
		10%	0.12		10%	0.35
LNOILX[(a)]	0.13*	1%	0.22	0.72**	1%	0.74
	[4]	5%	0.15	[4]	5%	0.46
		10%	0.12		10%	0.35
DLNOILX[(b)]	0.10	1%	0.22	0.17	1%	0.74
	[3]	5%	0.15	[0]	5%	0.46
		10%	0.12		10%	0.35
LREX[(a)]	0.07	1%	0.22	0.74**	1%	0.74
	[1]	5%	0.15	[4]	5%	0.46
		10%	0.12		10%	0.35
DLREX[(b)]	0.29***	1%	0.22	0.35	1%	0.74
	[18]	5%	0.15	[17]	5%	0.46
		10%	0.12		10%	0.35

Note: Bandwidth in [ ] (Newey-West automatic) using Bartlett kernel estimation method.

*, **, *** denote the rejection of the null hypothesis of a unit root at 10%, 5% and 1% respectively.

All the time series are tested for the unit root including intercept and trend (a) and intercept only(b). The letters in brackets indicate the selected model following Doldado et al. (1990).

Moreover, the SL test with a structural break is applied to this research in order to evaluate the time series properties. The SL test results for the log levels and first difference of the time series are presented in table 7.4.

Table 7.4: SL test results with structural break at logarithmic level and first difference for model 4 and model 5

	Without trend				**With trend**			
	UR	**Year**	**Test critical values of % level**		**UR**	**Year**	**Test critical values of % level**	
LFX	-0.23 [0]	1986	1% 5% 10%	-3.48 -2.88 -2.58	-1.86 [0]	1986	1% 5% 10%	-3.55 -3.03 -2.76
DLFX	-5.54*** [0]	1986	1% 5% 10%	-3.48 -2.88 -2.58	-5.28*** [0]	1986	1% 5% 10%	-3.55 -3.03 -2.76
LNOILX	0.85 [0]	1988	1% 5% 10%	-3.48 -2.88 -2.58	-2.50 [0]	1999	1% 5% 10%	-3.55 -3.03 -2.76
DLNOILX	-5.93*** [0]	1987	1% 5% 10%	-3.48 -2.88 -2.58	-5.11*** [0]	1987	1% 5% 10%	-3.55 -3.03 -2.76
LREX	-1.05 [0]	1987	1% 5% 10%	-3.48 -2.88 -2.58	-1.72 [1]	1985	1% 5% 10%	-3.55 -3.03 -2.76
DLREX	-6.79*** [0]	1987	1% 5% 10%	-3.48 -2.88 -2.58	-6.86*** [0]	1987	1% 5% 10%	-3.55 -3.03 -2.76

Note: Numbers in parentheses corresponding to UR test statistics are the optimal lags, chosen based on Schwarz Information Criterion (SIC).

Critical values are tabulated in Lanne et al. (2002).

*, **, *** denote the rejection of the null hypothesis of a unit root at 10%, 5% and 1% respectively.

All the time series are tested for the unit root including intercept and trend and intercept only.

The test is conducted including an intercept and linear trend and also including an intercept only. Both results indicate that the variables at level are non-stationary at conventional levels of significance, while the first-differenced series of LFX, LNOILX and LREX are stationary at 1% significance level. Since all variables are I(1), we can apply the cointegration test to investigate the existence of a long-run relationship between the variables.

7.3 Model 4: The causality between traditional exports and economic growth

7.3.1 Model 4: Lag Order selection

The lag length for the VAR system is determined by minimizing the Schwarz Information Criterion (SIC) and Akaike Information Criterion (AIC), allowing the maximum of two lags. Although both criteria suggest the use of 1 lag in the VAR system (table 7.5), lag length of two is used, as lag one introduces autocorrelation.

Table 7.5: Model 4: VAR Lag Order Selection Criteria

Lag	0	1	2
AIC	-3.376	-12.200*	-12.045
SC	-3.143	-10.799*	-9.477

*Indicates lag order selected by the criterion

AIC: Akaike Information Criterion

SC: Schwarz Information Criterion

The multivariate specification tests for the VAR(2) model indicate that there is no problem of serial correlation, while the residuals are multivariate normal and homoscedastic. Therefore, the selected VAR model adequately describes the data. The multivariate specification tests are presented in table G.9, Appendix G.

7.3.2 Model 4: Cointegration test

The Johansen cointegration test is conducted in order to investigate the existence of a long-run relationship between LY, LK, LHC, LFX and LIMP. Table 7.6 shows that null hypothesis of no cointegration is rejected at 5% significance level, indicating the existence of one cointegrating vector. In particular, the adjusted Trace statistic for no cointegration vector is 80.46, which is greater than the critical value at 5%. Therefore, the Johansen's cointegration results suggest that real GDP, real gross fixed capital formation, population, real fuel and mining exports and real imports are cointegrated and follow a common long path.

Table 7.6: Model 4: Johansen's Cointegration Test results

Hypothesized Number of Cointegrating equations	**Adjusted Trace Statistic**		**Critical Value**	
		1%	**5%**	**10%**
r=0	80.46**	84.45	76.07	71.86
r≤1	48.19	60.16	53.12	49.65
r≤2	28.18	41.07	34.91	32.00
r≤3	14.68	24.6	19.96	17.85

Note: Critical values are taken from Osterwald-Lenum (1992). The model includes a restricted constant (Model selection based on Pantula Principle)

*, ** and *** indicate rejection at 10%, 5% and 1% significance level respectively

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

$$LY_t = \underset{(8.709)}{0.499^{***}}\, LK_t - \underset{(2.474)}{0.137^{**}}\, LHC_t - \underset{(2.601)}{0.109^{***}}\, LFX_t + \underset{(5.216)}{0.322^{***}}\, LIMP_t + \underset{(19.952)}{10.473^{***}} \qquad (7.3.2.1)$$

From the above equation, a 1% increase in real fuel and mining exports leads to a 0.109% decrease in real GDP, while a 1% increase in physical capital rises real GDP by 0.499%. In addition, real GDP decreases by 0.137% in response to a 1% increase in human capital. In contrast, 1% increase in imports can lead to an increase in real GDP by 0.322%. These results suggest that fuel and mining exports do not enhance economic growth in the long-run.

7.3.3 Model 4: Vector Error Correction Model

Since the variables are integrated of order one and cointegrated, a VECM should be specified (for further details see table G.10, Appendix G). The VECM is checked for autocorrelation, normality and homoscedasticity of the residuals. As it can be seen from table G.11 at Appendix G, the null hypothesis of no autocorrelation of residuals cannot be rejected up to lag length 12 at 5% significance level, since all corresponding p-values are greater than 5%. In addition, the White test chi-square statistic is equal to 332.131, with the corresponding p-value of 0.457, indicating that the null hypothesis of homoscedasticity cannot be rejected at any significance level. As far the normality of the residuals is concerned, the p-value is greater than 5%, indicating that null hypothesis of multivariate normal residuals cannot be rejected.

Moreover, the stability of the VECM is checked by calculating the inverse roots of the characteristic AR polynomial. The analysis shows that the VEC specification imposes 4 unit roots, while the remaining roots have modulus less than one. Therefore, since there are 5 variables and one cointegrating equation in the system, the estimated VECM is stable. The stability results are presented in table G.12 and figure G.3, Appenix G.

Since the aim of this reseach is to find the direction of the causality between exports and economic growth, emphasis is placed on the estimated error correction models for ΔLY_t and ΔLFX_t. The absolute t-statistics are reported in the parentheses:

$$\Delta LY_t = \underset{(0.264)}{-0.097}\, \Delta LY_{t-1} - \underset{(0.150)}{0.057}\, \Delta LY_{t-2} + \underset{(1.675)}{0.290}\, \Delta LK_{t-1} - \underset{(1.331)}{0.227} \Delta LK_{t-2} -$$

$$- \underset{(0.325)}{0.079}\, \Delta LHC_{t-1} + \underset{(0.962)}{0.234}\, \Delta LHC_{t-2} + \underset{(2.323)}{0.341^{**}}\, \Delta LFX_{t-1} + \underset{(0.416)}{0.067}\, \Delta LFX_{t-2} +$$

$$- \underset{(0.998)}{0.173}\, \Delta LIMP_{t-1} + \underset{(1.778)}{0.314^{*}}\, \Delta LIMP_{t-2} - \underset{(2.207)}{0.532^{**}}\, ECT_{t-1} \tag{7.3.3.1}$$

$$\Delta LFX_t = \underset{(0.787)}{-0.802}\, \Delta LY_{t-1} - \underset{(0.010)}{0.010}\, \Delta LY_{t-2} + \underset{(2.423)}{1.166^{**}}\, \Delta LK_{t-1} - \underset{(2.157)}{1.021^{**}}\, \Delta LK_{t-2} -$$

$$- \underset{(0.496)}{0.336}\, \Delta LHC_{t-1} + \underset{(0.686)}{0.465}\, \Delta LHC_{t-2} + \underset{(2.860)}{1.168^{**}}\, \Delta LFX_{t-1} + \underset{(0.127)}{0.057} \Delta LFX_{t-2} +$$

$$- \underset{(1.543)}{0.746}\, \Delta LIMP_{t-1} + \underset{(1.804)}{0.884^{*}}\, \Delta LIMP_{t-2} - \underset{(2.421)}{1.623^{**}}\, ECT_{t-1} \tag{7.3.3.2}$$

7.3.4 Model 4: Granger Causality in VECM

The results show that the null hypothesis of non causality from fuel and mining exports to economic growth cannot be rejected at 5% significance level, indicating that the ELG hypothesis is not valid in the short-run. However, the null hypothesis of non causality from fuel and mining exports to economic growth can be rejected at 10% significance level, showing that fuel and mining exports Granger cause economic growth only at 10% significance level.

In addition, the null hypothesis of non causality from economic growth to fuel and mining exports cannot be rejected at any conventional significance level. Therefore, the GLE is not valid in the case of fuel and mining exports. As far as the other causal relationships are concerned, a unidirectional causality runs from physical capital to fuel and mining exports at 5% significance level, while fuel and mining exports Granger cause imports at 1% significance level. These results show that investments cause the expansion of fuel and mining exports, allowing the expansion of imports of services and capital goods, which are essential to improving productivity and economic growth (Gylfason, 1998; McKinnon, 1964; Chenery and Strout, 1966). The short-run causality results are reported in the following table.

Table 7.7: Model 4: Short-run Granger causality test

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

Note: *, ** and *** indicates significance at 10%, 5% and 1% significance level respectively

The diagnostic tests for the VECM model are presented in table G.10, Appendix G.

df in parentheses

In addition, the Chi-square test is performed to investigate the joint significance of the explanatory variables. The results indicate that the variables ΔLY_t, ΔLK_t, ΔLHC_t and ΔLFX_t, jointly cause imports ($\Delta LIMP_t$) at 5% significance level. Table 7.8 presents the short-run Granger causality results.

Table 7.8: Model 4: Short-run Granger Causality Results

ΔLFX_t	➔	ΔLY_t
ΔLK_t	➔	ΔLHC_t
ΔLK_t	➔	ΔLFX_t
ΔLY_t	➔	$\Delta LIMP_t$
ΔLK_t	➔	$\Delta LIMP_t$
ΔLFX_t	➔	$\Delta LIMP_t$
ΔLY_t, ΔLK_t, ΔLHC_t, LFX_t	➔	$\Delta LIMP_t$

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

Table 7.9 Presents the long-run causality results based on ECMs. In the estimated ECMs for economic growth and fuel-mining exports, the coefficients of the lagged error correction terms are significant at the conventional levels. Specifically, the coefficients of the lagged error correction terms in the ΔLY_t

equation (7.3.3.1) and in the equation where ΔLFX_t is the dependent variable (7.3.3.2), are significant at 5% significance level. These results can be interpreted as a long-run causality which runs interactively through the error correction term from fuel-mining exports, physical capital, human capital and imports to economic growth and vice versa.

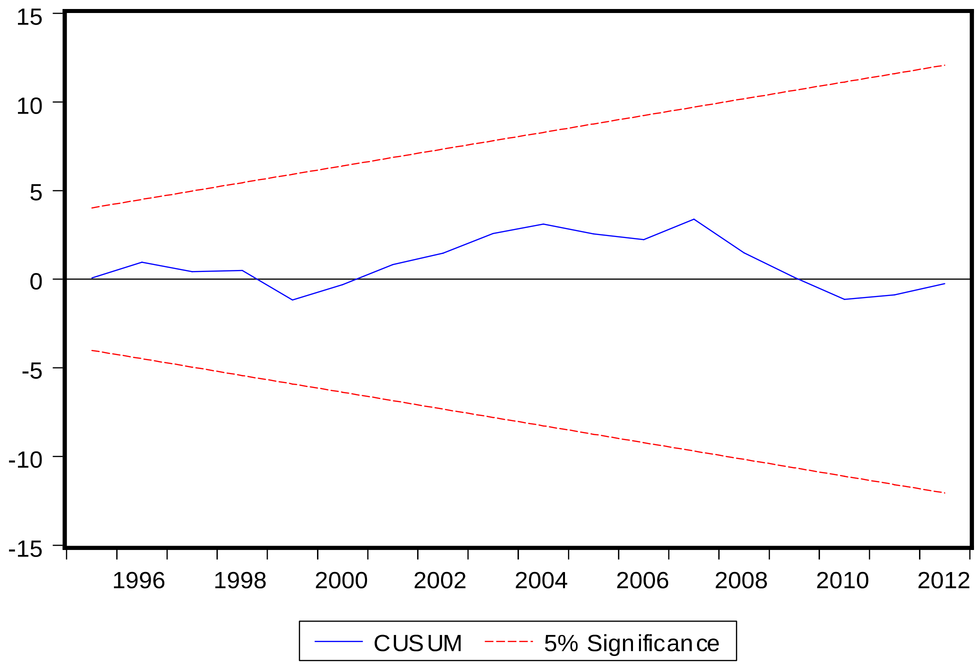
Table 7.9: Model 4: Long-run Granger Causality within ECM framework

Dependent Variables	ΔLY_t	ΔLFX_t
ECT_{t-1}	-0.532**	-1.623**
t-statistic	[-2.207]	[-2.421]

Note: ** indicates significance at 5% significance level. t-statistics in [ ]

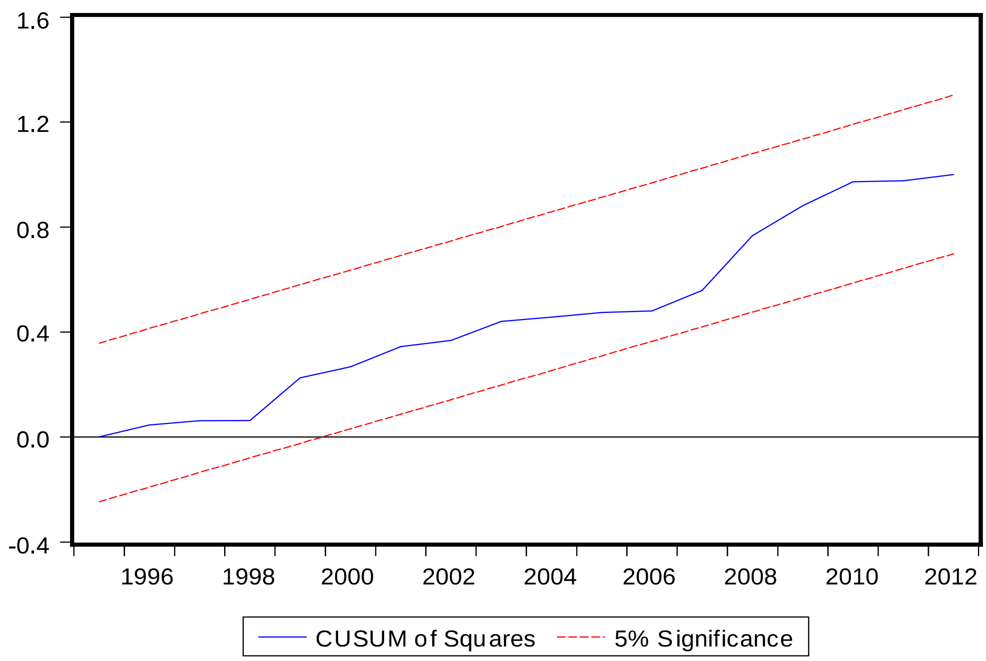
The structural stability of the parameters of the estimated equation 7.3.3.1 is tested by applying the cumulative sum of recursive residuals (CUSUM) and the CUSUM of squares (CUSUMQ). The CUSUM plots (Figures 7.2 and 7.3) show that there is no movement outside the 5% critical lines of parameter stability. Therefore, the model for economic growth is stable even during the oil crises of 1986 and 2000. As far as the structural stability of the parameters of the ECM for fuel-mining exports (equation 7.3.3.2), the CUSUM plots (Figures 7.4 and 7.5) show that there is no movement outside the 5% critical lines of parameter stability. Thus, the model for fuel-mining exports are stable even during the oil crises of 1986 and 2000.

Figure 7.2: Model 4: Plot of CUSUM for the estimated ECM for economic growth



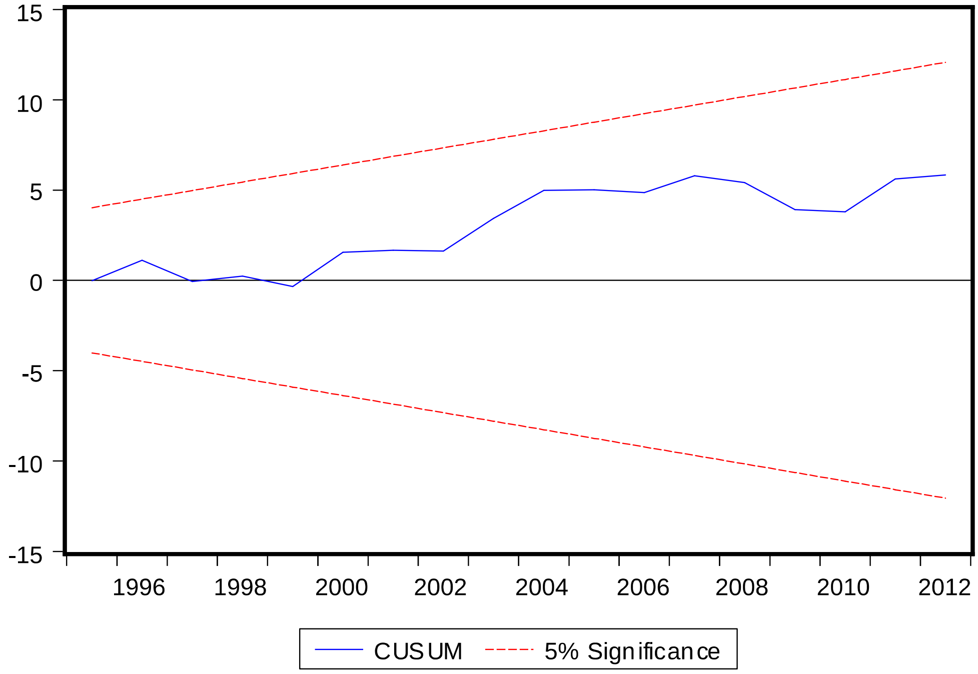
$\Delta LY_t = -0.097\,\Delta LY_{t-1} - 0.057\,\Delta LY_{t-2} + 0.290\,\Delta LK_{t-1} - 0.227\Delta LK_{t-2} - 0.079\,\Delta LHC_{t-1} + 0.234\,\Delta LHC_{t-2} + 0.341\,\Delta LFX_{t-1} + 0.067\,\Delta LFX_{t-2} - 0.173\,\Delta LIMP_{t-1} + 0.314\,\Delta LIMP_{t-2} - 0.532\,ECT_{t-1}$

Figure 7.3: Model 4: Plot of CUSUMQ for the estimated ECM for economic growth



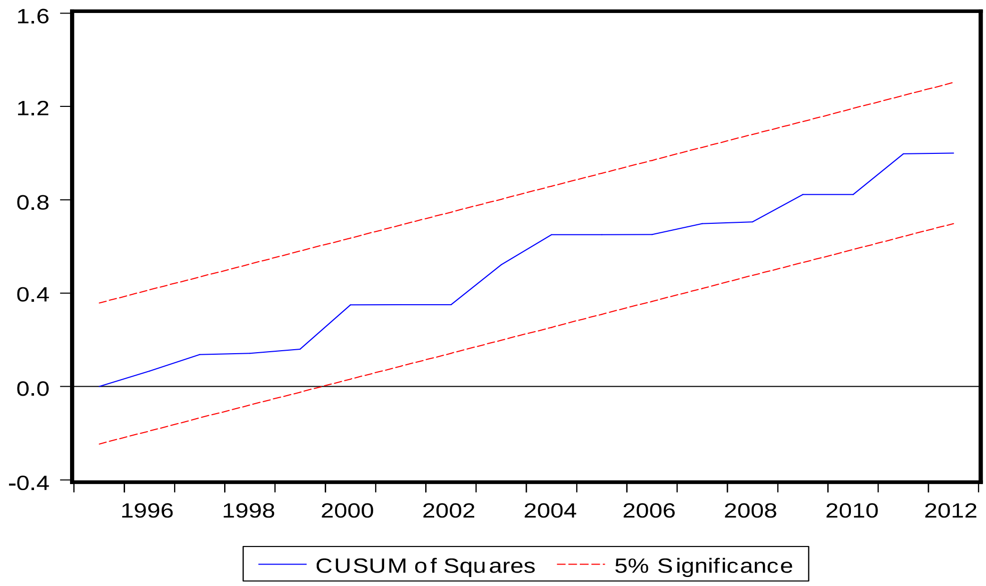
$\Delta LY_t = -0.097\,\Delta LY_{t-1} - 0.057\,\Delta LY_{t-2} + 0.290\,\Delta LK_{t-1} - 0.227\Delta LK_{t-2} - 0.079\,\Delta LHC_{t-1} + 0.234\,\Delta LHC_{t-2} + 0.341\,\Delta LFX_{t-1} + 0.067\,\Delta LFX_{t-2} - 0.173\,\Delta LIMP_{t-1} + 0.314\,\Delta LIMP_{t-2} - 0.532\,ECT_{t-1}$

Figure 7.4: Model 4: Plot of CUSUM for the estimated ECM for fuel-mining exports



ΔLFX_t= -0.802 ΔLY_{t-1} - 0.010 ΔLY_{t-2} + 1.166 ΔLK_{t-1} – 1.021 ΔLK_{t-2} - 0.336 ΔLHC_{t-1} + 0.465 ΔLHC_{t-2} + 1.168 ΔLFX_{t-1} + 0.057 ΔLFX_{t-2} - 0.746 $\Delta LIMP_{t-1}$ + 0.884 $\Delta LIMP_{t-2}$ - 1.623 ECT_{t-1}

Figure 7.5: Model 4: Plot of CUSUMQ for the estimated ECM for fuel-mining exports



ΔLFX_t= -0.802 ΔLY_{t-1} - 0.010 ΔLY_{t-2} + 1.166 ΔLK_{t-1} - 1.021 ΔLK_{t-2} - 0.336 ΔLHC_{t-1} + 0.465 ΔLHC_{t-2} + 1.168 ΔLFX_{t-1} + 0.057 ΔLFX_{t-2} - 0.746 $\Delta LIMP_{t-1}$ + 0.884 $\Delta LIMP_{t-2}$ - 1.623 ECT_{t-1}

7.3.5 Model 4: Toda-Yamamoto Granger causality test

In the case of UAE the maximum order of integration is d_{max} =1, while the optimal lag length is two. Therefore the selected lag length (p=2) is augmented by the maximum order of integration (d_{max}=1) and the Wald tests are applied to the first p VAR coefficients. The results are presented in table 7.10.

Table 7.10: Model 4: Granger Causality based on Toda-Yamamoto procedure

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

Note: *, ** and *** indicates significance at 10%, 5% and 1% significance level respectively

The diagnostic tests for the select VAR(p) model prior to the application of the Toda-Yamamoto procedure are presented in table G.9, Appendix G.

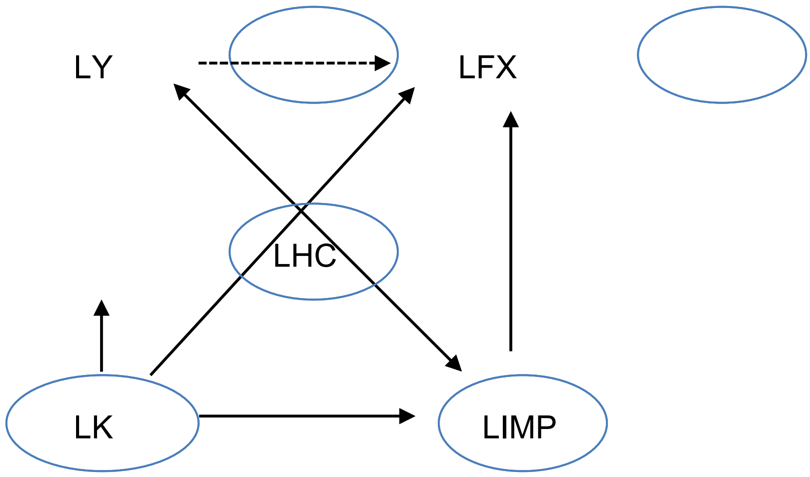
The results of the T-Y test show that there is no evidence to support the ELG hypothesis in the long-run, as the null hypothesis that LFX does not Granger cause LY cannot be rejected at any conventional significance level. According to Siliverstovs and Herzer (2007) these results show evidence of productivity-limiting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

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

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

It should be noted that an indirect long-run causal relationship exists between economic growth and fuel-mining exports, through imports of goods and services. In particular, LY Granger causes LIMP at 1% significance level and LIMP Granger causes LFX at 5% significance level. Therefore, economic growth indirectly causes the expansion of fuel and mining exports. In addition, the results show that LY, LK, LHC and LIMP jointly Granger cause LFX in the long-run at 1% significance level, while all variables in the model jointly cause LIMP at 1% significance level. The following figure summarizes the long-run causal relationships between the variables in the model.

Figure 7.6: Model 4: Long-run Causal relationships



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

7.4 Model 5: The causality between diversified exports and economic growth

7.4.1 Model 5: Lag Order Selection

The lag length for the cointegration test is determined by minimizing the Schwarz Information Criterion (SIC) and Akaike Information Criterion (AIC), while the maximum lag length is set equal to two. Table 7.11 reports that SIC suggests the use of 1 lag in the VAR system, while AIC suggests lag 2. It is known that SIC is preferable for small samples (Lutkepohl, 1991), while at the same time lag 1 is the smallest possible lag length which ensures that the residuals are multivariate normal and homoscedastic, with no evidence of serial correlation. Therefore, the VAR(1) model[8] adequately describes the data. The multivariate specification tests are presented in table G.13, Appendix G.

Table 7.11: Model 5: VAR Lag Order Selection Criteria

Lag	0	1	2
AIC	-4.046	-11.838	-12.844*
SC	-3.485	-9.596*	-8.921

*Indicates lag order selected by the criterion

AIC: Akaike Information Criterion

SC: Schwarz Information Criterion

7.4.2 Model 5: Cointegration test

The Johansen cointegration test is conducted in order to investigate the existence of a long-run relationship between real GDP, real physical capital, population, real non-oil exports, real re-exports and real imports of goods and services. Table 7.12, shows that null hypothesis of no cointegration is rejected at 1% significance level, indicating the existence of one cointegrating vector. In particular, the adjusted Trace statistic for no cointegration vector is 133.39, which is greater than the critical value at 1%. Therefore, the Johansen's cointegration results suggest that real GDP, real gross fixed capital formation, population, real non-oil exports, real re-exports and real imports are cointegrated and follow a common long path.

Table 7.12: Model 5: Johansen's Cointegration Test results

Hypothesized Number of Cointegrating equations	**Adjusted Trace Statistic**	**Critical Value**		
		1%	**5%**	**10%**
r=0	133.39***	111.01	102.14	97.18
r≤1	70.71	84.45	76.07	71.86
r≤2	40.89	60.16	53.12	49.65
r≤3	24.45	41.07	34.91	32

Note: Critical values are taken from Osterwald-Lenum (1992). The model includes a restricted constant (Model selection based on Pantula Principle)

*, ** and *** indicate rejection at 10%, 5% and 1% significance level respectively

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

$$LY_t = \underset{(12.322)}{0.565^{***}}LK_t - \underset{(7.019)}{0.531^{***}}LHC_t + \underset{(4.771)}{0.221^{***}}LNOILX_t + \underset{(15.888)}{0.750^{***}}LREX_t$$

$$-\underset{(8.078)}{0.556^{***}}LIMP_t + \underset{(25.111)}{11.567^{***}} \qquad (7.4.2.1)$$

From the above equation, an 1% increase in real non-oil exports leads to a 0.221% increase in real GDP, while a 1% increase in re-exports rises real GDP by 0.750%. In addition, real GDP increases by 0.565% in response to a 1% increase in physical capital. In contrast, 1% increase in population and imports can lead to a decrease in real GDP by 0.531% and 0.556% respectively. These results suggest that both categories of diversified exports enhance economic growth in UAE, with re-exports contributing more than non-oil exports in the long-run.

7.4.3 Model 5: Vector Error Correction Model

Since the variables are integrated of order one and cointegrated, a VECM should be specified (for further details see table G.14, Appendix G). The VECM is checked for autocorrelation, normality and homoscedasticity of the residuals. As it can be seen from table G.15 at Appendix G, the null hypothesis of no autocorrelation of residuals cannot be rejected up to lag length 12 at 5% significance level, since all corresponding p-values are greater than 5%. In addition, the White test chi-square statistic is equal to 323.581, with the corresponding p-value of 0.357, indicating that the null hypothesis of homoscedasticity cannot be rejected at any significance level. As far the normality of the residuals is concerned, the p-value 0.971 is greater than 5%, indicating that null hypothesis of multivariate normal residuals cannot be rejected.

In addition, the stability of the VECM is checked by calculating the inverse roots of the characteristic AR polynomial. The analysis shows that the VEC specification imposes 5 unit roots, while the remaining roots have modulus less than one. Therefore, since there are 6 variables and one cointegrating equation in the system, the estimated VECM is stable. The stability results are presented in table G.16 and figure G.4, Appendix G.

Since the aim of this reseach is to find the direction of the causality between exports and economic growth, emphasis is placed on the estimated error correction models for ΔLY_t and $\Delta LNOILX_t$. The absolute t-statistics are reported in the parentheses:

$$\Delta LY_t = \underset{(1.657)}{0.274\Delta LY_{t-1}} + \underset{(0.426)}{0.048\Delta LK_{t-1}} - \underset{(0.549)}{0.117\Delta LHC_{t-1}} + \underset{(1.550)}{0.080\Delta LNOILX_{t-1}} +$$
$$+ \underset{(1.277)}{0.085LREX_{t-1}} + \underset{(0.422)}{0.065\Delta LIMP_{t-1}} + \underset{(2.510)}{0.152^{**}DUM00} - \underset{(0.987)}{0.114ECT_{t-1}} \quad (7.4.3.1)$$

$$\Delta LNOILX_t = \underset{(0.675)}{0.443\Delta LY_{t-1}} - \underset{(0.271)}{0.122\,\Delta LK_{t-1}} + \underset{(2.347)}{1.992^{**}\Delta LHC_{t-1}} - \underset{(3.132)}{0.641^{***}\Delta LNOILX_{t-1}} +$$
$$+ \underset{(1.663)}{0.439LREX_{t-1}} - \underset{(0.152)}{0.093\Delta LIMP_{t-1}} - \underset{(1.971)}{0.474^{*}DUM00} - \underset{(0.227)}{0.104ECT_{t-1}} \quad (7.4.3.2)$$

7.4.4 Model 5: Granger Causality in VECM

The short-run Granger causality results for UAE are reported in table 7.13.

Table 7.13: Model 5: Short-run Granger causality test

	Source of causation						
	ΔLY_t	**ΔLK_t**	**ΔLHC_t**	**$\Delta LNOILX_t$**	**$\Delta LREX_t$**	**$\Delta LIMP_t$**	**ALL**
Dependent Variable	χ^2 *(1)*	χ^2 *(1)*	χ^2 *(1)*	χ^2 *(1)*	χ^2 *(1)*	χ^2 *(1)*	χ^2 *(5)*
ΔLY_t	-	0.181	0.301	2.403	1.631	0.178	6.813
ΔLK_t	5.676**	-	0.000	0.413	0.177	0.000	9.369*
ΔLHC_t	0.093	2.503	-	0.539	0.010	0.413	3.225
$\Delta LNOILX_t$	0.456	0.073	5.509**	-	2.764*	0.023	30.304***
$\Delta LREX_t$	1.361	3.250*	13.455***	20.138***	-	16.453***	38.403***
$\Delta LIMP_t$	4.141**	0.213	0.769	0.122	0.176	-	9.986*

Note: *, ** and *** indicates significance at 10%, 5% and 1% significance level respectively

The diagnostic tests for the VECM model are presented in table G.14, Appendix G

The results show that the null hypothesis of non causality from non-oil exports and re-exports to economic growth cannot be rejected at 1% significance level, indicating that the ELG hypothesis is not valid in the short-run. In addition, the null hypothesis that economic growth does not Granger cause non-oil exports and the null hypothesis that economic growth does not Granger cause re-exports cannot be rejected at any conventional significance level. Therefore, there is no direct causal relationship between economic growth, non-oil exports and re-exports in the short-run.

At the same time a significant causality runs from human capital to non-oil exports at 5% significance level, indicating that human capital is essential for the expansion of non-oil exports. In addition, re-exports are causally affected directly by human capital and imports of goods and services at 1% significance level, indicating that human capital and imports contribute to the expansion of re-exports. Morevoer, a bi-directional causal relationship exists between non-oil exports and re-exports in the short-run.

It should be noted that an indirect short-run causal relationship exists between economic growth and re-exports, through physical capital accumulation and imports. In particular, economic growth Granger causes physical capital at 5% significance level and physical capital Granger causes re-exports at 10% significance level. At the same time, economic growth Granger causes imports at 5% significance level and imports Granger causes re-exports at 1% significance level. Therefore, economic growth indirectly causes re-exports in the short-run, through physical capital accumulation and imports.

In addition, the results show that all the variables in the model jointly Granger cause non-oil exports and re-exports in the short-run at 1% significance level, while all variables in the model jointly cause physical capital and imports at 10% significance level. The Granger causality results in the short-run are summarized in the following table.

Table 7.14: Model 5: Short-run Granger Causality test results

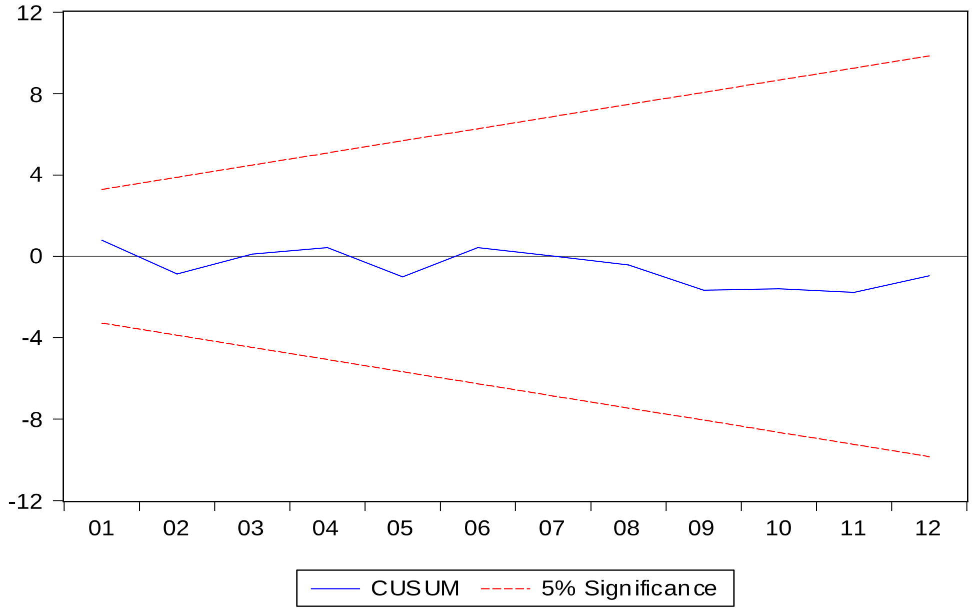
ΔLY_t	➔	ΔLK_t
ΔLY_t	➔	$\Delta LIMP_t$
ΔLHC_t	➔	$\Delta LNOILX_t$
$\Delta LREX_t$	➔	$\Delta LNOILX_t$
ΔLK_t	➔	$\Delta LREX_t$
ΔLHC_t	➔	$\Delta LREX_t$
$\Delta LNOILX_t$	➔	$\Delta LREX_t$
$\Delta LIMP_t$	➔	$\Delta LREX_t$
ΔLY_t, ΔLK_t, ΔLHC_t, $LREX_t$, $\Delta LIMP_t$	➔	$\Delta LNOILX_t$
ΔLK_t, ΔLHC_t, $LNOILX_t$, $\Delta LIMP_t$	➔	$\Delta LREX_t$
ΔLY_t, ΔLK_t, ΔLHC_t, $LNOILX_t$, $\Delta LREX_t$	➔	$\Delta LIMP_t$

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

Since the aim of this reseach focuses on the relationship between exports and economic growth, emphasis is placed on the structural stability of the parameters of the estimated error correction models for economic growth and diversified exports. The CUSUM plot (figure 7.7) for the estimated ECM for economic growth shows that there is no movement outside the 5% critical lines, indicating that the model is stable. Moreover, the cumulative sum of squares (figure 7.8) is within the 5% critical lines, suggesting parameter stability. Therefore, the estimated ECM for economic growth, including the impulse dummy for the year 2000, is stable. Thus, there is no reason to test for the presence of a second structural break.

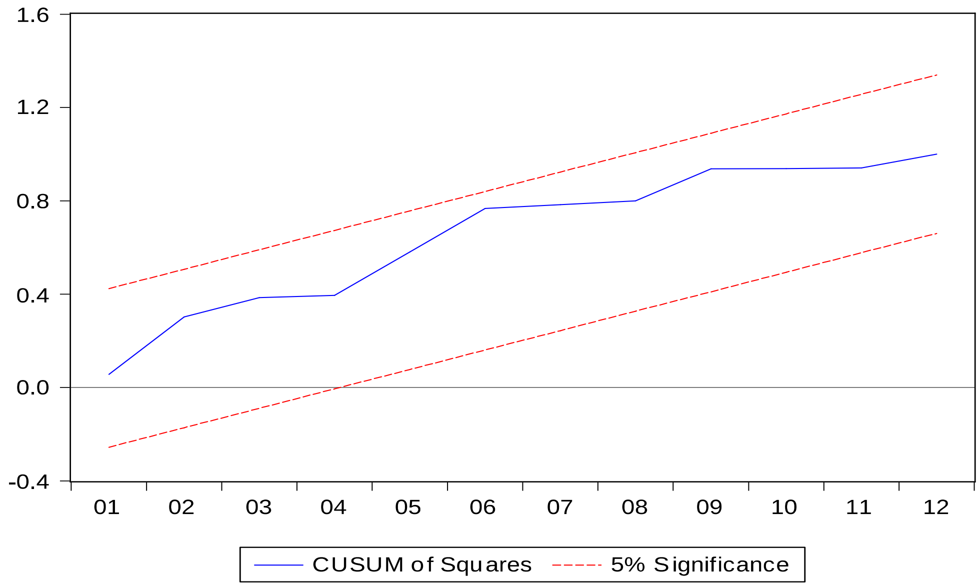
As far as the structural stability of the ECMs for diversified exports is concerned, the CUSUM plots (Figures 7.9-7.12) show that there is no movement outside the 5% critical lines of parameter stability. Therefore, the estimated models for diversified exports, including the impulse dummy for the year 2000, are stable. Thus, there is no reason to test for the presence of a second structural break.

Figure 7.7: Model 5*:* Plot of CUSUM for the estimated ECM for economic growth



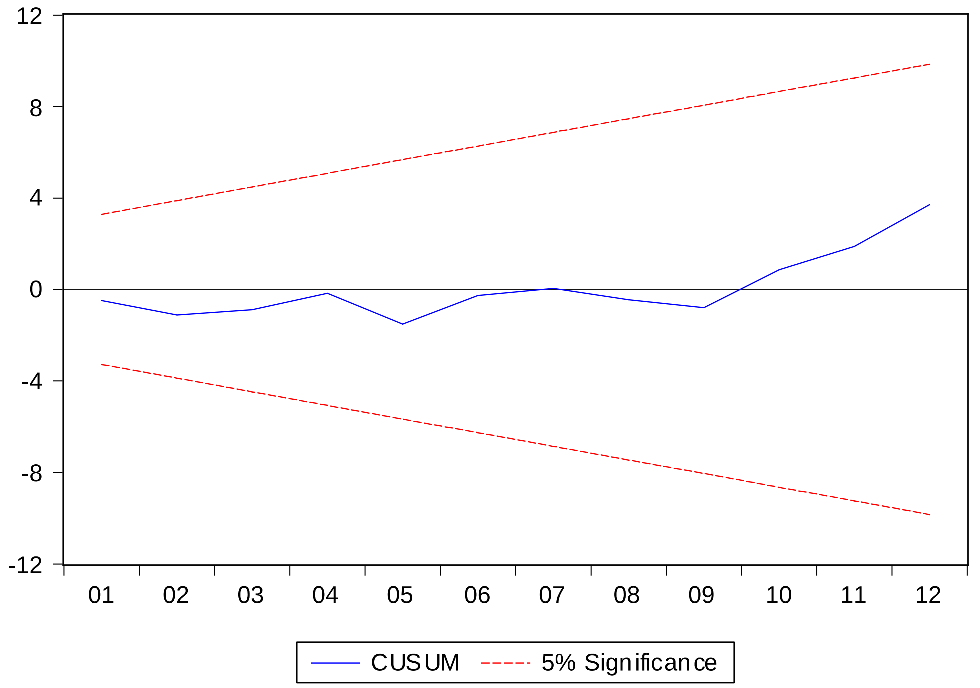
$\Delta LY_t = 0.274\ \Delta LY_{t-1} + 0.048\ \Delta LK_{t-1} - 0.117 \Delta LHC_{t-1} + 0.080 \Delta LNOILX_{t-1} + 0.085\ LREX_{t-1} + 0.065\ \Delta LIMP_{t-1} + 0.152\ DUM00 - 0.114\ ECT_{t-1}$

Figure 7.8: Model 5: Plot of CUSUMQ for the estimated ECM for economic growth



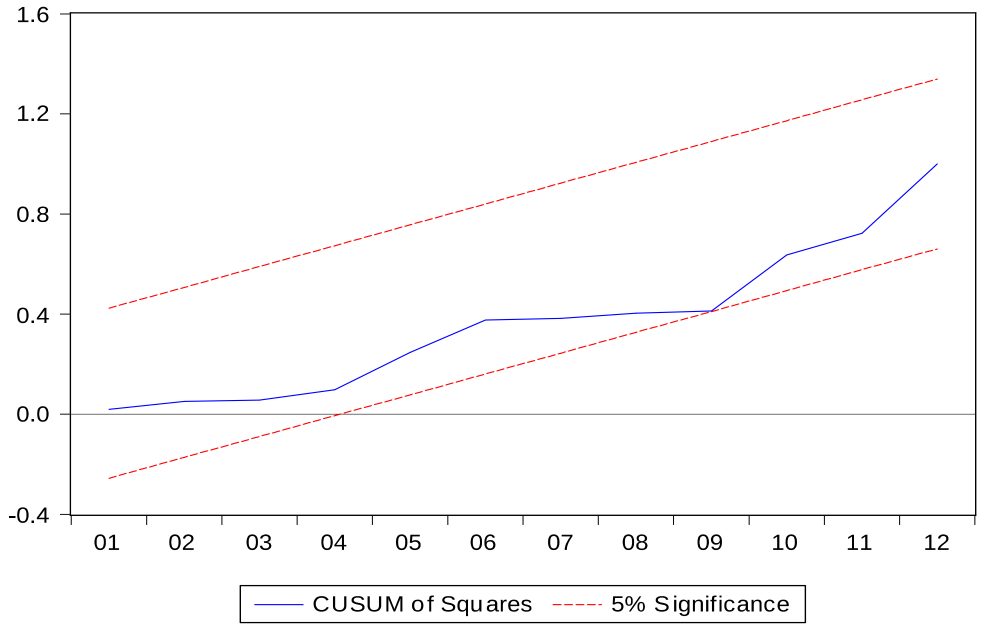
$\Delta LY_t = 0.274\ \Delta LY_{t-1} + 0.048\ \Delta LK_{t-1} - 0.117 \Delta LHC_{t-1} + 0.080 \Delta LNOILX_{t-1} + 0.085\ LREX_{t-1} + 0.065\ \Delta LIMP_{t-1} + 0.152\ DUM00 - 0.114\ ECT_{t-1}$

Figure 7.9: Model 5: Plot of CUSUM for the estimated ECM for Non-Oil exports



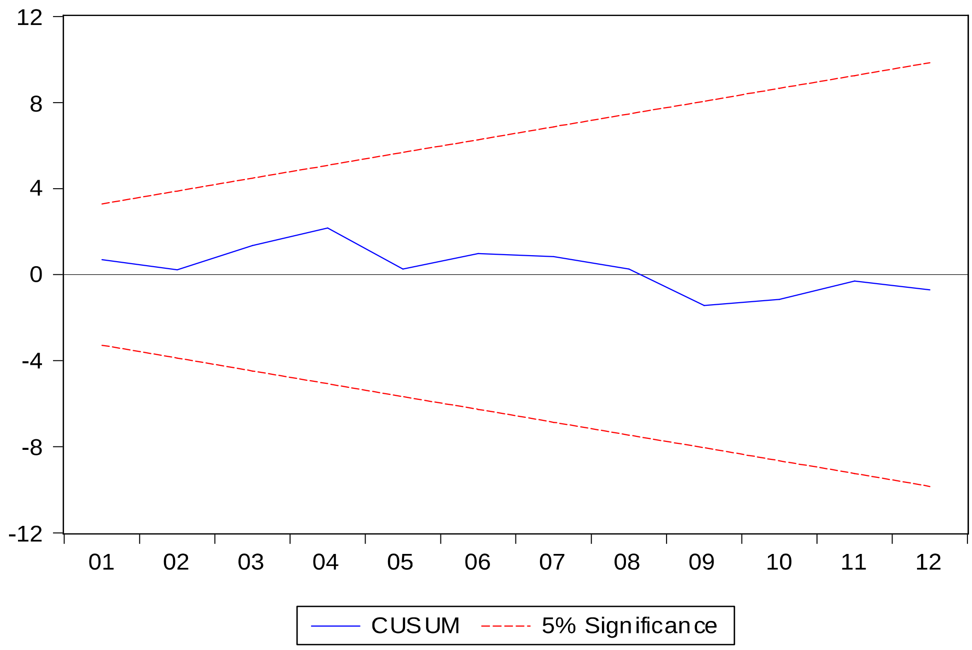
$\Delta LNOILX_t = 0.443\ \Delta LY_{t-1} - 0.122\ \Delta LK_{t-1} + 1.992\ \Delta LHC_{t-1} - 0.641\ \Delta LNOILX_{t-1} + 0.439\ LREX_{t-1} - 0.093\ \Delta LIMP_{t-1} - 0.474\ DUM00 - 0.104\ ECT_{t-1}$

Figure 7.10: Model 5: Plot of CUSUMQ for the estimated ECM for Non-Oil exports



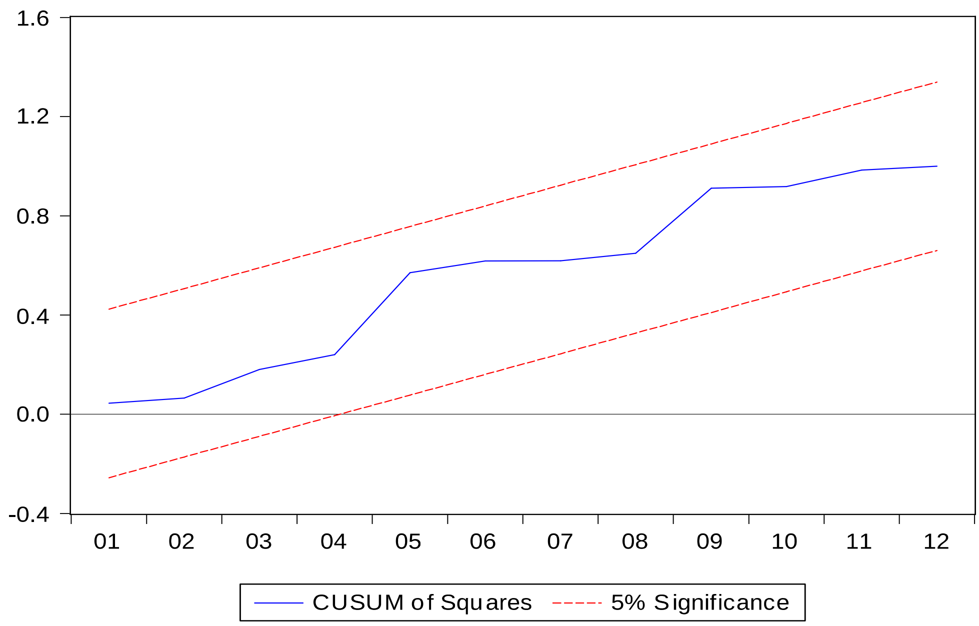
$\Delta LNOILX_t = 0.443\ \Delta LY_{t-1} - 0.122\ \Delta LK_{t-1} + 1.992\ \Delta LHC_{t-1} - 0.641\ \Delta LNOILX_{t-1} + 0.439\ LREX_{t-1} - 0.093\ \Delta LIMP_{t-1} - 0.474\ DUM00 - 0.104\ ECT_{t-1}$

Figure 7.11: Model 5: Plot of CUSUM for the estimated ECM for re-exports



$\Delta LREX_t$= 0.421ΔLY_{t-1} - 0.447ΔLK_{t-1} -1.712ΔLHC_{t-1} +0.505$\Delta LNOILX_{t-1}$ + 0.503$LREX_{t-1}$ +1.370$\Delta LIMP_{t-1}$ + 0.343DUM00 +1.623 ECT_{t-1}

Figure 7.12: Model 5: Plot of CUSUMQ for the estimated ECM for re-exports



$\Delta LREX_t$= 0.421ΔLY_{t-1} - 0.447ΔLK_{t-1} -1.712ΔLHC_{t-1} +0.505$\Delta LNOILX_{t-1}$ + 0.503$LREX_{t-1}$ +1.370$\Delta LIMP_{t-1}$ + 0.343DUM00 +1.623 ECT_{t-1}

7.4.5 Model 5: Toda-Yamamoto Granger causality test

In the case of UAE the maximum order of integration is d_{max} =1, while the optimal lag length, based on Schwarz Information Criterion is one. Therefore the selected lag length (p=1) is augmented by the maximum order of integration (d_{max}=1) and the Wald tests are applied to the first p VAR coefficients. The results are presented in table 7.15.

Table 7.15: Model 5:Granger Causality based on Toda-Yamamoto procedure

	Source of causation						
	LY_t	**LK_t**	**LHC_t**	**$LNOILX_t$**	**$LREX_t$**	**$LIMP_t$**	**ALL**
Dependent Variable	X^2 *(1)*	X^2 *(1)*	X^2 *(1)*	X^2 *(1)*	X^2 *(1)*	X^2 *(1)*	X^2 *(5)*
LY_t	-	1.633	0.563	0.003	3.709*	0.322	8.052
LK_t	3.795*	-	0.030	0.049	0.088	0.010	5.367
LHC_t	0.558	2.003	-	0.209	1.280	1.163	3.019
$LNOILX_t$	0.099	0.284	2.214	-	1.004	0.006	5.512
$LREX_t$	5.324**	8.225***	2.881*	1.064	-	13.893***	19.751***
$LIMP_t$	1.210	0.547	0.377	0.763	0.434	-	6.884

Note: *, ** and *** indicates significance at 10%, 5% and 1% significance level respectively

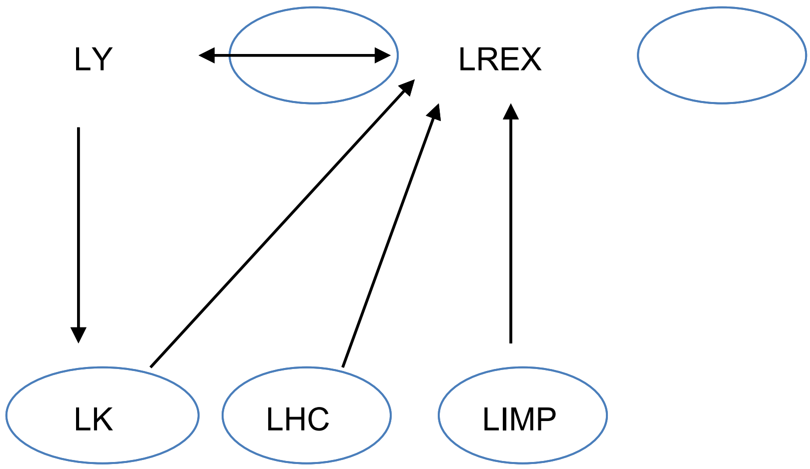
The diagnostic tests for the select VAR(p) model prior to the application of the Toda-Yamamoto procedure are presented in table G.13, Appendix G.

The results of the T-Y test indicate that LREX Granger causes LY at 10% significance level, while LY Granger causes LREX at 5% significance level, indicating that a bi-directional causal relationship exists between LY and LREX. These results show that economic growth can cause an increase in re-exports, by increasing the inflow of investments to the re-exports sector and improving the existing technology. At the same time, the expansion of re-exports increases the inflows of foreign exchange, leading to economic growth.

Moreover, economic growth indirectly causes re-exports in the long-run, through physical capital. In particular, LY Granger causes LK at 10% significance level and LK Granger causes LREX at 1% significance level.

In addition, re-exports are also affected directly by physical capital and imports of goods and services at 1% significance level, indicating that investments on advanced technology and imports contribute to the expansion of re-exports. It should be noted that a long-run causality runs from human capital to re-exports at 10% significance level, while all the variables jointly cause LREX in the long-run at 1% significance level. The following figure summarizes the long-run causal relationships between the variables in the model.

Figure 7.13: Model 5: Long-run causal relationships



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

7.5 Conclusions

This chapter provides evidence on the causal relationship of traditional exports and diversified exports with economic growth over the period 1981-2012, by estimating two models. Model 4 investigates the causality between traditional exports, consisting of fuel and mining exports, while model 5 examines the existence of a causality between non-oil exports, re-exports and economic growth.

The cointegration analysis of model 4 confirms the existence of a long-run relationship between GDP, physical capital, human capital, fuel-mining exports and imports, while fuel-mining exports are found to have a negative impact on economic growth. Theses findings are consistent with previous studies, which argued that this category of exports does not enhance economic growth in the long-run (e.g. Myrdal, 1957; Sachs and Warner, 1995; Herzer et al., 2006; Hosseini and Tang, 2014). Moreover, fuel-mining exports do not cause economic growth in the short-run or long-run. However, there is evidence to support the ELG at 10% in the short-run.

The results of model 5 show that GDP, physical capital, human capital, non-oil exports, re-exports and imports are cointegrated, while no causality exists between non-oil exports or re-exports and economic growth in the short-run. However, there is evidence to support the existence of a bidirectional causality between re-exports and economic growth in the long-run, which is in accordance with the study by Tuan and Ng (1998). Thus, re-exports are the only export category that causes economic growth in the long-run. Therefore, further increase in the degree of export diversification from oil could accelerate economic growth in UAE. However, re-exports may entail a false diversification, as this category of exports can be displaced by competition (Haddad, 2000).

In sum, the main findings regarding the causal relationship between traditional exports, diversified exports and economic growth are summarized below:

Model	**Granger causality in the short-run**	**Result**
Model 4	Fuel-mining Exports ⇢ Economic Growth	ELG
Model 5	No causality	No causality

Model	**Granger causality in the long-run**	**Result**
Model 4	No causality	No causality
Model 5	Re-Exports ↔ Economic Growth	ELG-GLE

CHAPTER 8. CONCLUSIONS

8.1 Summary

The present research tested the validity of the Export-Led Growth hypothesis, focusing on the causality between export categories and economic growth in UAE. Most of the previous studies indicate that export growth increases the inflows of investment in those sectors where the country has comparative advantage and this leads to the adoption of advanced technologies, increasing the national production and the rate of economic growth. Moreover, an increase in exports causes an increase in the inflows of foreign exchange, allowing the expansion of imports of services and capital goods, which are essential to improving productivity and economic growth. Within the context of UAE economy, evidence on the causal relationship between total exports and economic growth has been limited and mixed, while no study has yet examined the causal relationship between diversified exports and economic growth. Therefore, this study filled this literature gap and re-examined the causal relationship between exports and economic growth in UAE, unveiling the different causal effects that subcategories of exports can have.

In this research, the causal relationship between exports and economic growth in UAE was examined using annual time series for UAE for the period 1975-2012 and 1981-2012, depending on the estimated model. The real GDP was used as a proxy for economic growth, while the export variables consist of real merchandise exports and disaggregated merchandise exports. This study used five models for the empirical analysis of the causality between exports and economic growth. The first two models examined the causality between merchandise exports and economic growth, based on the AK-production function and the neoclassical production function, both augmented with merchandise exports and imports of goods and services (objective 1). In the third model, the merchandise exports were disaggregated into real primary exports and real manufactured exports in order to examine whether manufactured exports contribute more to economic growth than primary exports (objective 2). In the fourth model, fuel and mining exports were further disaggregated from primary exports in order to investigate whether UAE economic growth is caused by abundant oil exports (objective 3). Moreover, real non-oil exports and real re-exports were used in the fifth model, in order to examine the separate causal effects of diversified export categories on economic growth (objective 4). Models three, four and five were based on the neoclassical production function augmented with different categories of exports and imports of goods and services, while the examined period covered the years 1981-2012.

For the estimation of these models, the order of integration of the time series was examined by applying the Augmented Dickey-Fuller unit root test, the Phillips-Perron unit root test, the Kwiatkowski-Phillips-Schmidt-Shin unit root test and the unit root test with a structural break proposed by Saikkonen and Lutkepohl (2002). To investigate the existence of a long-run relationship between exports and economic growth in the UAE context, this study performed the Johansen cointegration test, while the direction of the causality was examined by applying the Granger causality test in VECM framework. Finally, this study applied a modified Wald test in an augmented vector autoregressive model, developed by Toda and Yamamoto (1995), in order to investigate the existence of a long-run causality between the variables.

The findings of this study confirm that the ELG hypothesis is valid for UAE in the short-run, highlighting the importance of export sector in the UAE economy. However, by disaggregating merchandise exports into primary and manufactured exports, this research provides evidence that a circular causality exists between manufactured exports and economic growth in the short-run. Primary exports and especially fuel and mining exports, contrary to the generally held belief, do not cause economic growth in UAE, however are essential for the industrial production. Based on these results, further increase in the degree of export diversification could enhance the rate of economic growth in UAE.

8.2 Main Policy Impications

It is noticeable that UAE manufactured exports have been increasing steadily since 1981, while the share of manufactured exports in total merchandise exports increased from around 3.4% in 1981 to approximately 23% in 2012. At the same time, the share of fuel-mining exports decreased from around 83.8% in 1981 to around 43.1% in 2012, indicating that there is a significant diversification process in the UAE. Thus, the government of UAE should continue the successful export promotion policy, focusing on manufactured exports in order to accelerate economic growth in UAE.

Furthermore, the present study provides evidence to support the existence of a bidirectional causality between re-exports and economic growth in the long-run, indicating that re-exports are the only export category that causes economic growth in the long-run. Therefore, there is a need for the government to continue promoting re-exports, by implementing Foreign Trade Zones programs. In parallel, programs that enhance UAE competitiveness should be implemented, as re-exports can be easily displaced by competition.

The UAE is one of the largest re-export hubs in the world, with the majority of re-exports going to Iran, India and the GCC region. Given that pearls, precious stones and precious metals comprise 39.71% of total re-exports, followed by machinery (20.8%) and vehicles of transport (16.2%), further expansion of these re-exports will continue to enhance economic growth. However, emphasis should be placed on physical and human capital accumulation, as these factors directly or indirectly cause exports and economic growth.

8.3 Further direction of research

The case of UAE should be explored in depth in this area and the present study provides a basis to target future research in a deeper disaggregation of export components. Furthermore, the causal effect of export destination diversification on economic growth may need to be taken into consideration by future studies.

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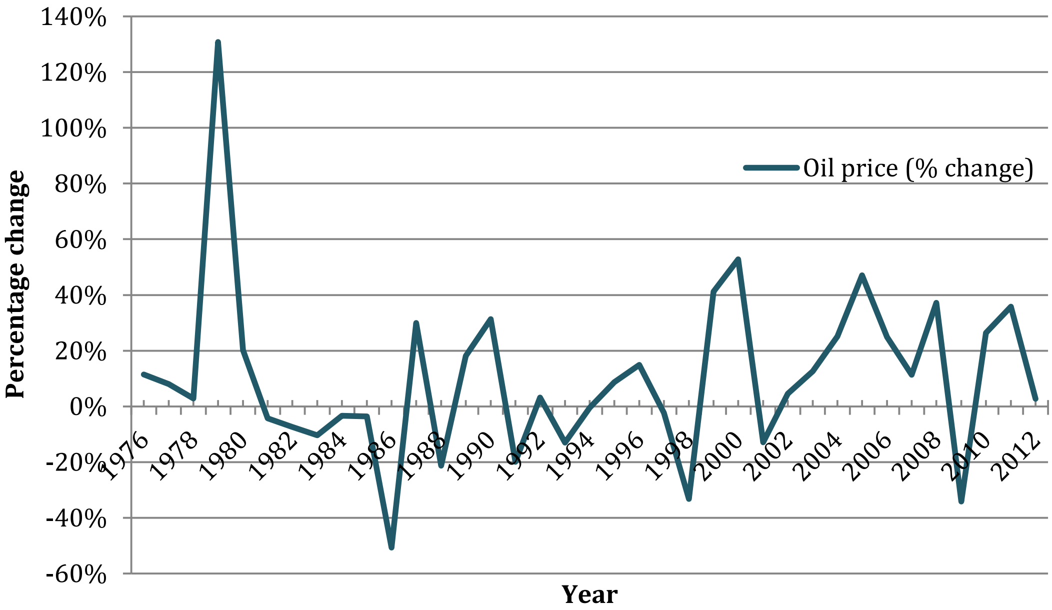
APPENDIX A. Percentage Change in Oil Price (US$ per barrel) over the period 1975-2012

Figure A. 1: Percentage change in Oil price (US$ per barrel) over the period 1975-2012



Source: Author's calculation based on International Financial Statistics, International Monetary Fund

APPENDIX B. World Trade Organization Product Definitions

All product groups are defined according to Revision 3 of the Standard intarnational Trade Classification.

PRIMARY EXPORTS

(i) <u>Agricultural products:</u> '(SITC sections 0, 1, 2, 4 minus 27 and 28)'

- '*Food:* food and live animals, beverages and tobacco, animal and vegetable oils, fats and waxes, oilseeds and oleaginous fruit (SITC sections 0, 1, 4 and division 22), of which:'

-- '*Fish* (SITC division 03)'

-- '*Other food products and live animals, beverages and tobacco, animal and vegetable oils, fats and waxes, oilseeds and oleaginous fruit* (SITC sections 0, 1, 4 and division 22 less division 03).'

- '*Raw materials*: hides, skins and furskins, raw, crude rubber (including synthetic and reclaimed), cork and wood, pulp and waste paper, textile fibres and their wastes, crude animal and vegetable materials, n.e.s. (SITC divisions 21, 23, 24, 25, 26, 29).'

(ii) <u>Fuels and mining products</u>

- 'Ores and other minerals: crude fertilizers (other than those classified in chemicals) and crude minerals, metalliferous ores and metal scrap (SITC divisions 27, 28).'

- 'Fuels: (SITC section 3).'

- 'Non-ferrous metals: (SITC division 68).'

MANUFACTURED EXPORTS: '(SITC sections 5, 6, 7, 8 minus division 68 and group 891).'

***(i) Iron and steel*:** '(SITC division 67).'

***(ii) Chemicals*:** '(SITC section 5), of which:'

- '*Pharmaceuticals* (SITC division 54).'
- '*Other chemicals*: organic chemicals (SITC division 51), plastics (SITC divisions 57, 58), inorganic chemicals (SITC division 52), other chemicals n.e.s. (SITC divisions 53, 55, 56, 59).'

***(iii) Other semi-manufactures*:** 'leather, leather manufactures, n.e.s., and dressed furskins, rubber manufactures, n.e.s., cork and wood manufactures (excluding furniture), paper, paperboard and articles of paper pulp, of paper or of paperboard, non-metallic mineral manufactures, n.e.s., manufactures of metals, n.e.s. (SITC divisions 61, 62, 63, 64, 66, 69).'

***(iv) Machinery and transport equipment*:** '(SITC section 7), of which:'

- '*Office and telecommunications equipment*: office machines and automatic data processing machines, telecommunications and sound recording and reproducing apparatus and equipment, thermionic, cold cathode or photo-cathode valves and tubes (SITC divisions 75, 76 and group 776), of which:'

-- '*Electronic data processing and office equipment* (SITC division 75).'

-- '*Telecommunications equipment* (SITC division 76).'

-- '*Integrated circuits, and electronic components* (SITC group 776).'

- '*Transport equipment* (SITC group 713, sub-group 7783, groups 78 and 79), of which:'

-- '*Automotive products*: motor cars and other motor vehicles principally designed for the transport of persons (other than public transport type vehicles) including station wagons and racing cars, motor vehicles for the transport of goods and special purpose motor vehicles, road motor vehicles, n.e.s., parts and accessories of motor vehicles and tractors, internal combustion piston engines for vehicles listed above, electrical equipment, n.e.s., for internal combustion engines and vehicles, and parts thereof (SITC groups 781, 782, 783, 784, and subgroups 7132, 7783).'

-- '*Other transport equipment*: railway vehicles, aircraft, spacecraft, ships and boats, and associated parts and equipment, motorcycles and cycles, motorized and non-motorized, trailers and semi-trailers, other vehicles (not mechanically propelled), and specially designed and equipped transport containers, internal combustion piston engines for aircraft, and parts thereof, n.e.s., internal combustion piston engines, marine propulsion, internal combustion piston engines, n.e.s., parts, n.e.s., for internal combustion piston engines listed above (SITC division 79, groups 713, 785, 786 minus sub-group 7132).'

- '*Other machinery* (SITC divisions 71, 72, 73, 74, 77 minus groups 713, 776 and minus sub-group 7783), of which:'

-- '*Power generating machinery*: power generating machinery and equipment minus internal combustion piston engines and parts thereof, n.e.s. (SITC division

71 minus group 713).'

-- '*Non-electrical machinery*: machinery specialized for particular industries, metalworking machinery, general industrial machinery and equipment, n.e.s., and machine parts, n.e.s. (SITC divisions 72, 73, 74).'

-- '*Electrical machinery*: electrical machinery, apparatus and appliances, n.e.s., and electrical parts thereof, minus thermionic, cold cathode or photo-cathode valves and tubes, minus electrical equipment, n.e.s., for internal combustion piston engines and parts thereof, n.e.s. (SITC division 77 minus group 776 and subgroup 7783).'

***(v) Textiles*: '**(SITC division 65).'

***(vi) Clothing*:** '(SITC division 84).'

***(vii) Other manufactures*:** '(SITC divisions 81, 82, 83, 85, 87, 88, 89 excluding group 891), of which:'

- '*Personal and household goods*: furniture (SITC division 82), travel goods (SITC division 83) and footwear (SITC division 85).'
- '*Scientific and controlling instruments* (SITC division 87).'
- '*Miscellaneous manufactures*: instruments and apparatus, photography, optical goods, watches and clocks, toys and games, and other manufactured articles, n.e.s. (SITC divisions 81, 88, 89 minus group 891).'

OTHER PRODUCTS: 'Commodities and transactions not classified elsewhere (including gold), arms and ammunition (SITC section 9 and group 891).'

Note: i) The exports are divided into primary and manufactured exports, according to Revision 3 of the Standard International Trade Classification (SITC)–WTO Statistical data sets.

ii) The sum of agricultural products, mining products and manufactures does not add up to total merchandise due to unspecified products.

Source: World Trade Organization Statistical Data Sets- METADATA. Available at http://stat.wto.org

APPENDIX C. Non-Oil Exports and Re-Exports by commodity according to HS code

Table C. 1: Non-Oil exports by commodity according to HS code (%), 2012

Products	%
Live animals and their products	0.73
Vegetable products	0.36
Animal or vegetable fats, oils and waxes	0.57
Foodstuffs, beverages, spirits and tobacco	3.76
Mineral products	3.92
Products of the chemical or allied industries	2.10
Plastics, rubber and articles thereof	8.18
Articles of leather and animal gut; travel goods	0.01
Articles of wood, cork; basketware and wickerwork	0.06
Pulp of wood, waste, scrap and articles of paper	1.56
Textiles and textile articles	0.68
Footwear, umbrellas, articles of feat-her & hair	0.02
Articles of stone, mica;ceramic products and glass	1.57
Pearls, stones, precious metals and its articles	63.79
Base metals and articles of base metal	10.17
Machinery, sound recorders, reproducers and parts	1.25
Vehicles of transport	0.76
Photographic, medical, musical instruments & parts	0.06
Arms and ammunition; parts & accessories	0.00
Miscellaneous manufactured articles	0.44
Pieces and antiques 'works of art, collectors	0.02

Source: National Bureau of Statistics of United Arab Emirates

Table C. 2: Re-Exports by commodity according to HS code (%), 2012

Products	%
Live animals and their products	0.34
Vegetable products	2.33
Animal or vegetable fats, oils and waxes	0.05
Foodstuffs, beverages, spirits and tobacco	2.20
Mineral products	0.37
Products of the chemical or allied industries	2.19
Plastics, rubber and articles thereof	2.89
Articles of leather and animal gut; travel goods	0.28
Articles of wood, cork; basketware and wickerwork	0.45
Pulp of wood, waste, scrap and articles of paper	0.28
Textiles and textile articles	4.05
Footwear, umbrellas, articles of feat-her & hair	0.42
Articles of stone, mica; ceramic products and glass	0.83
Pearls, stones, precious metals and its articles	39.71
Base metals and articles of base metal	4.03
Machinery, sound recorders, reproducers and parts	20.75
Vehicles of transport	16.20
Photographic, medical, musical instruments & parts	1.25
Arms and ammunition; parts & accessories	0.01
Miscellaneous manufactured articles	1.03
Pieces and antiques 'works of art, collectors	0.35

Source: National Bureau of Statistics of United Arab Emirates

APPENDIX D. Correlograms for the time series, period 1975-2012

Figure D. 1: Correlograms of the series at level and first difference

Variable: LY

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |******|	. |******|	1	0.886	0.886	32.236	0.000
. |******|	. | . |	2	0.777	-0.035	57.731	0.000
. |***** |	. | . |	3	0.689	0.034	78.335	0.000
. |**** |	.*| . |	4	0.589	-0.101	93.862	0.000
. |**** |	. | . |	5	0.502	0.001	105.48	0.000
. |*** |	. | . |	6	0.444	0.071	114.83	0.000
. |*** |	. | . |	7	0.397	0.028	122.58	0.000
. |** |	. | . |	8	0.350	-0.024	128.80	0.000
. |** |	. | . |	9	0.298	-0.061	133.46	0.000
. |** |	. | . |	10	0.258	0.020	137.08	0.000
. |*. |	. | . |	11	0.212	-0.048	139.61	0.000
. |*. |	.*| . |	12	0.141	-0.131	140.78	0.000
. | . |	.*| . |	13	0.071	-0.066	141.09	0.000
. | . |	.*| . |	14	-0.003	-0.095	141.09	0.000
.*| . |	. | . |	15	-0.067	-0.005	141.39	0.000
.*| . |	. | . |	16	-0.116	-0.008	142.32	0.000

Variable: DLY

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |** |	. |** |	1	0.293	0.293	3.4527	0.063
. | . |	.*| . |	2	-0.007	-0.102	3.4549	0.178
. |*. |	. |*. |	3	0.124	0.173	4.1095	0.250
. | . |	.*| . |	4	0.018	-0.087	4.1233	0.390
.*| . |	.*| . |	5	-0.120	-0.090	4.7737	0.444
**| . |	**| . |	6	-0.325	-0.322	9.6866	0.138
**| . |	. | . |	7	-0.220	-0.044	12.024	0.100
.*| . |	.*| . |	8	-0.138	-0.112	12.976	0.113
.*| . |	.*| . |	9	-0.203	-0.088	15.096	0.088
. |*. |	. |** |	10	0.112	0.258	15.769	0.106
. | . |	**| . |	11	-0.025	-0.238	15.804	0.149
.*| . |	. | . |	12	-0.098	-0.055	16.355	0.176
. |*. |	. | . |	13	0.103	-0.026	16.991	0.200
. | . |	.*| . |	14	-0.001	-0.163	16.991	0.257
. | . |	. | . |	15	0.009	0.016	16.996	0.319
. | . |	. |*. |	16	0.070	0.125	17.333	0.364

Variable: LK

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |******|</td><td>. |******|</td><td>1</td><td>0.892</td><td>0.892</td><td>32.720</td><td>0.000</td></tr>
<tr><td>. |******|</td><td>. | . |</td><td>2</td><td>0.792</td><td>-0.022</td><td>59.207</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>. | . |</td><td>3</td><td>0.696</td><td>-0.035</td><td>80.226</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. | . |</td><td>4</td><td>0.617</td><td>0.029</td><td>97.222</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. | . |</td><td>5</td><td>0.537</td><td>-0.045</td><td>110.52</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>.*| . |</td><td>6</td><td>0.451</td><td>-0.086</td><td>120.17</td><td>0.000</td></tr>
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<tr><td>. |*. |</td><td>.*| . |</td><td>11</td><td>0.130</td><td>-0.081</td><td>138.76</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>12</td><td>0.063</td><td>-0.058</td><td>138.99</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>13</td><td>0.006</td><td>-0.012</td><td>138.99</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>.*| . |</td><td>14</td><td>-0.060</td><td>-0.106</td><td>139.22</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>15</td><td>-0.124</td><td>-0.058</td><td>140.23</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>16</td><td>-0.193</td><td>-0.085</td><td>142.80</td><td>0.000</td></tr>
</table>

Variable: DLK

<table>
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<tr><td>. |*. |</td><td>. |*. |</td><td>1</td><td>0.152</td><td>0.152</td><td>0.9223</td><td>0.337</td></tr>
<tr><td>. |*. |</td><td>. |*. |</td><td>2</td><td>0.131</td><td>0.111</td><td>1.6298</td><td>0.443</td></tr>
<tr><td>. | . |</td><td>.*| . |</td><td>3</td><td>-0.050</td><td>-0.088</td><td>1.7379</td><td>0.629</td></tr>
<tr><td>. | . |</td><td>. |*. |</td><td>4</td><td>0.072</td><td>0.080</td><td>1.9630</td><td>0.743</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>5</td><td>-0.085</td><td>-0.094</td><td>2.2875</td><td>0.808</td></tr>
<tr><td>. |*. |</td><td>. |*. |</td><td>6</td><td>0.111</td><td>0.121</td><td>2.8569</td><td>0.827</td></tr>
<tr><td>**| . |</td><td>**| . |</td><td>7</td><td>-0.279</td><td>-0.305</td><td>6.5989</td><td>0.472</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>8</td><td>-0.118</td><td>-0.067</td><td>7.2971</td><td>0.505</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>9</td><td>-0.090</td><td>0.032</td><td>7.7169</td><td>0.563</td></tr>
<tr><td>.*| . |</td><td>**| . |</td><td>10</td><td>-0.190</td><td>-0.262</td><td>9.6479</td><td>0.472</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>11</td><td>-0.172</td><td>-0.048</td><td>11.295</td><td>0.419</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>12</td><td>-0.067</td><td>-0.067</td><td>11.553</td><td>0.482</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>13</td><td>-0.018</td><td>0.069</td><td>11.572</td><td>0.563</td></tr>
<tr><td>. | . |</td><td>.*| . |</td><td>14</td><td>-0.044</td><td>-0.119</td><td>11.694</td><td>0.631</td></tr>
<tr><td>. |*. |</td><td>. |*. |</td><td>15</td><td>0.126</td><td>0.090</td><td>12.736</td><td>0.623</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>16</td><td>-0.058</td><td>-0.060</td><td>12.969</td><td>0.675</td></tr>
</table>

Variable: LHC

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |*******	. |*******	1	0.905	0.905	33.646	0.000
. |******|	.*| . |	2	0.804	-0.082	60.947	0.000
. |***** |	. | . |	3	0.706	-0.039	82.598	0.000
. |**** |	. | . |	4	0.608	-0.060	99.111	0.000
. |**** |	. | . |	5	0.511	-0.054	111.12	0.000
. |*** |	. | . |	6	0.435	0.053	120.10	0.000
. |*** |	. | . |	7	0.368	-0.010	126.73	0.000
. |** |	. | . |	8	0.311	0.006	131.63	0.000
. |** |	. | . |	9	0.258	-0.032	135.12	0.000
. |*. |	. | . |	10	0.206	-0.038	137.43	0.000
. |*. |	. | . |	11	0.158	-0.017	138.84	0.000
. |*. |	. | . |	12	0.110	-0.040	139.55	0.000
. | . |	. | . |	13	0.064	-0.026	139.80	0.000
. | . |	. | . |	14	0.019	-0.037	139.83	0.000
. | . |	. | . |	15	-0.024	-0.036	139.86	0.000
.*| . |	. | . |	16	-0.066	-0.037	140.17	0.000

Variable: DLHC

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |*** |	. |*** |	1	0.444	0.444	7.8938	0.005
. |*. |	. | . |	2	0.151	-0.057	8.8312	0.012
. | . |	.*| . |	3	-0.063	-0.135	8.9970	0.029
**| . |	.*| . |	4	-0.214	-0.160	10.993	0.027
. | . |	. |*. |	5	-0.049	0.164	11.103	0.049
.*| . |	.*| . |	6	-0.099	-0.153	11.563	0.072
. | . |	. | . |	7	-0.054	-0.004	11.703	0.111
. | . |	. | . |	8	-0.057	-0.062	11.862	0.157
.*| . |	. | . |	9	-0.086	-0.020	12.246	0.200
. | . |	.*| . |	10	-0.063	-0.072	12.455	0.256
. | . |	. | . |	11	-0.058	-0.000	12.640	0.318
. | . |	. | . |	12	-0.046	-0.058	12.763	0.387
. | . |	. | . |	13	0.024	0.059	12.797	0.464
. | . |	.*| . |	14	-0.048	-0.139	12.939	0.531
. | . |	. | . |	15	-0.027	0.027	12.987	0.603
. | . |	.*| . |	16	-0.059	-0.092	13.229	0.656

Variable: LX

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |******|</td><td>. |******|</td><td>1</td><td>0.899</td><td>0.899</td><td>33.236</td><td>0.000</td></tr>
<tr><td>. |******|</td><td>.*| . |</td><td>2</td><td>0.794</td><td>-0.079</td><td>59.856</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>. | . |</td><td>3</td><td>0.696</td><td>-0.019</td><td>80.892</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. | . |</td><td>4</td><td>0.603</td><td>-0.035</td><td>97.126</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. | . |</td><td>5</td><td>0.512</td><td>-0.041</td><td>109.22</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>. |*. |</td><td>6</td><td>0.449</td><td>0.082</td><td>118.81</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>. | . |</td><td>7</td><td>0.394</td><td>-0.008</td><td>126.43</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>. | . |</td><td>8</td><td>0.335</td><td>-0.058</td><td>132.12</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>. | . |</td><td>9</td><td>0.277</td><td>-0.035</td><td>136.13</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>. | . |</td><td>10</td><td>0.230</td><td>0.016</td><td>139.01</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>11</td><td>0.190</td><td>0.003</td><td>141.03</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>**| . |</td><td>12</td><td>0.114</td><td>-0.213</td><td>141.80</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>13</td><td>0.043</td><td>-0.037</td><td>141.91</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>14</td><td>-0.025</td><td>-0.049</td><td>141.95</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>15</td><td>-0.076</td><td>0.034</td><td>142.33</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>16</td><td>-0.129</td><td>-0.066</td><td>143.49</td><td>0.000</td></tr>
</table>

Variable: DLX

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |*. |</td><td>. |*. |</td><td>1</td><td>0.136</td><td>0.136</td><td>0.7443</td><td>0.388</td></tr>
<tr><td>.*| . |</td><td>**| . |</td><td>2</td><td>-0.201</td><td>-0.224</td><td>2.4168</td><td>0.299</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>3</td><td>-0.168</td><td>-0.111</td><td>3.6106</td><td>0.307</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>4</td><td>0.064</td><td>0.067</td><td>3.7912</td><td>0.435</td></tr>
<tr><td>. | . |</td><td>.*| . |</td><td>5</td><td>-0.024</td><td>-0.109</td><td>3.8180</td><td>0.576</td></tr>
<tr><td>**| . |</td><td>**| . |</td><td>6</td><td>-0.215</td><td>-0.210</td><td>5.9736</td><td>0.426</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>7</td><td>-0.115</td><td>-0.069</td><td>6.6082</td><td>0.471</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>8</td><td>-0.075</td><td>-0.179</td><td>6.8879</td><td>0.549</td></tr>
<tr><td>. | . |</td><td>.*| . |</td><td>9</td><td>0.011</td><td>-0.076</td><td>6.8940</td><td>0.648</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>10</td><td>0.087</td><td>0.035</td><td>7.2997</td><td>0.697</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>11</td><td>0.103</td><td>0.013</td><td>7.8850</td><td>0.724</td></tr>
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<tr><td>. | . |</td><td>. | . |</td><td>13</td><td>0.014</td><td>0.037</td><td>8.0894</td><td>0.838</td></tr>
<tr><td>. | . |</td><td>.*| . |</td><td>14</td><td>-0.007</td><td>-0.111</td><td>8.0926</td><td>0.884</td></tr>
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</table>

Variable: LIMP

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |*******</td><td>. |*******</td><td>1</td><td>0.903</td><td>0.903</td><td>33.529</td><td>0.000</td></tr>
<tr><td>. |******|</td><td>. | . |</td><td>2</td><td>0.805</td><td>-0.061</td><td>60.880</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>. | . |</td><td>3</td><td>0.721</td><td>0.026</td><td>83.454</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>.*| . |</td><td>4</td><td>0.633</td><td>-0.072</td><td>101.38</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. | . |</td><td>5</td><td>0.549</td><td>-0.026</td><td>115.28</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>. | . |</td><td>6</td><td>0.478</td><td>0.012</td><td>126.15</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>. | . |</td><td>7</td><td>0.419</td><td>0.017</td><td>134.76</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>. | . |</td><td>8</td><td>0.362</td><td>-0.028</td><td>141.38</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>. | . |</td><td>9</td><td>0.302</td><td>-0.052</td><td>146.15</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>. | . |</td><td>10</td><td>0.246</td><td>-0.024</td><td>149.42</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>11</td><td>0.188</td><td>-0.055</td><td>151.40</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>12</td><td>0.129</td><td>-0.045</td><td>152.37</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>13</td><td>0.078</td><td>-0.006</td><td>152.74</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>.*| . |</td><td>14</td><td>0.020</td><td>-0.088</td><td>152.77</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>.*| . |</td><td>15</td><td>-0.042</td><td>-0.079</td><td>152.88</td><td>0.000</td></tr>
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</table>

Variable: DLIMP

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |** |</td><td>. |** |</td><td>1</td><td>0.340</td><td>0.340</td><td>4.6370</td><td>0.031</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>2</td><td>0.075</td><td>-0.046</td><td>4.8711</td><td>0.088</td></tr>
<tr><td>. |*. |</td><td>. |*. |</td><td>3</td><td>0.177</td><td>0.188</td><td>6.2073</td><td>0.102</td></tr>
<tr><td>.*| . |</td><td>**| . |</td><td>4</td><td>-0.136</td><td>-0.301</td><td>7.0125</td><td>0.135</td></tr>
<tr><td>**| . |</td><td>.*| . |</td><td>5</td><td>-0.266</td><td>-0.133</td><td>10.205</td><td>0.070</td></tr>
<tr><td>**| . |</td><td>.*| . |</td><td>6</td><td>-0.245</td><td>-0.189</td><td>12.999</td><td>0.043</td></tr>
<tr><td>***| . |</td><td>**| . |</td><td>7</td><td>-0.447</td><td>-0.328</td><td>22.629</td><td>0.002</td></tr>
<tr><td>***| . |</td><td>**| . |</td><td>8</td><td>-0.441</td><td>-0.262</td><td>32.291</td><td>0.000</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>9</td><td>-0.133</td><td>-0.008</td><td>33.208</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. |*. |</td><td>10</td><td>0.019</td><td>0.077</td><td>33.228</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>11</td><td>0.086</td><td>0.036</td><td>33.635</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>12</td><td>0.194</td><td>-0.046</td><td>35.812</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>.*| . |</td><td>13</td><td>0.196</td><td>-0.105</td><td>38.126</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>. | . |</td><td>14</td><td>0.233</td><td>-0.019</td><td>41.536</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>. | . |</td><td>15</td><td>0.296</td><td>0.047</td><td>47.278</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>16</td><td>0.114</td><td>-0.064</td><td>48.173</td><td>0.000</td></tr>
</table>

APPENDIX E. Specification Tests for model 1 and model 2

Table E. 1: Model 1: Specification tests for VAR(1)

Multivariate Tests		
Serial Correlation LM Test		
Lags	**LM-Stat**	**Prob.**
1	24.925	0.071
2	12.723	0.693
3	15.329	0.501
4	7.242	0.968
5	5.665	0.991
6	15.378	0.497
7	19.750	0.232
8	15.036	0.522
9	17.488	0.355
10	24.769	0.074
11	8.869	0.919
12	20.019	0.219
Test for normality		
Jarque-Bera test		0.865
Test for heteroskedasticity		
White test		0.090

Note: 1. The null hypothesis for the LM test is that there is no serial correlation at lag order h (Probs from chi-square with 16 df).

2. The null hypothesis for the normality test is that the residuals are multivariate normal (Orthogonalization: Residual Covariance (Urzua), Prob. From J-B with 55 df).

3. The null hypothesis for heteroskedasticity is that the residuals are homoscedastic (Prob. From chi-square with 80 df).

Table E. 2: Model 1: VECM results

DEPENDENT VARIABLE	ΔLY	ΔLK	ΔLX	ΔLIMP
ΔLY_{t-1}	-0.023	0.569	-0.542	0.157
	[-0.112]	[1.332]	[-1.099]	[0.393]
ΔLK_{t-1}	0.228**	0.171	0.253	0.134
	[2.087]	[0.759]	[0.972]	[0.635]
ΔLX_{t-1}	0.378***	-0.068	0.673**	0.251
	[3.609]	[-0.314]	[2.688]	[1.236]
$\Delta LIMP_{t-1}$	-0.241*	0.086	-0.252	0.258
	[-1.892]	[0.325]	[-0.827]	[1.046]
ECT_{t-1}	-0.346***	0.144	-0.623***	-0.083
	-[5.648]	[1.138]	[-4.262]	[-0.702]
R-squared	0.590	0.148	0.415	0.127
Adj. R-squared	0.537	0.038	0.340	0.014
F-statistic	11.146	1.348	5.499	1.128
Specification tests (p-values)				
BG $\chi^2(1)$	0.246	0.094	0.733	1.000
BG $\chi^2(2)$	0.414	0.151	0.690	1.000
JB test	0.701	0.571	0.098	0.207
W-het $\chi^2\{15\}$	0.256	0.295	0.648	0.245
ARCH (1)	0.025	0.300	0.698	0.442
ARCH (2)	0.149	0.274	0.927	0.726
ARCH (3)	0.092	0.157	0.872	0.817

Note: 1. *, ** and *** indicates significance at 10%, 5% and 1% significance level respectively.

2. The null hypothesis for the Breusch- Godfrey Serial correlation test is that there is no residual autocorrelation.

3. The null hypothesis for the normality test is that the residuals are multivariate normal.

4. The null hypothesis for the White heteroskedasticity test is that the residuals are homoscedastic.

5. The null hypothesis for the ARCH heteroskedasticity test is the absence of ARCH component.

6. t-statistics in [ ], lags in ( ), df in { }

Table E. 3: Model 1: Diagnostic Tests for VECM

Multivariate Specification Tests

Residual Portmanteau test for Autocorrelations

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	6.250	NA*	6.428	NA*	NA*
2	12.716	0.996	13.275	0.995	29
3	21.601	0.999	22.967	0.997	45
4	37.843	0.991	41.240	0.975	61
5	44.604	0.999	49.091	0.995	77
6	57.513	0.999	64.582	0.989	93
7	69.073	0.999	78.933	0.987	109
8	76.796	1.000	88.862	0.994	125
9	91.253	1.000	108.138	0.982	141
10	104.020	1.000	125.816	0.968	157
11	116.982	1.000	144.481	0.944	173
12	121.850	1.000	151.782	0.978	189

Test for Normality

Jarque-Bera test	**JB statistic**	**Prob.**	**df**
	14.104	0.0791	8

Test for heteroskedasticity

White test	**Chi-square**	**Prob.**	**df**
	116.057	0.130	100

Note: 1. The null hypothesis for the Portmanteau test is that there is no residual autocorrelation up to lag h.

2. The null hypothesis for the normality test is that the residuals are multivariate normal (Orthogonalization: Cholesky (Lutkepohl).

3. The null hypothesis for heteroskedasticity is that the residuals are homoscedastic.

* The test is valid only for lags larger than the VAR lag order and df is degrees of freedom for chi-square distribution.

Table E. 4: Model 1: The inverse roots of the characteristic AR polynomial

Root	Modulus
1.000000	1.000000
1.000000	1.000000
1.000000	1.000000
0.731504	0.731504
0.081495 - 0.532505i	0.538705
0.081495 + 0.532505i	0.538705
0.326584	0.326584
0.099409	0.099409

Note: VEC specification imposes 3 unit roots.

Figure E. 1: Model 1: AR roots

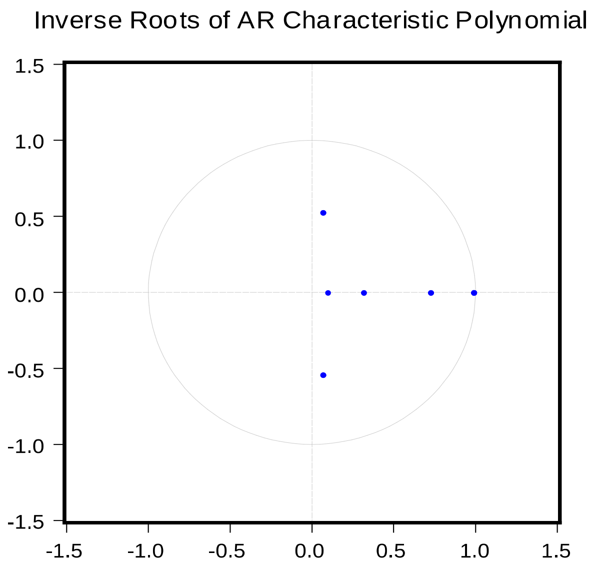


Table E. 5: Model 2: Diagnostic test for VAR(1)

Multivariate Specification Tests		
Serial Correlation LM Test		
Lags	**LM-Stat**	**Prob.**
1	31.659	0.168
2	17.700	0.855
3	34.919	0.090
4	24.724	0.478
5	16.038	0.914
6	20.837	0.702
7	24.015	0.519
8	25.596	0.429
9	22.472	0.608
10	37.609	0.051
11	13.314	0.972
12	25.068	0.459
Test for normality		
Jarque-Bera test		0.092
Test for heteroskedasticity		
White test		0.152

Note: 1. The null hypothesis for the LM test is that there is no serial correlation at lag order h (Probs from chi-square with 25 df).

2. The null hypothesis for the normality test is that the residuals are multivariate normal (Orthogonalization: Residual Covariance (Urzua), Prob. from J-B with 105 df).

3. The null hypothesis for heteroskedasticity is that the residuals are homoscedastic (Prob. From chi-square with 150 df).

Table E. 6: Model 2: VECM results

DEPENDENT VARIABLE	ΔLY	ΔLK	ΔLHC	ΔLX	ΔLIMP
ΔLY_{t-1}	-0.143	0.577	0.095	-0.743	0.093
	[-0.695]	[1.319]	[0.448]	[-1.432]	[0.230]
ΔLK_{t-1}	0.194*	0.206	0.202*	0.203	0.172
	[1.768]	[0.885]	[1.785]	[0.733]	[0.801]
ΔLHC_{t-1}	-0.019	0.212	0.671***	-0.031	0.291
	[-0.140]	[0.733]	[4.762]	[-0.090]	[1.087]
ΔLX_{t-1}	0.393***	-0.075	0.017	0.678**	0.218
	[3.769]	[-0.339]	[0.161]	[2.579]	[1.064]
$\Delta LIMP_{t-1}$	-0.258*	-0.016	-0.104	-0.246	0.159
	[-1.851]	[-0.054]	[-0.719]	[-0.699]	[0.580]
ECT_{t-1}	-0.413***	0.156	-0.075	-0.693***	-0.038
	[-5.858]	[1.039]	[-1.025]	[-3.895]	[-0.271]
R-squared	0.614	0.153	0.220	0.386	0.152
Adj. R-squared	0.550	0.012	0.091	0.284	0.010
F-statistic	9.555	1.086	1.697	3.777	1.072
Specification tests (p-values)					
BG χ^2(1)	0.460	0.062	1.000	0.648	1.000
BG χ^2(2)	0.737	0.142	1.000	0.802	1.000
JB test	0.655	0.802	0.007	0.357	0.374
W-het χ^2{21}	0.250	0.130	0.216	0.636	0.214
ARCH (1)	0.043	0.321	0.195	0.748	0.423
ARCH (2)	0.201	0.185	0.418	0.942	0.748
ARCH (3)	0.224	0.063	0.399	0.662	0.802

Note: 1. *, ** and *** indicates significance at 10%, 5% and 1% significance level respectively.

2. The null hypothesis for the Breusch- Godfrey Serial correlation test is that there is no residual autocorrelation.

3. The null hypothesis for the normality test is that the residuals are multivariate normal.

4. The null hypothesis for the White heteroskedasticity test is that the residuals are homoscedastic.

5. The null hypothesis for the ARCH heteroskedasticity test is the absence of ARCH component.

6. t-statistics in [ ], lags in ( ), df in { }

Table E. 7: Model 2: Diagnostic test for VECM

Multivariate Specification Tests

Residual Portmanteau test for Autocorrelations

Lags	**Q-Stat**	**Prob.**	**Adj Q-Stat**	**Prob.**	**df**
1	7.718	NA*	7.939	NA*	NA*
2	18.414	1.000	19.264	1.000	46
3	38.474	0.999	41.148	0.998	71
4	68.938	0.983	75.420	0.940	96
5	82.940	0.997	91.680	0.978	121
6	102.233	0.998	114.831	0.973	146
7	120.000	0.999	136.887	0.974	171
8	132.938	1.000	153.522	0.989	196
9	150.982	1.000	177.580	0.986	221
10	172.312	1.000	207.113	0.966	246
11	189.684	1.000	232.129	0.958	271
12	198.998	1.000	246.101	0.984	296

Test for Normality

Jarque-Bera test	**JB statistic**	**Prob.**	**df**
	17.167	0.071	10

Test for heteroskedasticity

White test	**Chi-square**	**Prob.**	**df**
	188.269	0.321	180

Note: 1. The null hypothesis for the Portmanteau test is that there is no residual autocorrelation up to lag h.

2. The null hypothesis for the normality test is that the residuals are multivariate normal (Orthogonalization: Cholesky (Lutkepohl).

3. The null hypothesis for heteroskedasticity is that the residuals are homoscedastic.

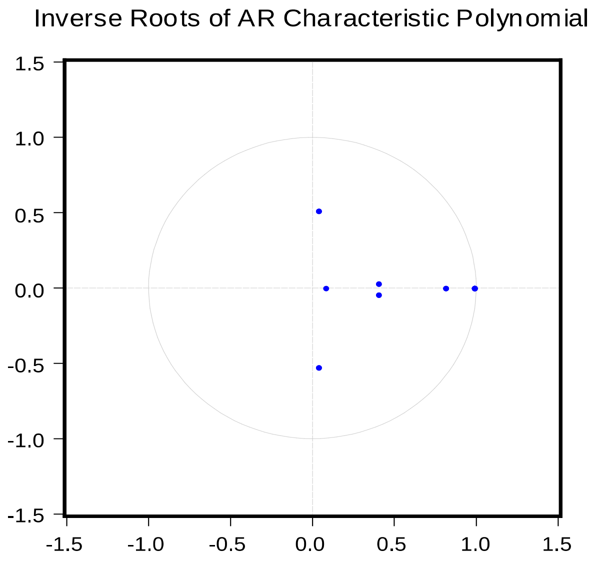
* The test is valid only for lags larger than the VAR lag order and df is degrees of freedom for chi-square distribution.

Table E. 8: Model 2: The inverse roots of the characteristic AR polynomial

Root	Modulus
1.000000	1.000000
1.000000	1.000000
1.000000	1.000000
1.000000	1.000000
0.827065	0.827065
0.041751 - 0.520960i	0.522630
0.041751 + 0.520960i	0.522630
0.416818 - 0.041637i	0.418892
0.416818 + 0.041637i	0.418892
0.090092	0.090092

Note: VEC specification imposes 4 unit roots.

Figure E. 2: Model 2: AR roots



APPENDIX F. Correlograms for the time series, period 1981-2012

Figure F. 1: Correlograms for the series at level and first difference

Variable: LY

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |*******</td><td>. |*******</td><td>1</td><td>0.937</td><td>0.937</td><td>30.799</td><td>0.000</td></tr>
<tr><td>. |******|</td><td>. *| . |</td><td>2</td><td>0.863</td><td>-0.121</td><td>57.792</td><td>0.000</td></tr>
<tr><td>. |******|</td><td>. *| . |</td><td>3</td><td>0.783</td><td>-0.081</td><td>80.785</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>. *| . |</td><td>4</td><td>0.699</td><td>-0.072</td><td>99.769</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. *| . |</td><td>5</td><td>0.602</td><td>-0.154</td><td>114.37</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. *| . |</td><td>6</td><td>0.490</td><td>-0.174</td><td>124.41</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>. *| . |</td><td>7</td><td>0.375</td><td>-0.087</td><td>130.52</td><td>0.000</td></tr>
<tr><td>. |**. |</td><td>. | . |</td><td>8</td><td>0.264</td><td>-0.043</td><td>133.68</td><td>0.000</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>9</td><td>0.162</td><td>-0.000</td><td>134.92</td><td>0.000</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>10</td><td>0.079</td><td>0.093</td><td>135.23</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>11</td><td>0.001</td><td>-0.038</td><td>135.23</td><td>0.000</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>12</td><td>-0.076</td><td>-0.083</td><td>135.54</td><td>0.000</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>13</td><td>-0.152</td><td>-0.112</td><td>136.87</td><td>0.000</td></tr>
<tr><td>.**| . |</td><td>. | . |</td><td>14</td><td>-0.215</td><td>-0.027</td><td>139.67</td><td>0.000</td></tr>
<tr><td>.**| . |</td><td>. *| . |</td><td>15</td><td>-0.272</td><td>-0.087</td><td>144.42</td><td>0.000</td></tr>
<tr><td>.**| . |</td><td>. *| . |</td><td>16</td><td>-0.328</td><td>-0.096</td><td>151.74</td><td>0.000</td></tr>
</table>

Variable: DLY

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |**. |</td><td>. |**. |</td><td>1</td><td>0.246</td><td>0.246</td><td>2.0635</td><td>0.151</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>2</td><td>0.053</td><td>-0.008</td><td>2.1628</td><td>0.339</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>3</td><td>0.106</td><td>0.101</td><td>2.5712</td><td>0.463</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>4</td><td>-0.087</td><td>-0.147</td><td>2.8585</td><td>0.582</td></tr>
<tr><td>. | . |</td><td>. |* . |</td><td>5</td><td>0.040</td><td>0.105</td><td>2.9219</td><td>0.712</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>6</td><td>0.065</td><td>0.020</td><td>3.0969</td><td>0.797</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>7</td><td>-0.055</td><td>-0.057</td><td>3.2269</td><td>0.863</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>8</td><td>-0.114</td><td>-0.126</td><td>3.8007</td><td>0.875</td></tr>
<tr><td>. *| . |</td><td>. | . |</td><td>9</td><td>-0.097</td><td>-0.035</td><td>4.2368</td><td>0.895</td></tr>
<tr><td>. | . |</td><td>. |* . |</td><td>10</td><td>0.073</td><td>0.148</td><td>4.4956</td><td>0.922</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>11</td><td>-0.027</td><td>-0.087</td><td>4.5318</td><td>0.952</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>12</td><td>-0.101</td><td>-0.099</td><td>5.0821</td><td>0.955</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>13</td><td>-0.001</td><td>0.029</td><td>5.0822</td><td>0.973</td></tr>
<tr><td>. *| . |</td><td>. | . |</td><td>14</td><td>-0.088</td><td>-0.032</td><td>5.5519</td><td>0.977</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>15</td><td>-0.032</td><td>-0.004</td><td>5.6183</td><td>0.985</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>16</td><td>0.121</td><td>0.078</td><td>6.6190</td><td>0.980</td></tr>
</table>

Variable: LK

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |*******</td><td>. |*******</td><td>1</td><td>0.928</td><td>0.928</td><td>30.203</td><td>0.000</td></tr>
<tr><td>. |******|</td><td>. | . |</td><td>2</td><td>0.855</td><td>-0.040</td><td>56.714</td><td>0.000</td></tr>
<tr><td>. |******|</td><td>. *| . |</td><td>3</td><td>0.765</td><td>-0.166</td><td>78.652</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>. | . |</td><td>4</td><td>0.675</td><td>-0.046</td><td>96.366</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. *| . |</td><td>5</td><td>0.572</td><td>-0.138</td><td>109.57</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>. *| . |</td><td>6</td><td>0.460</td><td>-0.138</td><td>118.44</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>. | . |</td><td>7</td><td>0.359</td><td>0.017</td><td>124.05</td><td>0.000</td></tr>
<tr><td>. |**. |</td><td>. | . |</td><td>8</td><td>0.267</td><td>0.009</td><td>127.27</td><td>0.000</td></tr>
<tr><td>. |* . |</td><td>. *| . |</td><td>9</td><td>0.172</td><td>-0.104</td><td>128.66</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>10</td><td>0.066</td><td>-0.170</td><td>128.87</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>11</td><td>-0.035</td><td>-0.062</td><td>128.94</td><td>0.000</td></tr>
<tr><td>. *| . |</td><td>. | . |</td><td>12</td><td>-0.129</td><td>-0.062</td><td>129.84</td><td>0.000</td></tr>
<tr><td>. *| . |</td><td>. |* . |</td><td>13</td><td>-0.183</td><td>0.205</td><td>131.77</td><td>0.000</td></tr>
<tr><td>.**| . |</td><td>. *| . |</td><td>14</td><td>-0.243</td><td>-0.087</td><td>135.34</td><td>0.000</td></tr>
<tr><td>.**| . |</td><td>. *| . |</td><td>15</td><td>-0.300</td><td>-0.132</td><td>141.11</td><td>0.000</td></tr>
<tr><td>***| . |</td><td>. *| . |</td><td>16</td><td>-0.359</td><td>-0.133</td><td>149.88</td><td>0.000</td></tr>
</table>

Variable: DLK

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. | . |</td><td>. | . |</td><td>1</td><td>-0.004</td><td>-0.004</td><td>0.0006</td><td>0.981</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>2</td><td>0.124</td><td>0.124</td><td>0.5395</td><td>0.764</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>3</td><td>-0.023</td><td>-0.023</td><td>0.5593</td><td>0.906</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>4</td><td>0.114</td><td>0.100</td><td>1.0530</td><td>0.902</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>5</td><td>-0.096</td><td>-0.093</td><td>1.4183</td><td>0.922</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>6</td><td>0.119</td><td>0.098</td><td>1.9982</td><td>0.920</td></tr>
<tr><td>.**| . |</td><td>.**| . |</td><td>7</td><td>-0.272</td><td>-0.261</td><td>5.1567</td><td>0.641</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>8</td><td>0.041</td><td>0.023</td><td>5.2318</td><td>0.733</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>9</td><td>0.112</td><td>0.200</td><td>5.8129</td><td>0.758</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>10</td><td>-0.047</td><td>-0.114</td><td>5.9200</td><td>0.822</td></tr>
<tr><td>. *| . |</td><td>. | . |</td><td>11</td><td>-0.071</td><td>-0.026</td><td>6.1764</td><td>0.861</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>12</td><td>-0.028</td><td>-0.079</td><td>6.2196</td><td>0.905</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>13</td><td>-0.010</td><td>0.044</td><td>6.2253</td><td>0.938</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>14</td><td>-0.094</td><td>-0.145</td><td>6.7611</td><td>0.944</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>15</td><td>0.040</td><td>0.034</td><td>6.8651</td><td>0.961</td></tr>
<tr><td>. *| . |</td><td>. | . |</td><td>16</td><td>-0.173</td><td>-0.057</td><td>8.9013</td><td>0.917</td></tr>
</table>

Variable: LHC

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |*******	. |*******	1	0.902	0.902	28.564	0.000
. |******|	. *| . |	2	0.797	-0.093	51.573	0.000
. |***** |	. | . |	3	0.690	-0.062	69.439	0.000
. |**** |	. *| . |	4	0.578	-0.093	82.422	0.000
. |*** |	. *| . |	5	0.464	-0.080	91.095	0.000
. |*** |	. | . |	6	0.367	0.015	96.718	0.000
. |**. |	. | . |	7	0.285	0.010	100.25	0.000
. |**. |	. | . |	8	0.218	0.012	102.41	0.000
. |* . |	. | . |	9	0.157	-0.041	103.58	0.000
. |* . |	. | . |	10	0.098	-0.054	104.06	0.000
. | . |	. | . |	11	0.043	-0.046	104.15	0.000
. | . |	. | . |	12	-0.010	-0.039	104.16	0.000
. | . |	. | . |	13	-0.059	-0.032	104.36	0.000
. *| . |	. | . |	14	-0.107	-0.042	105.05	0.000
. *| . |	. | . |	15	-0.149	-0.032	106.48	0.000
. *| . |	. | . |	16	-0.191	-0.059	108.97	0.000

Variable: DLHC

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |**** |	. |**** |	1	0.489	0.489	8.1428	0.004
. |* . |	. *| . |	2	0.141	-0.129	8.8425	0.012
. *| . |	. *| . |	3	-0.084	-0.133	9.1031	0.028
. *| . |	. *| . |	4	-0.177	-0.081	10.297	0.036
. *| . |	. |* . |	5	-0.082	0.080	10.561	0.061
. *| . |	. *| . |	6	-0.082	-0.105	10.834	0.094
. | . |	. | . |	7	-0.051	-0.011	10.946	0.141
. | . |	. | . |	8	-0.055	-0.045	11.079	0.197
. *| . |	. | . |	9	-0.071	-0.040	11.311	0.255
. | . |	. | . |	10	-0.061	-0.039	11.496	0.320
. | . |	. | . |	11	-0.049	-0.015	11.618	0.393
. | . |	. | . |	12	-0.033	-0.030	11.675	0.472
. | . |	. |* . |	13	0.058	0.089	11.866	0.539
. | . |	. *| . |	14	-0.016	-0.139	11.882	0.616
. | . |	. | . |	15	-0.050	-0.021	12.042	0.676
. | . |	. | . |	16	-0.018	0.042	12.063	0.740

Variable: LPX

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |******|	. |******|	1	0.885	0.885	27.512	0.000
. |***** |	. *| . |	2	0.760	-0.111	48.457	0.000
. |***** |	. | . |	3	0.656	0.032	64.613	0.000
. |**** |	. | . |	4	0.575	0.031	77.444	0.000
. |*** |	. *| . |	5	0.469	-0.167	86.313	0.000
. |*** |	. | . |	6	0.386	0.063	92.541	0.000
. |**. |	. *| . |	7	0.281	-0.188	95.986	0.000
. |* . |	. | . |	8	0.195	0.025	97.708	0.000
. |* . |	. *| . |	9	0.089	-0.171	98.085	0.000
. | . |	. |* . |	10	0.021	0.083	98.106	0.000
. | . |	. *| . |	11	-0.046	-0.067	98.217	0.000
. *| . |	. *| . |	12	-0.117	-0.124	98.967	0.000
. *| . |	. | . |	13	-0.193	-0.016	101.10	0.000
.**| . |	. | . |	14	-0.232	0.000	104.36	0.000
.**| . |	. | . |	15	-0.260	0.026	108.69	0.000
.**| . |	. *| . |	16	-0.292	-0.125	114.50	0.000

Variable: DLPX

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |* . |	. |* . |	1	0.084	0.084	0.2427	0.622
. | . |	. | . |	2	0.065	0.058	0.3918	0.822
. *| . |	. *| . |	3	-0.164	-0.176	1.3803	0.710
. *| . |	. *| . |	4	-0.129	-0.109	2.0135	0.733
. *| . |	. | . |	5	-0.104	-0.065	2.4369	0.786
. |* . |	. |* . |	6	0.088	0.095	2.7557	0.839
. | . |	. | . |	7	0.012	-0.029	2.7615	0.906
. |**. |	. |* . |	8	0.239	0.199	5.3031	0.725
. | . |	. *| . |	9	-0.047	-0.077	5.4052	0.798
. | . |	. | . |	10	0.045	0.042	5.5052	0.855
. | . |	. |* . |	11	0.014	0.097	5.5158	0.904
. *| . |	. *| . |	12	-0.183	-0.200	7.3195	0.836
. | . |	. | . |	13	-0.031	0.037	7.3728	0.882
. *| . |	. *| . |	14	-0.084	-0.101	7.8008	0.899
. |* . |	. |* . |	15	0.157	0.189	9.3837	0.857
. |* . |	. | . |	16	0.148	0.046	10.884	0.817

Variable: LMX

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |******|</td><td>. |******|</td><td>1</td><td>0.897</td><td>0.897</td><td>28.208</td><td>0.000</td></tr>
<tr><td>. |******|</td><td>. *| . |</td><td>2</td><td>0.785</td><td>-0.097</td><td>50.540</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>. | . |</td><td>3</td><td>0.688</td><td>0.016</td><td>68.292</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. | . |</td><td>4</td><td>0.599</td><td>-0.024</td><td>82.227</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. *| . |</td><td>5</td><td>0.494</td><td>-0.135</td><td>92.062</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>. *| . |</td><td>6</td><td>0.383</td><td>-0.090</td><td>98.203</td><td>0.000</td></tr>
<tr><td>. |**. |</td><td>. | . |</td><td>7</td><td>0.282</td><td>-0.037</td><td>101.65</td><td>0.000</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>8</td><td>0.192</td><td>-0.028</td><td>103.33</td><td>0.000</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>9</td><td>0.121</td><td>0.023</td><td>104.02</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>10</td><td>0.058</td><td>-0.014</td><td>104.18</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>11</td><td>-0.001</td><td>-0.041</td><td>104.18</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. |* . |</td><td>12</td><td>-0.030</td><td>0.094</td><td>104.23</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>13</td><td>-0.049</td><td>-0.016</td><td>104.37</td><td>0.000</td></tr>
<tr><td>. *| . |</td><td>. | . |</td><td>14</td><td>-0.066</td><td>-0.028</td><td>104.63</td><td>0.000</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>15</td><td>-0.110</td><td>-0.167</td><td>105.41</td><td>0.000</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>16</td><td>-0.158</td><td>-0.085</td><td>107.10</td><td>0.000</td></tr>
</table>

Variable: DLMX

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. | . |</td><td>. | . |</td><td>1</td><td>0.051</td><td>0.051</td><td>0.0880</td><td>0.767</td></tr>
<tr><td>.**| . |</td><td>.**| . |</td><td>2</td><td>-0.210</td><td>-0.213</td><td>1.6393</td><td>0.441</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>3</td><td>-0.117</td><td>-0.098</td><td>2.1389</td><td>0.544</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>4</td><td>-0.014</td><td>-0.050</td><td>2.1462</td><td>0.709</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>5</td><td>0.114</td><td>0.076</td><td>2.6608</td><td>0.752</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>6</td><td>-0.097</td><td>-0.138</td><td>3.0462</td><td>0.803</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>7</td><td>-0.182</td><td>-0.152</td><td>4.4658</td><td>0.725</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>8</td><td>-0.093</td><td>-0.124</td><td>4.8544</td><td>0.773</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>9</td><td>0.053</td><td>-0.029</td><td>4.9844</td><td>0.836</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>10</td><td>-0.065</td><td>-0.186</td><td>5.1913</td><td>0.878</td></tr>
<tr><td>. *| . |</td><td>.**| . |</td><td>11</td><td>-0.172</td><td>-0.223</td><td>6.7043</td><td>0.823</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>12</td><td>0.052</td><td>-0.015</td><td>6.8491</td><td>0.867</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>13</td><td>0.093</td><td>-0.061</td><td>7.3396</td><td>0.884</td></tr>
<tr><td>. |**. |</td><td>. |* . |</td><td>14</td><td>0.235</td><td>0.142</td><td>10.650</td><td>0.713</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>15</td><td>0.103</td><td>0.087</td><td>11.334</td><td>0.729</td></tr>
<tr><td>.**| . |</td><td>. *| . |</td><td>16</td><td>-0.218</td><td>-0.166</td><td>14.590</td><td>0.555</td></tr>
</table>

Variable: LFX

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |******|	. |******|	1	0.880	0.880	27.179	0.000
. |***** |	. *| . |	2	0.749	-0.112	47.535	0.000
. |***** |	. | . |	3	0.643	0.039	63.060	0.000
. |**** |	. | . |	4	0.562	0.035	75.324	0.000
. |*** |	. *| . |	5	0.458	-0.155	83.774	0.000
. |*** |	. | . |	6	0.379	0.072	89.778	0.000
. |**. |	. *| . |	7	0.277	-0.187	93.119	0.000
. |* . |	. | . |	8	0.193	0.026	94.811	0.000
. |* . |	. *| . |	9	0.085	-0.193	95.151	0.000
. | . |	. | . |	10	0.012	0.073	95.159	0.000
. | . |	. *| . |	11	-0.058	-0.075	95.335	0.000
. *| . |	. *| . |	12	-0.133	-0.131	96.297	0.000
.**| . |	. | . |	13	-0.209	-0.002	98.799	0.000
.**| . |	. | . |	14	-0.246	-0.004	102.46	0.000
.**| . |	. | . |	15	-0.270	0.046	107.12	0.000
.**| . |	. *| . |	16	-0.298	-0.130	113.17	0.000

Variable: DLFX

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |* . |	. |* . |	1	0.082	0.082	0.2290	0.632
. | . |	. | . |	2	0.055	0.048	0.3348	0.846
. *| . |	. *| . |	3	-0.168	-0.178	1.3679	0.713
. *| . |	. *| . |	4	-0.139	-0.118	2.0972	0.718
. *| . |	. | . |	5	-0.096	-0.059	2.4564	0.783
. |* . |	. |* . |	6	0.089	0.092	2.7840	0.835
. | . |	. | . |	7	0.023	-0.023	2.8058	0.902
. |**. |	. |* . |	8	0.248	0.208	5.5319	0.700
. | . |	. *| . |	9	-0.040	-0.069	5.6064	0.779
. | . |	. | . |	10	0.043	0.047	5.6975	0.840
. | . |	. |* . |	11	0.011	0.096	5.7034	0.892
. *| . |	. *| . |	12	-0.191	-0.198	7.6586	0.811
. | . |	. | . |	13	-0.036	0.026	7.7325	0.861
. *| . |	. *| . |	14	-0.088	-0.106	8.2024	0.879
. |* . |	. |* . |	15	0.155	0.177	9.7325	0.836
. |* . |	. | . |	16	0.147	0.040	11.213	0.796

Variable: LNOILX

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |******|</td><td>. |******|</td><td>1</td><td>0.852</td><td>0.852</td><td>25.455</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>. | . |</td><td>2</td><td>0.745</td><td>0.071</td><td>45.567</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>. *| . |</td><td>3</td><td>0.624</td><td>-0.095</td><td>60.159</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. | . |</td><td>4</td><td>0.512</td><td>-0.051</td><td>70.340</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>. *| . |</td><td>5</td><td>0.399</td><td>-0.071</td><td>76.751</td><td>0.000</td></tr>
<tr><td>. |**. |</td><td>. | . |</td><td>6</td><td>0.312</td><td>0.016</td><td>80.836</td><td>0.000</td></tr>
<tr><td>. |* . |</td><td>. *| . |</td><td>7</td><td>0.207</td><td>-0.116</td><td>82.703</td><td>0.000</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>8</td><td>0.149</td><td>0.072</td><td>83.714</td><td>0.000</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>9</td><td>0.095</td><td>-0.004</td><td>84.137</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>10</td><td>0.046</td><td>-0.042</td><td>84.241</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>11</td><td>0.021</td><td>0.045</td><td>84.264</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>12</td><td>0.007</td><td>0.010</td><td>84.267</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>13</td><td>-0.007</td><td>-0.008</td><td>84.270</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>14</td><td>-0.031</td><td>-0.083</td><td>84.328</td><td>0.000</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>15</td><td>-0.097</td><td>-0.192</td><td>84.931</td><td>0.000</td></tr>
<tr><td>. *| . |</td><td>. | . |</td><td>16</td><td>-0.138</td><td>0.009</td><td>86.231</td><td>0.000</td></tr>
</table>

Variable: DLNOILX

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>***| . |</td><td>***| . |</td><td>1</td><td>-0.460</td><td>-0.460</td><td>7.2151</td><td>0.007</td></tr>
<tr><td>. |**. |</td><td>. | . |</td><td>2</td><td>0.267</td><td>0.070</td><td>9.7277</td><td>0.008</td></tr>
<tr><td>. | . |</td><td>. |* . |</td><td>3</td><td>-0.011</td><td>0.173</td><td>9.7317</td><td>0.021</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>4</td><td>-0.116</td><td>-0.105</td><td>10.245</td><td>0.037</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>5</td><td>0.163</td><td>0.044</td><td>11.289</td><td>0.046</td></tr>
<tr><td>. | . |</td><td>. |* . |</td><td>6</td><td>-0.022</td><td>0.145</td><td>11.308</td><td>0.079</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>7</td><td>0.041</td><td>0.073</td><td>11.379</td><td>0.123</td></tr>
<tr><td>. *| . |</td><td>.**| . |</td><td>8</td><td>-0.165</td><td>-0.257</td><td>12.595</td><td>0.127</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>9</td><td>0.136</td><td>-0.008</td><td>13.457</td><td>0.143</td></tr>
<tr><td>. *| . |</td><td>. | . |</td><td>10</td><td>-0.114</td><td>0.057</td><td>14.085</td><td>0.169</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>11</td><td>-0.057</td><td>-0.184</td><td>14.252</td><td>0.219</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>12</td><td>0.071</td><td>-0.095</td><td>14.526</td><td>0.268</td></tr>
<tr><td>.**| . |</td><td>. *| . |</td><td>13</td><td>-0.224</td><td>-0.102</td><td>17.366</td><td>0.183</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>14</td><td>0.145</td><td>0.037</td><td>18.631</td><td>0.180</td></tr>
<tr><td>. | . |</td><td>. |* . |</td><td>15</td><td>-0.006</td><td>0.121</td><td>18.634</td><td>0.231</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>16</td><td>-0.028</td><td>0.020</td><td>18.689</td><td>0.285</td></tr>
</table>

Variable: LREX

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |*******	. |*******	1	0.905	0.905	28.730	0.000
. |******|	. *| . |	2	0.797	-0.121	51.751	0.000
. |***** |	. |* . |	3	0.715	0.093	70.942	0.000
. |***** |	. *| . |	4	0.623	-0.127	86.048	0.000
. |**** |	. *| . |	5	0.517	-0.110	96.817	0.000
. |*** |	. *| . |	6	0.412	-0.071	103.91	0.000
. |**. |	. | . |	7	0.324	0.011	108.46	0.000
. |**. |	. *| . |	8	0.228	-0.118	110.82	0.000
. |* . |	. | . |	9	0.145	0.033	111.81	0.000
. |* . |	. | . |	10	0.075	-0.032	112.09	0.000
. | . |	. | . |	11	0.020	0.023	112.11	0.000
. | . |	. | . |	12	-0.016	0.050	112.12	0.000
. | . |	. | . |	13	-0.049	-0.037	112.26	0.000
. *| . |	. *| . |	14	-0.102	-0.166	112.89	0.000
. *| . |	. | . |	15	-0.155	-0.059	114.42	0.000
. *| . |	. *| . |	16	-0.202	-0.087	117.20	0.000

Variable: DLREX

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. *| . |	. *| . |	1	-0.162	-0.162	0.8973	0.344
. *| . |	. *| . |	2	-0.156	-0.188	1.7609	0.415
. *| . |	. *| . |	3	-0.108	-0.179	2.1844	0.535
. |* . |	. | . |	4	0.079	-0.010	2.4199	0.659
. *| . |	.**| . |	5	-0.154	-0.209	3.3544	0.646
. |* . |	. | . |	6	0.132	0.057	4.0702	0.667
. *| . |	. *| . |	7	-0.124	-0.167	4.7296	0.693
. | . |	. | . |	8	0.015	-0.059	4.7400	0.785
. | . |	. | . |	9	0.046	0.017	4.8398	0.848
. *| . |	.**| . |	10	-0.105	-0.206	5.3746	0.865
.**| . |	***| . |	11	-0.298	-0.381	9.9186	0.538
. |* . |	. *| . |	12	0.152	-0.169	11.158	0.515
. |* . |	. | . |	13	0.171	-0.051	12.829	0.461
. |* . |	. |* . |	14	0.136	0.082	13.949	0.453
. | . |	. | . |	15	-0.006	0.063	13.952	0.529
. | . |	. | . |	16	-0.051	-0.037	14.127	0.589

Variable: LIMP

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |*******</td><td>. |*******</td><td>1</td><td>0.926</td><td>0.926</td><td>30.088</td><td>0.000</td></tr>
<tr><td>. |******|</td><td>. *| . |</td><td>2</td><td>0.843</td><td>-0.103</td><td>55.841</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>. *| . |</td><td>3</td><td>0.751</td><td>-0.099</td><td>77.020</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>. *| . |</td><td>4</td><td>0.646</td><td>-0.148</td><td>93.230</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. *| . |</td><td>5</td><td>0.530</td><td>-0.129</td><td>104.55</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>. | . |</td><td>6</td><td>0.416</td><td>-0.050</td><td>111.81</td><td>0.000</td></tr>
<tr><td>. |**. |</td><td>. | . |</td><td>7</td><td>0.316</td><td>0.030</td><td>116.15</td><td>0.000</td></tr>
<tr><td>. |**. |</td><td>. | . |</td><td>8</td><td>0.224</td><td>-0.012</td><td>118.42</td><td>0.000</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>9</td><td>0.139</td><td>-0.035</td><td>119.33</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>10</td><td>0.068</td><td>0.007</td><td>119.56</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>11</td><td>0.008</td><td>-0.025</td><td>119.57</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>12</td><td>-0.042</td><td>-0.018</td><td>119.66</td><td>0.000</td></tr>
<tr><td>. *| . |</td><td>. | . |</td><td>13</td><td>-0.072</td><td>0.070</td><td>119.96</td><td>0.000</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>14</td><td>-0.109</td><td>-0.136</td><td>120.68</td><td>0.000</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>15</td><td>-0.158</td><td>-0.160</td><td>122.28</td><td>0.000</td></tr>
<tr><td>.**| . |</td><td>. *| . |</td><td>16</td><td>-0.210</td><td>-0.106</td><td>125.27</td><td>0.000</td></tr>
</table>

Variable: DLIMP

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |**. |</td><td>. |**. |</td><td>1</td><td>0.335</td><td>0.335</td><td>3.827</td><td>0.050</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>2</td><td>0.020</td><td>-0.104</td><td>3.841</td><td>0.147</td></tr>
<tr><td>. |* . |</td><td>. |**. |</td><td>3</td><td>0.190</td><td>0.247</td><td>5.158</td><td>0.161</td></tr>
<tr><td>. | . |</td><td>.**| . |</td><td>4</td><td>-0.059</td><td>-0.258</td><td>5.288</td><td>0.259</td></tr>
<tr><td>. *| . |</td><td>. | . |</td><td>5</td><td>-0.144</td><td>0.012</td><td>6.103</td><td>0.296</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>6</td><td>-0.115</td><td>-0.167</td><td>6.646</td><td>0.355</td></tr>
<tr><td>***| . |</td><td>***| . |</td><td>7</td><td>-0.407</td><td>-0.347</td><td>13.718</td><td>0.056</td></tr>
<tr><td>***| . |</td><td>.**| . |</td><td>8</td><td>-0.432</td><td>-0.218</td><td>22.004</td><td>0.005</td></tr>
<tr><td>. *| . |</td><td>. | . |</td><td>9</td><td>-0.131</td><td>0.006</td><td>22.798</td><td>0.007</td></tr>
<tr><td>. |* . |</td><td>. |**. |</td><td>10</td><td>0.076</td><td>0.258</td><td>23.080</td><td>0.010</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>11</td><td>0.081</td><td>0.072</td><td>23.418</td><td>0.015</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>12</td><td>0.139</td><td>0.090</td><td>24.454</td><td>0.018</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>13</td><td>0.170</td><td>-0.041</td><td>26.105</td><td>0.016</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>14</td><td>0.188</td><td>-0.010</td><td>28.223</td><td>0.013</td></tr>
<tr><td>. |**. |</td><td>. | . |</td><td>15</td><td>0.269</td><td>0.003</td><td>32.859</td><td>0.005</td></tr>
<tr><td>. |* . |</td><td>. *| . |</td><td>16</td><td>0.102</td><td>-0.168</td><td>33.572</td><td>0.006</td></tr>
</table>

APPENDIX G. Specification tests for model 3, model 4 and model 5

Table G. 1: Model 3.α: Diagnostic test for VAR(1)

Multivariate Specification Test		
Serial Correlation LM Test		
Lags	**LM-Stat**	**Prob.**
1	45.285	0.138
2	32.344	0.643
3	35.361	0.499
4	54.455	0.025
5	51.669	0.044
6	32.642	0.629
7	41.239	0.252
8	55.021	0.022
9	44.594	0.154
10	29.008	0.789
11	40.124	0.292
12	43.893	0.172
Test for Normality		
Jarque-Bear test		0.928
Test for Heteroskedasticity		
White test		0.149

Note: 1. The null hypothesis for the LM test is that there is no serial correlation at lag order h (Probs from chi-square with 36 df).

2. The null hypothesis for the normality test is that the residuals are multivariate normal (Orthogonalization: Residual Covariance (Urzua), Prob. From J-B with 182 df).

3. The null hypothesis for heteroskedasticity is that the residuals are homoscedastic (Prob. From chi-square with 252 df).

Table G. 2: Model 3.α: VECM results

DEPENDENT VARIABLE	ΔLY	ΔLK	ΔLHC	ΔLPX	ΔLMX	ΔLIMP
ΔLY_{t-1}	0.093	0.497	0.059	-0.105	1.898**	0.878
	[0.240]	[0.713]	[0.175]	[-0.093]	[2.782]	[1.512]
ΔLK_{t-1}	0.105	0.152	0.228	0.512	-0.257	-0.195
	[0.610]	[0.493]	[1.529]	[1.024]	[-0.848]	[-0.758]
ΔLHC_{t-1}	0.022	0.036	0.636***	-0.488	-0.944**	0.225
	[0.101]	[0.090]	[3.325]	[-0.760]	[-2.427]	[0.680]
ΔLPX_{t-1}	0.050	0.192	0.054	0.227	-0.382	-0.113
	[0.346]	[0.742]	[0.431]	[0.543]	[-1.507]	[-0.525]
ΔLMX_{t-1}	0.101	0.047	0.069	0.149	0.263*	0.082
	[1.327]	[0.348]	[1.049]	[0.677]	[1.968]	[0.725]
$\Delta LIMP_{t-1}$	0.059	-0.082	-0.088	0.112	0.715**	0.334
	[0.332]	[-0.257]	[-0.576]	[0.217]	[2.296]	[1.261]
ECT_{t-1}	-0.038	0.103	0.030	-0.062	0.658***	0.011
	[-0.569]	[0.869]	[0.522]	[-0.325]	[5.682]	[0.116]
R-squared	0.174	0.225	0.278	0.199	0.639	0.242
Adj. R-squared	-0.041	0.023	0.090	-0.009	0.545	0.044
F-statistic	0.807	1.115	1.479	0.955	6.783	1.225
Specification tests (p-values)						
BG $\chi^2(1)$	1.000	0.105	1.000	1.000	0.285	1.000
BG $\chi^2(2)$	0.301	0.217	1.000	1.000	0.195	0.100
JB test	0.822	0.472	0.000	0.885	0.880	0.421
W-het $\chi^2\{28\}$	0.396	0.377	0.371	0.421	0.365	0.367
ARCH (1)	0.681	0.376	0.733	0.863	0.253	0.192
ARCH (2)	0.716	0.129	0.804	0.836	0.499	0.404
ARCH (3)	0.822	0.240	0.454	0.759	0.556	0.622

Note: 1. *, ** and *** indicates significance at 10%, 5% and 1% significance level respectively.

2. The null hypothesis for the Breusch- Godfrey Serial correlation test is that there is no residual autocorrelation.

3. The null hypothesis for the normality test is that the residuals are multivariate normal.

4. The null hypothesis for the White heteroskedasticity test is that the residuals are homoscedastic.

5. The null hypothesis for the ARCH heteroskedasticity test is the absence of ARCH component.

6. lags in ( ), df in [ ]

Table G. 3: Model 3.α: Diagnostic test for VECM

Multivariate Specification Tests

Residual Portmanteau test for Autocorrelations

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	22.873	NA*	23.662	NA*	NA*
2	46.855	0.971	49.357	0.948	67
3	80.974	0.947	87.267	0.867	103
4	111.230	0.960	122.178	0.844	139
5	142.144	0.967	159.274	0.797	175
6	169.246	0.984	193.152	0.806	211
7	202.703	0.982	236.792	0.669	247
8	236.392	0.980	282.731	0.493	283
9	262.160	0.991	319.542	0.481	319
10	285.434	0.997	354.454	0.498	355
11	308.566	0.999	390.978	0.491	391
12	327.625	1.000	422.743	0.549	427

Test for Normality

Jarque-Bera test	**JB statistic**	**Prob.**	**df**
	137.722	0.994	182

Test for heteroskedasticity

White test	**Chi-square**	**Prob.**	**df**
	299.677	0.397	294

Note: 1. The null hypothesis for the Portmanteau test is that there is no residual autocorrelation up to lag h.

2. The null hypothesis for the normality test is that the residuals are multivariate normal (Orthogonalization: Residual Covariance (Urzua).

3. The null hypothesis for heteroskedasticity is that the residuals are homoscedastic.

* The test is valid only for lags larger than the VAR lag order and df is degrees of freedom for chi-square distribution.

Table G. 4: Model 3.α: The inverse roots of the characteristic AR polynomial:

Root	Modulus
1.000000 - 3.93e-16i	1.000000
1.000000 + 3.93e-16i	1.000000
1.000000 - 3.09e-16i	1.000000
1.000000 + 3.09e-16i	1.000000
1.000000	1.000000
0.829460	0.829460
0.539396 - 0.171138i	0.565895
0.539396 + 0.171138i	0.565895
-0.277883 - 0.230997i	0.361356
-0.277883 + 0.230997i	0.361356
0.105351 - 0.260187i	0.280706
0.105351 + 0.260187i	0.280706

Note: VEC specification imposes 5 unit roots.

Figure G. 1: Model 3.α: AR Roots

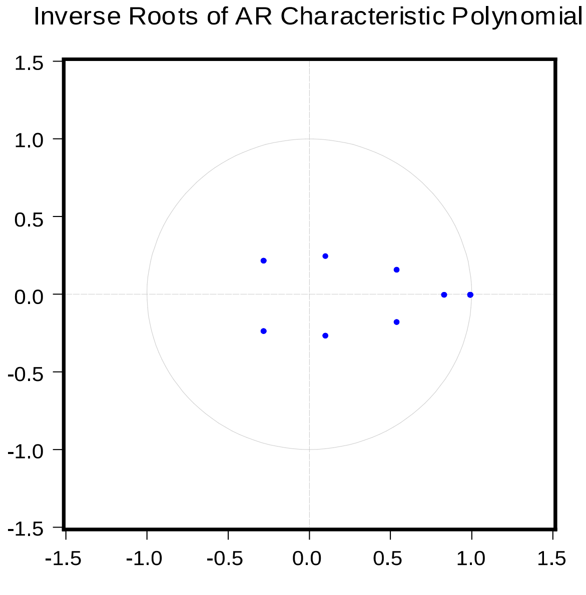


Table G. 5: Model 3.β: Diagnostic tests for VAR(1)

Multivariate Specification Test		
Serial Correlation LM Test		
Lags	**LM-Stat**	**Prob.**
1	48.131	0.085
2	33.701	0.578
3	36.020	0.468
4	56.911	0.015
5	55.732	0.019
6	37.650	0.394
7	42.601	0.208
8	54.407	0.025
9	47.183	0.101
10	46.267	0.117
11	52.690	0.036
12	44.661	0.153
Test for Normality		
Jarque-Bera test		0.979
Test for Heteroskedasticity		
White test		0.244

Note: 1. The null hypothesis for the LM test is that there is no serial correlation at lag order h (Probs from chi-square with 36 df).

2. The null hypothesis for the normality test is that the residuals are multivariate normal (Orthogonalization: Residual Covariance (Urzua), Prob. From J-B with 182 df).

3. The null hypothesis for heteroskedasticity is that the residuals are homoscedastic (Prob. From chi-square with 273 df).

Table G. 6: Model 3.β: VECM results

DEPENDENT VARIABLE	ΔLY	ΔLK	ΔLHC	ΔLPX	ΔLMX	ΔLIMP
ΔLY_{t-1}	-0.076	0.588	0.029	-0.558	1.862**	0.939
	[-0.232]	[0.825]	[0.085]	[-0.566]	[2.641]	[1.579]
ΔLK_{t-1}	0.035	0.184	0.213	0.325	-0.305	-0.174
	[0.242]	[0.586]	[1.393]	[0.747]	[-0.980]	[-0.661]
ΔLHC_{t-1}	-0.069	0.095	0.628***	-0.739	-0.948**	0.279
	[-0.371]	[0.238]	[3.223]	[-1.333]	[-2.388]	[0.833]
ΔLPX_{t-1}	0.083	0.172	0.058	0.318	-0.375	-0.130
	[0.688]	[0.658]	[0.455]	[0.879]	[-1.449]	[-0.597]
ΔLMX_{t-1}	0.193**	-0.001	0.085	0.401*	0.318**	0.042
	[2.778]	[-0.006]	[1.156]	[1.923]	[2.132]	[0.334]
$\Delta LIMP_{t-1}$	0.125	-0.117	-0.077	0.289	0.737**	0.310
	[0.837]	[-0.360]	[-0.487]	[0.645]	[2.299]	[1.147]
DUM00	0.200***	-0.105	0.035	0.542***	0.103	-0.082
	[3.314]	[-0.798]	[0.546]	[2.994]	[0.794]	[-0.754]
ECT_{t-1}	-0.049	0.102	0.024	-0.091	0.622***	0.009
	[-0.918]	[0.885]	[0.428]	[-0.572]	[5.468]	[0.091]
R-squared	0.449	0.245	0.287	0.431	0.642	0.261
Adj. R-squared	0.274	0.005	0.060	0.250	0.528	0.026
F-statistic	2.564	1.023	1.262	2.381	5.625	1.109
Specification tests (p-values)						
BG $\chi^2(1)$	0.384	0.398	1.000	0.039	0.180	1.000
BG $\chi^2(2)$	0.598	0.517	0.949	0.118	0.101	0.162
JB test	0.657	0.624	0.000	0.580	0.976	0.557
W-het $\chi^2\{8\}$	0.611	0.876	0.013	0.567	0.550	0.337
ARCH (1)	0.652	0.281	0.603	0.132	0.167	0.104
ARCH (2)	0.844	0.110	0.681	0.199	0.358	0.246
ARCH (3)	0.646	0.165	0.457	0.255	0.416	0.442

Note: 1. *, ** and *** indicates significance at 10%, 5% and 1% significance level respectively.

2. The null hypothesis for the Breusch- Godfrey Serial correlation test is that there is no residual autocorrelation.

3. The null hypothesis for the normality test is that the residuals are multivariate normal.

4. The null hypothesis for the White heteroskedasticity test is that the residuals are homoscedastic (White cross terms are not included).

5. The null hypothesis for the ARCH heteroskedasticity test is the absence of ARCH component.

6. lags in ( ), df in [ ]

Table G. 7: Model 3.β: Diagnostic test for VECM

Multivariate Specification Tests					
Residual Portmanteau test for Autocorrelations					
Lags	**Q-Stat**	**Prob.**	**Adj Q-Stat**	**Prob.**	**df**
1	24.026	NA*	24.854	NA*	NA*
2	44.948	0.982	47.270	0.968	67
3	81.919	0.938	88.350	0.848	103
4	110.960	0.962	121.858	0.849	139
5	142.193	0.967	159.338	0.796	175
6	174.055	0.970	199.166	0.710	211
7	209.532	0.960	245.440	0.516	247
8	243.304	0.958	291.493	0.351	283
9	263.089	0.990	319.757	0.478	319
10	283.203	0.998	349.929	0.566	355
11	308.195	0.999	389.389	0.514	391
12	326.124	1.000	419.271	0.596	427
Test for Normality					
Jarque-Bera test			**JB statistic**	**Prob.**	**df**
			144.147	0.982	182
Test for heteroskedasticity					
White test			**Chi-square**	**Prob.**	**df**
			301.511	0.698	315

Note: 1. The null hypothesis for the Portmanteau test is that there is no residual autocorrelation up to lag h.

2. The null hypothesis for the normality test is that the residuals are multivariate normal (Orthogonalization: Residual Covariance (Urzua).

3. The null hypothesis for heteroskedasticity test is that the residuals are homoscedastic.

* The test is valid only for lags larger than the VAR lag order and df is degrees of freedom for chi-square distribution.

Table G. 8: Model 3.β: The inverse roots of the characteristic AR polynomial

Root	Modulus
1.000000	1.000
1.000000	1.000
1.000000	1.000
1.000000 - 3.51e-16i	1.000
1.000000 + 3.51e-16i	1.000
0.848327	0.848
0.474183 - 0.240179i	0.532
0.474183 + 0.240179i	0.532
-0.342907 - 0.297194i	0.454
-0.342907 + 0.297194i	0.454
0.211949 - 0.304246i	0.371
0.211949 + 0.304246i	0.371

Note: VEC specification imposes 5 unit roots.

Figure G. 2: Model 3.β: AR roots

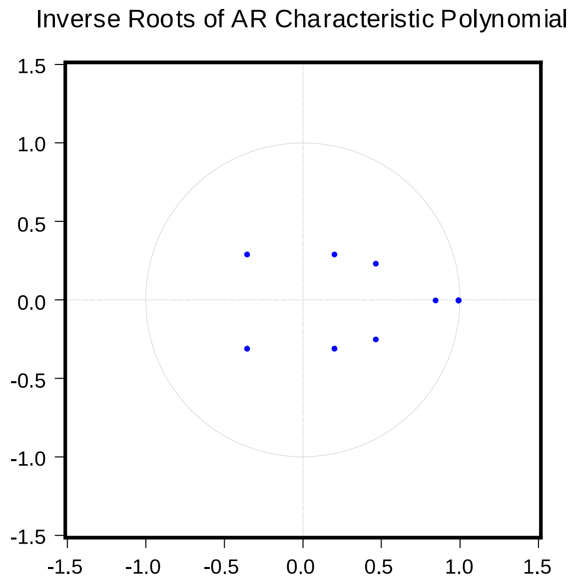


Table G. 9: Model 4: Diagnostic tests for VAR(2)

Multivariate Specification Test		
Serial Correlation LM Test		
Lags	**LM-Stat**	**Prob.**
1	29.224	0.255
2	28.459	0.287
3	24.190	0.508
4	30.783	0.196
5	21.443	0.668
6	42.141	0.017
7	16.255	0.907
8	22.987	0.578
9	26.755	0.368
10	32.082	0.156
11	20.348	0.728
12	21.441	0.668
Test for Normality		
Jarque-Bera test		0.999
Test for Heteroskedasticity		
White test		0.261

Note: 1. The null hypothesis for the LM test is that there is no serial correlation at lag order h (Probs from chi-square with 25 df).

2. The null hypothesis for the normality test is that the residuals are multivariate normal (Orthogonalization: Residual Covariance (Urzua), Prob. From J-B with 105 df).

3. The null hypothesis for heteroskedasticity is that the residuals are homoscedastic (Prob. From chi-square with 300 df).

Table G. 10: Model 4: VECM results

DEPENDENT VARIABLE	ΔLY	ΔLK	ΔLHC	ΔLFX	ΔLIMP
ΔLY_{t-1}	-0.097	0.209	-0.117	-0.802	0.593
	[-0.264]	[0.306]	[-0.315]	[-0.787]	[1.147]
ΔLY_{t-2}	-0.057	0.554	0.405	-0.010	1.015*
	[-0.150]	[0.787]	[1.061]	[-0.010]	[1.907]
ΔLK_{t-1}	0.290	0.121	0.364*	1.166**	0.078
	[1.674]	[0.374]	[2.076]	[2.423]	[0.318]
ΔLK_{t-2}	-0.227	-0.227	-0.400**	-1.021**	-0.678**
	[-1.331]	[-0.714]	[-2.321]	[-2.157]	[-2.820]
ΔLHC_{t-1}	-0.079	-0.267	0.786***	-0.336	0.317
	[-0.325]	[-0.587]	[3.192]	[-0.497]	[0.922]
ΔLHC_{t-2}	0.234	0.102	-0.053	0.465	-0.316
	[0.962]	[0.225]	[-0.214]	[0.686]	[-0.917]
ΔLFX_{t-1}	0.341**	-0.165	0.105	1.168**	-0.340
	[2.323]	[-0.603]	[0.705]	[2.860]	[-1.640]
ΔLFX_{t-2}	0.067	-0.375	-0.230	0.057	-0.667***
	[0.416]	[-1.235]	[-1.399]	[0.127]	[-2.908]
$\Delta LIMP_{t-1}$	-0.173	0.210	-0.146	-0.746	0.468*
	[-0.998]	[0.648]	[-0.830]	[-1.543]	[1.907]
$\Delta LIMP_{t-2}$	0.314*	0.274	0.235	0.884*	0.375
	[1.778]	[0.831]	[1.316]	[1.804]	[1.505]
ECT_{t-1}	-0.532**	1.298***	0.104	-1.623**	1.194***
	[-2.207]	[2.883]	[0.427]	[-2.421]	[3.507]
R-squared	0.488	0.514	0.425	0.603	0.582
Adj. R-squared	0.203	0.244	0.106	0.382	0.350
F-statistic	1.713	1.901	1.332	2.729	2.508
Specification tests (p-values)					
BG $\chi^2(1)$	1.000	0.260	1.000	1.000	0.495
BG $\chi^2(2)$	1.000	0.491	0.946	1.000	0.792
JB test	0.357	0.606	0.048	0.802	0.743
W-het $\chi^2\{11\}$	0.696	0.229	0.036	0.785	0.338
ARCH (1)	0.989	0.115	0.996	0.838	0.767
ARCH (2)	0.478	0.090	0.984	0.491	0.795
ARCH (3)	0.753	0.044	0.828	0.700	0.920

Note: 1. *, ** and *** indicates significance at 10%, 5% and 1% significance level respectively.

2. The null hypothesis for the Breusch- Godfrey Serial correlation test is that there is no residual autocorrelation.

3. The null hypothesis for the normality test is that the residuals are multivariate normal.

4. The null hypothesis for the White heteroskedasticity test is that the residuals are homoscedastic (White cross terms are not included).

5. The null hypothesis for the ARCH heteroskedasticity test is the absence of ARCH

component.

6. t-statistics in [ ], lags in ( ), df in { }

Table G. 11: Model 4: Diagnostic Tests for VECM

Multivariate Specification Tests

Residual Portmanteau test for Autocorrelations

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	8.671	NA*	8.980	NA*	NA*
2	24.436	NA*	25.914	NA*	NA*
3	49.610	0.331	53.992	0.196	46
4	68.584	0.559	76.002	0.321	71
5	95.319	0.500	8.306	0.184	96
6	115.769	0.617	134.092	0.196	121
7	131.166	0.805	154.388	0.301	146
8	154.264	0.816	186.285	0.201	171
9	173.592	0.874	214.311	0.176	196
10	194.662	0.899	246.470	0.115	221
11	207.169	0.966	266.620	0.175	246
12	223.479	0.984	294.443	0.157	271

Test for Normality

Jarque-Bera test	**JB statistic**	**Prob.**	**df**
	70.150	0.996	105

Test for heteroskedasticity

White test	**Chi-square**	**Prob.**	**df**
	332.131	0.457	330

Note: 1. The null hypothesis for the Portmanteau test is that there is no residual autocorrelation up to lag h.

2. The null hypothesis for the normality test is that the residuals are multivariate normal (Orthogonalization: Residual Covariance (Urzua).

3. The null hypothesis for heteroskedasticity is that the residuals are homoscedastic.

* The test is valid only for lags larger than the VAR lag order and df is degrees of freedom for chi-square distribution.

Table G. 12: Model 4: The inverse roots of the characteristic AR polynomial

Root	Modulus
1.000000	1.000000
1.000000	1.000000
1.000000	1.000000
1.000000	1.000000
0.899532	0.899532
-0.184790 - 0.804432i	0.825384
-0.184790 + 0.804432i	0.825384
0.566832 - 0.406859i	0.697734
0.566832 + 0.406859i	0.697734
-0.644389	0.644389
0.204843 - 0.451355i	0.495663
0.204843 + 0.451355i	0.495663
0.485117	0.485117
-0.097413 - 0.153073i	0.181440
-0.097413 + 0.153073i	0.181440

Note: VEC specification imposes 4 unit roots.

Figure G. 3: Model 4: AR Roots

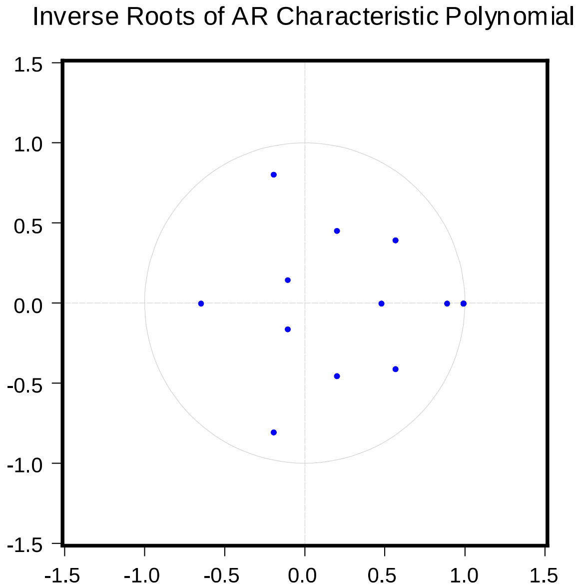


Table G. 13: Model 5: Diagnostic Tests for VAR(1)

Multivariate Specification Test		
Serial Correlation LM Test		
Lags	**LM-Stat**	**Prob.**
1	49.318	0.069
2	36.333	0.453
3	25.644	0.900
4	54.418	0.025
5	35.390	0.497
6	40.696	0.271
7	25.743	0.897
8	33.753	0.576
9	41.928	0.229
10	50.872	0.051
11	38.402	0.361
12	27.316	0.851
Test for Normality		
Jarque-Bera test		0.9814
Test for Heteroskedasticity		
White test		0.3734

Note: 1. The null hypothesis for the LM test is that there is no serial correlation at lag order h (Probs from chi-square with 36 df).

2. The null hypothesis for the normality test is that the residuals are multivariate normal (Orthogonalization: Residual Covariance (Urzua), Prob. From J-B with 182 df).

3. The null hypothesis for heteroskedasticity is that the residuals are homoscedastic (Prob. From chi-square with 273 df).

Table G. 14: Model 5: VECM results

DEPENDENT VARIABLE	ΔLY	ΔLK	ΔLHC	ΔLNOILX	ΔLREX	ΔLIMP
ΔLY_{t-1}	0.274 [1.657]	0.871** [2.382]	0.053 [0.305]	0.443 [0.675]	0.421 [1.167]	0.610* [2.035]
ΔLK_{t-1}	0.048 [0.426]	-0.016 [-0.064]	0.190 [1.582]	-0.122 [-0.271]	-0.447* [-1.803]	-0.095 [-0.462]
ΔLHC_{t-1}	-0.117 [-0.549]	-0.006 [-0.012]	0.889*** [3.944]	1.992** [2.347]	-1.712*** [-3.668]	0.340 [0.877]
$\Delta LNOILX_{t-1}$	0.080 [1.550]	0.073 [0.643]	-0.040 [-0.734]	-0.641*** [-3.132]	0.505*** [4.488]	0.033 [0.350]
$\Delta LREX_{t-1}$	0.085 [1.277]	0.062 [0.421]	-0.007 [-0.098]	0.439 [1.663]	0.503*** [3.463]	0.051 [0.419]
$\Delta LIMP_{t-1}$	0.065 [0.422]	0.005 [0.015]	-0.105 [-0.643]	-0.093 [-0.152]	1.370*** [4.056]	0.233 [0.831]
DUM00	0.152** [2.510]	-0.046 [-0.347]	-0.018 [-0.286]	-0.474* [-1.971]	0.343** [2.593]	-0.080 [-0.728]
ECT_{t-1}	-0.114 [-0.987]	0.210 [0.825]	-0.143 [-1.174]	-0.104 [-0.227]	1.663*** [6.597]	-0.068 [-0.324]
R-squared	0.462	0.234	0.299	0.523	0.645	0.273
Adj. R-squared	0.291	-0.010	0.076	0.371	0.532	0.042
F-statistic	2.701	0.959	1.343	3.445	5.701	1.183
Specification tests (p-values)						
BG $\chi^2(1)$	1.000	0.638	1.000	0.097	1.000	1.000
BG $\chi^2(2)$	0.942	0.518	1.000	0.252	0.798	0.121
JB test	0.648	0.755	0.000	0.844	0.660	0.673
W-het $\chi^2\{8\}$	0.917	0.806	0.014	0.296	0.216	0.668
ARCH (1)	0.772	0.247	0.928	0.794	0.610	0.165
ARCH (2)	0.915	0.105	0.870	0.754	0.768	0.335
ARCH (3)	0.983	0.169	0.749	0.569	0.827	0.549

Note: 1. *, ** and *** indicates significance at 10%, 5% and 1% significance level respectively.

2. The null hypothesis for the Breusch- Godfrey Serial correlation test is that there is no residual autocorrelation.

3. The null hypothesis for the normality test is that the residuals are multivariate normal.

4. The null hypothesis for the White heteroskedasticity test is that the residuals are homoscedastic (White cross terms are not included).

5. The null hypothesis for the ARCH heteroskedasticity test is the absence of ARCH component.

6. t-statistics in [ ], lags in ( ), df in { }

Table G. 15: Model 5: Diagnostic Test for VECM

Multivariate Specification Tests

Residual Portmanteau test for Autocorrelations

Lags	**Q-Stat**	**Prob.**	**Adj Q-Stat**	**Prob.**	**df**
1	13.472	NA*	13.937	NA*	NA*
2	44.935	0.983	47.647	0.965	67
3	86.069	0.886	93.351	0.741	103
4	119.161	0.887	131.534	0.661	139
5	147.819	0.933	165.924	0.677	175
6	180.088	0.940	206.260	0.579	211
7	207.910	0.966	242.550	0.568	247
8	239.096	0.973	285.076	0.454	283
9	260.502	0.993	315.656	0.542	319
10	290.661	0.995	360.895	0.403	355
11	315.343	0.998	399.867	0.368	391
12	326.870	1.000	419.077	0.599	427

Test for Normality

Jarque-Bera test	**JB statistic**	**Prob.**	**df**
	147.57	0.971	182

Test for heteroskedasticity

White test	**Chi-square**	**Prob.**	**df**
	323.581	0.357	315

Note: 1. The null hypothesis for the Portmanteau test is that there is no residual autocorrelation up to lag h.

2. The null hypothesis for the normality test is that the residuals are multivariate normal (Orthogonalization: Residual Covariance (Urzua).

3. The null hypothesis for heteroskedasticity test is that the residuals are homoscedastic.

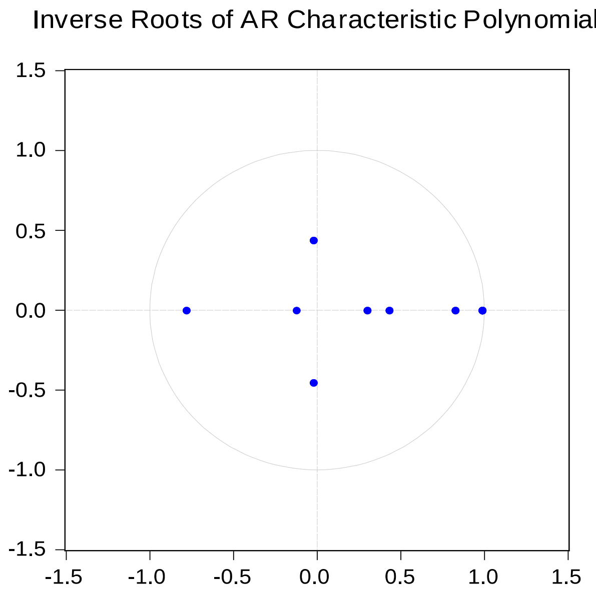
* The test is valid only for lags larger than the VAR lag order and df is degrees of freedom for chi-square distribution.

Table G. 16: Model 5: The inverse roots of the characteristic AR polynomial

Root	Modulus
1.000000	1.000000
1.000000	1.000000
1.000000	1.000000
1.000000 - 1.37e-15i	1.000000
1.000000 + 1.37e-15i	1.000000
0.838093	0.838093
-0.770107	0.770107
-0.010900 - 0.450793i	0.450924
-0.010900 + 0.450793i	0.450924
0.435403	0.435403
0.303689	0.303689
-0.114863	0.114863

Note: VEC specification imposes 5 unit roots

Figure G. 4: Model 5: AR roots



NOTES

[1] The countries under investigation were divided into two groups: The first group consists of 23 countries with a per capita income of above 300 dollars in 1972 and the second group consists of 18 countries with a per capita income of 300 dollars or less in the same year.

[2] In US 1977 dollars

[3] See: Lanne, M., Lütkepohl, H. and Saikkonen, P. (2003) 'Test procedures for unit roots in time series with level shifts at unknown time.' *Oxford Bulletin of Economics and Statistics*, 65(1) pp. 91-115.

[4] See: Pantula, S. G. (1989) 'Testing for unit roots in time series data.' *Econometric Theory*, 5(2) pp. 256–271.

[5] KPSS test with constant and linear trend in the equation shows that LMX and LIMP are stationary at 5% significance level. However, when a constant is included in the equation, all the variables are non-stationary at level. Therefore, ADF, PP, KPSS and SL with structural break show that all the variables under consideration are integrated of order one.

[6] In the second half of 2000, due to the production cuts by OPEC, the oil price increased approximately by 200% comparing with the 1999 level, reaching over US$30 per barrel.

[7] See: Belaunde E., (2001) ‘The 2000 oil crisis and its consequences in the EU energy sector.’ Proc. of Scientific and Technological Options Assessment, Briefing Note 12, European Parliament.

[8] Model 5 for diversified exports is estimated with the inclusion of an impulse dummy variable for the year 2000, as the CUSUMQ plot of the initially estimated ECM for economic growth shows evidence of structural instability. The estimated ECM without the inclusion of the dummy variable is not reported here, but is available upon request.