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布吉納法索出口芝麻的績效與因素

Sesame Seed Exports in Burkina Faso: Performance and Determinants

艾書立

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本論文係艾書立君（R06627028）在國立臺灣大學農業經濟學研究所完成之碩士學位論文，於 2019 年 03 月 01 日承下列考試委員審查通過及口試及格，特此證明。

This is to certify that the Master thesis above is completed by Kafando Wendata Achille (Student ID R06627028) during his/her studying in the Agricultural Economics at National Taiwan University, and that the oral defense of this thesis is passed on 1 March 2019 in accordance with decisions of the following committee members:

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"When times are good, be happy; but when times are bad, consider: God has made the one as well the other. Therefore, a man cannot discover anything about his future" (Ecclesiastes 7, 14). Praise be to the Almighty God for the live He has given to me.

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"**G**oal-**D**etermination-**H**umility-**L**ove"

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Abbreviations

AGR	Average Growth per year
AGSDS	Accelerated Growth and Sustainable Development Strategy
BFA	Burkina Faso
CEP	Comparative Export Performance
ECT	Error Correction Term
FAO	Food and Agriculture Organization
FCFA	Burkina Faso Currency
GDP	Gross Domestic Product
INSD	National Institute of Statistics and Demography (Burkina Faso)
Log	Natural logarithm
NPESD	National Program of Economic and Social Development
OLS	Ordinary Least Square
SSA	Sub-Saharan Africa
SAP	Structural Adjustment Program

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SFCP	Strategic Framework to Combat Poverty
UNCTAD	United Nations Conference on Trade and Development
USD	United State Dollar
VAR	Vector Auto-Regressive
VECM	Vector Error Correction Model
WAEMU	West African Economic and Monetary Union

Abstract

Following recent tremendous growth in volume and value of sesame seed exports from BFA, and with an unequaled performance observed, we deemed it necessary to identify through a co-integration approach the effects of key determinants and their magnitude on sesame exports performance. Purposely, this thesis specified export earnings of sesame seed as the independent variable to analyze the country export performance using time series data for the period of 47 years (1970-2016). One co-integration vector is observed in the system. Thereby the Vector Error Correction Model (VECM) is performed in order to tie the short-run dynamics to the long-run equilibrium.

The empirical results reveal that nominal exchange rate, producer price, world export volume of sesame seed as a proxy of world demand, and world export price are key factors affecting the country's exports performance in the short-run. Moreover, the empirical results show that nominal exchange rate, the production, producer price and world demand are factors affecting positively exports performance of sesame seed in the long-run. However, the effects of producer price and world demand are insignificant. The long-run results show evidence of a significant and negative effect of international prices

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on sesame exports performance in the long-run. Both the negative effects and the insignificant effects could be caused by the unaddressed short-run inefficiencies and development constraints in the sector. Identifying and critically addressing these inefficiencies is necessary for the country to keep its exports competiveness in the future. The Error Correction Term (ECT) adjusts any deviation from the long-run to the equilibrium by 36.86% within a year.

Key words: BFA, Exports of Sesame seed, Determinants, Co-integration, VECM, Granger Causality.

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Chapter I: Introduction

1.1 Introduction

Historically, Sub-Saharan Africa (SSA) is seen as supplier of raw materials, and countries' economies have continued to produce primarily crop for export. These countries have comparative advantage in exporting agricultural commodities due to the low cost of labor, the availability of natural resources and tropical climate. Thus, agriculture is still the most important single activity for the SSA countries, engages almost 80% of the population; contributes on average of 30%-60% of the Gross Domestic Product (GDP) and about 30% of the export earnings Bruntrup et al. (2009). Both industry and services are dependent on the performance of agriculture, which provides raw materials, generates foreign currency for the import of essential inputs and food for the fast growing population. Among the tropical agricultural commodities exported by SSA countries, sesame seed represents an important export product. The seed is widely cultivated across the world; however, it constitutes a major export crop for West and East African countries where the seed is voluminously produced. The major producers of sesame seed in Africa are Tanzania, Sudan, Nigeria, Ethiopia and Burkina Faso (BFA). Their production represents 57% worldwide. The growing demand in the world market for sesame seed and the available capacity to expand production could make sesame seed sector ultimately turn into one of engines of economic growth of African producing countries.

1.2 Background and Motivations

As many other SSA countries, trade liberalization policies were instituted in 1980s in BFA. The persistent decline in economic growth recorded in post mid-1960s led to the

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implementation of trade policy reforms to salvage the economy from collapse. Specifically, BFA implemented the SAP in 1983, which aimed to reposition the economy on the path of desired economic growth. The trade reform in 1983 and its fortification in 2000 by the SFCP, and the adoption of the AGSDS later in 2011 resulted principally in reducing poverty, sustaining the economic growth and diversifying the agricultural sector. Moreover, the principal vision of the current economic program of BFA (NPESD) is still to promote export-led growth through agriculture and to enhance its international competitiveness.

Yet, agriculture remains an important sector of BFA economy and contributes between 35% and 40% of the GDP. The sector engages 80% of the population and is the backbone of economic growth, poverty reduction and sustainable development. Agricultural exports are cotton, livestock products, groundnuts, sesame seed, green beans, shea butter, and fruits among others. In 2016, total exports value of BFA was worth of 2.4 billion USD (20% of GDP), with 37.5% attributed to total agricultural exports (UN Comtrade data). Cotton industry, the first and the biggest industry, alone contributes to 60% to agricultural export earnings. However, the cotton sector is facing many serious difficulties caused by the downward pressure on world prices and internal problems, which partly led farmers to switch in other cash crops production. After the cotton, sesame is considered as the second major cash crop for export in BFA, and the country is one of the world largest producer and exporter. Sesame in BFA is grown entirely under rainfed conditions with little or no use of machinery or modern inputs under the traditional farming system. The seed is cultivated throughout the country but the major growing areas are located in western, central and eastern regions.

The sesame sector is relatively young in BFA, and over the past decade, the sector has been characterized by a tremendous growth caused by the increasing world demand.

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The demand principally comes from the oil industry and the confectionary sector. However, recently the sesame oil is not only for human consumption (cooking), but is also used in cosmetic products (soaps paints, perfumes...), pharmaceuticals, and insecticides. These have induced a surplus of demand for the sesame seed worldwide. Consequently, the increasing world demand of sesame seed induced significant variations in BFA's sesame sector both in production and in exports. Sesame seed is a cash crop and the country exports nearly 80% of its production. According to FAO database total export quantity increased from 20,600 tons in 2007 to 160,000 tons in 2016 (average growth of 22.75% per annual). In terms of value, sesame seed exports value maintained an average growth of 18.5% per year over the decade (2007-2016) and export earnings reached 103 billion FCFA (170 million USD) in 2015. BFA's export markets for sesame are quite concentrated in Asia such as Japan, Singapore, China and South Korea. Within Africa, BFA's performance in the sesame sector (growth in terms of export quantities and value) compared to its major competitors (Nigeria, Ethiopia, Tanzania, Sudan) is unequaled. With nearly 10% in world total export of sesame and with an unequaled performance, BFA ranked eighth and fifth as world and Africa largest exporter of sesame seed in 2016 respectively (FAO database).

Further, according to the Households' Survey on Living Conditions in BFA, carried out in 2003 by INSD it indicated that sesame contributes on average of 1.4% to the household's (farmers) monetary income with a different importance according to the region. This statistic has certainly evolved over the years; however, it points out both the impact that sesame seed export could have in boosting farmers' income, reducing poverty in the rural sector and sustaining the economy growth. **Table 1** below shows sesame exports quantities, values, and share during the period 2012-2016. Sesame exports in 2012-2016 accounted for about 21% of agricultural exports and about 6% of total export,

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on average. In addition, the logCEP[1] for the sesame sector is greater than one, which highlights the competitiveness of the country in exporting sesame. Sesame exports are becoming source of agricultural exports diversification, an emerging economic sector; and one of the leading export commodities in BFA since the cotton sector is facing many difficulties. Despite the double-digit contribution of sesame exports to the earnings of agricultural exports and its impacts on farmers' income, there has been no study conducted to investigate the factors that determine sesame exports in the country. It turs out to be relevant to ask these questions are: what are the factors that determine sesame seed exports in BFA? , and what can be done to enhance the earnings of sesame exports for BFA? Concisely, this study intends to answer these questions.

Table 1. Sesame export quantities and values of BFA (2012-2016)

Years	**Quantity (ton)**	**Value (1000 USD)**	**Unit value ($/Ton)**	**Share in agricultural exports %**	**Share in total exports %**	**Export performance logCEP**
2012	98 754	89 469	906	20.64	4	4.80
2013	113 093	163 803	1448.4	27.73	7.12	4.97
2014	94 889	132 379	1395	19.00	5.10	4.56
2015	171 461	169 857	990.7	22.34	12.13	5.28
2016	159 837	113 363	709	16.35	4.72	4.87
Average	127 607	133 774	1048	21.21	6	4.90

Source: Own compilation based on FAO database, October 2018 (www.fao.org)

[1] CEP: Comparative Export Performance $= \frac{X_{iB}/X_B}{X_{iA}/X_A}$
X_{iA}: value of world exports of sesame seed, X_{iB}: value of sesame seed exports from BFA,
X_B: total value of agricultural exports from BFA, X_A: total value of world agricultural exports

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1.3 Objectives and Outline

This paper attempts principally to identify and quantify the effects of possible factors that affect sesame exports in BFA through the application of the co-integration analysis. The study sources to achieve the following specific objectives:

1- To identify key external and internal factor-drivers of sesame exports in BFA for the period 1970-2016

2- To quantify the effects and analyze the magnitude of these factors on export performance

3- To inform relevant policy prescriptions and agricultural trade recommendations based on the findings.

This paper is structured into six chapters. The following chapter i.e. second chapter presents an overview of sesame seed production and trade across the world (production, export and import, with an emphasis on Burkina Faso). The third chapter goes through the literature on the determinants of agricultural exports while stressing on factors affecting agricultural exports in SSA. The fourth chapter presents the methodology used in this study, model specification and justifies the variables employed. The fifth chapter tables the empirical results, interprets and discusses. Finally, the sixth chapter comes up with concluding remarks and proposes some policy recommendations.

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Chapter II: An overview of sesame seed production and trade across the world

2.1 Agronomic practices, different uses and worldwide trend of sesame seed Production

Sesame (Sesamum indicum L. 2n=26), member of the family Pedaliaceae, is known as one of the oldest and the most traditional oilseeds crop to mankind (Raemaekers, 2001). It is an annual crop with quadrangular stem, which height varies between sixty (60) and two hundred (200) centimeters depending on the variety. The seeds have been growing in tropical regions (hot and humid) with temperatures around 27 Celsius degree and precipitation of 625 -1100mn. The crop is intolerant to water logging (excessive rainfall) or poor drainage, and can be grown on soil types ranging from fertile soils to sandy soils. Sesame seeds color varies from white (cream-white), yellow, red, to brown but it is mainly white or black and is highly valued for its high-quality seed oil. The production of sesame is for oil and margarines. Particularly, the crop contains up to 60% oil of a very high quality and up to 25% protein. Sesame seeds are used whole or processed to produce oil and meal while in Africa sesame seeds are made into porridges and soups (Gooding, Murdoch, & Ellis, 2000). The quality of oil is determined by the fatty acid compositions of the total oil. Its oil is used for salad and cooking dishes. Moreover, the oil is especially important in the Far Eastern cuisine, mainly Japan and china.

World production of sesame seed is estimated by FAO at 6.1 million metric tons in 2016, an increase of 68.5% based on year 2007 (**Table 2**), with declines observed in 2015 (-4.6%) and 2016 (-1.6%). Over the decade (2007-2016), world production of sesame seed is increasing with an average growth of 5.35% per year. The increase in world production is mainly due to an extension of cultivated area given that, on average, yield

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rarely exceeds 500kg per hectare for most producers. Asian countries are generally the largest producers of sesame seed. From 2007 to 2016, on average, Myanmar, India and China are the world largest producers of sesame seed (**Table 2**). These three countries shared 43% of global production worldwide. They are followed by African countries i.e. Tanzania, Nigeria and Ethiopia, which as a whole shares 30% of worldwide production. It should be noticed that data about Sudan are not completely available since the countries is divided into two independent countries (Sudan and the South Sudan), and for this reason, Sudan data are not included in this analysis. According to FAO data, the volume of sesame seed produced in Africa represents between 50% and 55% of worldwide production since 2012. Asian production of sesame seed (grouped by India, Myanmar and China) is declining due to land scarcity principally in countries such as India and China. In addition, in these countries sesame seed productivity/yield is decreasing due to changing climate patterns, and also due the cultivation of more diversified cash crop (e.g. Myanmar) Raitzer et al. (2015). For instance, the three Asian largest producers; Myanmar, India and China totalized 37% of world sesame seed production in 2016 compared to 54% in 2009.

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Table 2. Worldwide Trend of Sesame Production and Major Producers 2007-2016 (measured in ton)

*AGR = Average growth per Year

Year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Average**	**AGR%**
World	3627068	3725531	3865092	4321616	4712193	5406592	6005553	6529085	6172368	6111548	5047664.6	5.35
India	756900	64030	588400	893000	810000	685000	715000	828000	850000	797700	756430	0.52
Ethiopia	149388	186772	260534	327741	244783	181376	220216	288770	302273	267867	242972	6.00
Tanzania	155794	46767	90000	144420	357162	456000	1050000	1113982	1174589	940221	552893.5	19.70
Nigeria	117700	121610	119710	149410	229167	994800	584980	434990	432900	460988	364625.5	14.63
Myanmar	701100	840000	790100	787400	832100	794600	817100	801600	828270	812952	800522.2	1.50
China	557537	586701	622905	587947	605770	639989	624831	632108	642427	649589	614980.4	1.54

Source: FAO database, October 2018 (www.fao.org)

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2.2 World Major Exporters and Importers of sesame seed

Since 2000s, world export of sesame seed or world sesame seed supply have been increasing steadily and ragged between 25% and 30% of total world sesame seed production. Between 2007 and 2016, world export volume or world demand of sesame seed has been increasing at a growth of 6.28% per year (**Table 3**). Nonetheless, on detailed level, world export volume showed certain variability because of year-to-year rainfall fluctuations and other natural factors. India, Ethiopia, Nigeria, BFA, Tanzania, Myanmar and China are the seven larger exporters of sesame seed in the world between 2007 and 2016. These seven countries share 65% of world market of sesame seed. Moreover, in recent years the global supply of sesame seed is quite concentrated in Africa that shares more than 55% of global export market (FAO database, 2018).

On the other hand, and historically China, Japan and Turkey are the world largest importers of sesame seed. As indicated in **table 4**, they are still the world largest importers of sesame seed and share 54% of world import market. During the period (2007-2016), the average growth per year of for China's imports (15.70%) exceeded that of the world (6.72%). However, Japan recorded a slight decrease in quantities imported over the period, which can be explained partly by some fluctuations in the production of its suppliers. Based on ICT trademap data, the concentration of supplying countries in the main importing markets is quite strong. Typically, 70% of China's imports of sesame seeds is supplied by three countries and this proportion is 75 % for Turkey imports. The sesame market appears to be concentrated in view of the large number of importing countries.

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Table 3. World export volume and major exporters of sesame seed between 2007 and 2016

	Total cumulated from 2007 to 2016	Unit	Share %
World	14,302,469	tonne	100
India	3,066,242	tonne	21.43
Ethiopia	2,535,678	tonne	17.8
Nigeria	1,305,199	tonne	9.12
BFA	846,459	tonne	6.00
Tanzania	815,133	tonne	5.70
Myanmar	467,022	tonne	3.26
China	306,040	tonne	2.14

Source: Own compilation based on FAO data, October 2018 (www.fao.org)

Table 4. World import and major importers of sesame seed between 2007 and 2016

	Total cumulated from 2007 to 2016	Unit	Share %
World	14,531,934	tonne	100
China	4,606,446	tonne	31.70
Japan	1,614,535	tonne	11.11
Turkey	1,619,741	tonne	11.14
South Korea	746,782	tonne	5.13
Israel	475,657	tonne	3.27

Source: Own compilation based on FAO data, October 2018 (www.fao.org)

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2.3 Sesame seed sector in Burkina Faso

The diversified agro-ecology of BFA makes the country suitable for sesame production. Sesame is both a secondary crop and a cash crop for most farmers in BFA, and is grown throughout the country either in pure culture (82% of parcels) or in association with other crops (groundnuts, beans etc.). The sesame sector in BFA is a relatively young sector that has been characterized by a tremendous growth over the past two decades both in terms of area and production volume (**Table 5**). Total production stepped up from 18,802 metric tonne in 2007 to 230,000 tonnes in 2016, corresponding an average growth of 28.45% per year. This is an outstanding performance among Africa's larger producers given that Nigeria, Ethiopia and Tanzania recorded an average growth of 14.63%, 6% and 19.70% per year respectively during the same period. In 2016, BFA was the second in West Africa, the fifth in Africa and the eighth largest producer in the world, with production representing respectively 28%, 7% and 4%. Nevertheless, BFA recorded a low yield in sesame production compared to other producing countries which was averagely 603 kg/ha. Further, the production was characterized by a strong variability over the period; which is mainly due to the rainfall conditions and the adjustment between sesame and cotton acreage. However, sesame seed production in BFA possesses promising aspects including good future prospects; land suitability for sesame production; abundant labor, and a growing amount of sesame research and development.

BFA exports nearly 80% of its total production on average (FAO data). **Table 6** shows a rising trend for both export quantities and exports value of sesame seed. Over the decade (from 2007 to 2016), BFA's export quantities and exports value of sesame seed recorded respectively an average growth of 22.75% and 18.5% per year. There have been some fluctuations as the case of global trend but the export performance of the country is

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well above the global average (6.28%). Comparatively, from 2007 to 2016, the average growth of sesame seed export quantities was 10.6%, 7.72% and 18.30% per annual for Ethiopia, Nigeria, and Tanzania respectively; while that of export value was 11.20%, 12% and 22.5% respectively.

On the other hand, the top market destinations of BFA's sesame seed are Singapore, China, and Japan in Asia; Togo and Ghana in West Africa based on the total volume of sesame seed imported by these countries from 2007 to 2016 (**Table 7)**. Taken the cumulative from 2007 to 2016, Asian market (Singapore, China and Japan) shares 58%, 62.5% of BFA's exports quantity and value respectively. Chinese's market recorded the fastest growth value in importing BFA's sesame seed up to 58% between 2011 and 2016 (ICT data, 2018). Togo and Ghana account for about 29% of BFA's exports market; however, this proportion might related to the fact that Togo and Ghana are countries with ports serving BFA to export.

Table 5. BFA's sesame production trend from 2007 to 2016 (area in hectare and production in ton)

*AGR = Average Growth per Year

Crop Year	Area (Ha)	Production (MT)	Yield (MT/Ha)
2007	55 058	18 802	0.3415
2008	91 997	51 924	0.5644
2009	93 384	56 252	0.6024
2010	125 471	90 649	0.7225
2011	120 750	84 759	0.7019
2012	165 575	100 488	0.6069
2013	203 449	137 347	0.6751

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2014	506 095	321 837	0.6359
2015	400 000	235 000	0.5875
2016	390 000	230 000	0.5897
Average	215 178	132 706	0.6028
AGR%	21.62	28.45	

Source: Own compilation based on FAO data, October 2018 (www.fao.org)

Table 6. Trend of BFA's sesame seed export from 2007 to 2016

*AGR = Average Growth per Year

Year	Export quantity (Metric Tonne)	Export value ($ million)
2007	20 600	20 898
2008	21 331	25 056
2009	49 518	47 524
2010	61 298	55 791
2011	58 650	56 730
2012	98 754	89 469
2013	113 093	163 803
2014	94 889	132 379
2015	171 461	169 857
2016	159 837	113 363
Average	84 943	87 487
AGR %	22.75	18.5

Source: Own compilation based on FAO database, October 2018 (www.fao.org)

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Table 7. Major market destinations of BFA's sesame seed from 2007 to 2016 (quantity in metric tonne, value in $ million)

	Exported quantity from 2007 to 2016 (MT)	Export value from 2007 to 2016 ($ million)	Share %	
			In quantity	In value
BFA total	849 430	874 870	100.00	100.00
Singapore	232 386	274 653	27.35	31.40
China	152 675	150 978	18.00	17.25
Togo	133 346	82 172	15.70	9.40
Ghana	114 962	123 832	13.53	14.15
Japan	106 945	120 459	12.60	13.77

Source: Own compilation based on ICT data, October 2018 (www.trademap.org)

2.4 Market Opportunities and Tariff Advantages for BFA

Based on ICT trademap data, BFA has a yearly export potential untapped of sesame seed. The markets with greatest untapped potential for BFA's exports of sesame seed are Japan, China, Egypt, Turkey, Germany and France. These markets, as a whole, show the largest absolute difference between potential and actual exports in value terms, leaving room to realize additional exports worth of 32 million USD yearly. Ultimately, it is important for BFA to intensify sesame production, increase quality and diversify market destinations in order to take advantage of this untapped potential.

In terms of tariff advantages, analysis from Trademap data showed that tariffs are practically the same in the exporting markets of sesame seed. It can be seen from **table 8** that BFA and other competitors face the same tariffs in the markets. However, BFA is disadvantaged in China's market compared to others competitors such as Ethiopia and

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Tanzania which face 0% tariffs. Ultimately, bilateral trade negotiation could help to remove the tariff faces by BFA in China's market.

Table 8. Target markets tariffs on sesame seed

Countries	**Average tariffs faced**			
	BFA	**Nigeria**	**Ethiopia**	**Tanzania**
Singapore	0%	0%	0%	0%
China	5%	5%	0%	0%
Japan	0%	0%	0%	0%
Turkey	12.5%	12.5%	12.5%	12.5%

Source: www.trademap.org (October, 2018)

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Chapter III: Literature review

2.1 Theoretical modeling on export determination

The technological approach of trade pioneered by the classics and their proponents explain that, specialization of countries in international trade can be explained by differences in productivity in these countries. The theory of absolute advantage developed by Adam Smith in 1776 expresses the idea that a country gains to specialize in the production and export of products for which it has an absolute advantage, i.e. conditions of production better than the other countries. However, David Ricardo (1817) criticized the principle of absolute advantage, which is neither necessary nor sufficient for mutually beneficial trade Krugman et al. (2009). The concept of comparative according to David Ricardo (1817) is that, the exchange between two countries is favorable to each of them from the moment the relative cost (or opportunity cost) of produced goods differs. The model developed by Ricardo assumes constant productivity with only one factor of production (labor), and therefore constant opportunity cost that leads to complete specialization. However, international trade is a result of other factors of production such as capital and natural resources, which are can be source of comparative advantage. In order to respond to the limited classical approach in explaining international trade, the HOS theorem (developed by Hecksher (1919) and Olhin (1933), perfected by Samuelson) stressed that international exchange results from the abundance or scarcity of production's factors (capital, labor, land). According to the HOS theorem, a country possesses a comparative advantage in the production of a commodity that uses the relatively abundant resource in that country more intensively. International trade must lead to a tendency to level prices of these factors: trade will level what was scarce and expensive.

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In the perspective of comparative advantage, international trade would result in automatic way and static differences in productivity or factor endowments. In that sense, it will be impotent for a country, which is endowed in labor and deficient in capital to voluntarily invest in capital and thereby increase its production. The static approach of the international trade is unrealistic in its assumptions (perfect competition, constant returns, stability of trade and industrial policies…), and presented inconstancies in empirical work (Carbaugh (2002) cited by Anaman and Mahmod (2003)). In addition, in the analysis of factors endowment, the context of imperfect competition and the presence of economies of scale cannot hold neither as assumptions nor a condition created by the factor endowment. Because, a potent industrial policy or a proactive government that puts up better policies (in infrastructure or education sector) can lower production costs thereby providing economies of scale to the country. The existence of dynamic economic factors such as large domestic market (demand), and/or some policy-induced accessibility to a larger market outside the country (for example due to customs union) can lower production cost and may boost or create a comparative advantage (Linnemann, 1966), (Hong, 2000). It follows that comparative advantage based on resource endowment like capital or labor cannot longer explain international trade. These comparative advantages are neither static nor automatic and can be created voluntarily or provoked.

2.2 Empirical modeling on agricultural exports

In developing countries, international trade is often motivated by the accessibility of foreign markets and the capacity to supply. However, the supply of primary export of developing nation is price inelastic (i.e. the quantities supplied do not respond very much in their price) because of international rigidities, the instability of the international demand and inflexibilities in resource used in most developing nations specially in case

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of agricultural products that involve long gestation periods. The supplies of developing nations are unstable or swinging because of weather conditions, pests, and other climatic hazards. Large exporters (usually large landowners or large farmers) and medium- sized local business engaged in foreign trade stand to benefit the most. Huge benefit to exporters will encourage them to supply more. Therefore, foreign exchange rate system of the country will determine the export supply of that country (Salvatore, 2008). The effect of exchange rate on export depends on the price elasticity of export supply because real exchange rate should incorporate the price effect on export. Thus, the higher the price elasticity, the more competition face exports of a particular country on the world market (Roshan, 2007).

Models developed latterly on international trade provide a foundation for investigating the importance of supply capacity in determining the export performance of a country. Supply capacity depends on local conditions; factors that affect the supply capacity may include location related elements that could affect the access to raw materials and other resources. It may also depends upon determinants such as infrastructure, labour costs, and capital. Even with factor endowments, these costs are primarily the outcome of economic policy and the access to technology that is likely to affect productivity can be another determinant of supply capacity (Fugazza, 2004). In addition, according to the endogenous growth theory, countries with a large domestic market can grow faster because of economies of scale. The point is that, countries with population spread (proxy of a large domestic market) over large geographical areas can gain from distinct regional specialization, by extension, to a large mix of national export diversification (Barro & Sala-i-Martin, 2004).

Furthermore, institutional factors mentioned by UNCTAD (UNCTAD, 2005) study could affect export sector development at early stage. UNCTAD study has been carried

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on a short period of time (1988-1991) and therefore could have some limits in emphasizing significantly the contribution of institutional factors at such a stage. Because, these factors are related to the general macroeconomic environment and the contribution of Foreign Direct Investments (FDI). However, the study indicated that institutional factors matter more at a higher level of export. The quality of institutional framework comes in as an essential competitiveness ingredient and better institutions are expected to guarantee better protection of property rights, which becomes essential as production becomes more and more capital-intensive. UNCTAD's study also pointed out that infrastructural development in any country, especially in developing countries, would reduce production costs, increase efficiency and productivity and thereby to maximize export profitability. Adequate infrastructure, especially in developing countries, comes with a very strong stimulus to private sector development and product diversification. Thereby, good infrastructure is a necessary condition for foreign investors to operate successfully and boost exports (Wheeler & Mody, 1992).

2.3 Factors affecting agricultural exports in Sub-Saharan Africa

Determinants of agricultural exports in SSA countries are still a controversial issue in economics, and studies on the determinants of agricultural exports in developing countries produced mixed results. In general, export sector is affected by multiplicity of factors in low-income countries especially in Sub-Saharan African countries. Fugazza (2004) as Allaro (2011) classified determinants of export performance into external and internal, where external factors are related to market access conditions and other factors affecting import demand. Apart from trade barriers and competition factors foreign market access is also determined by transportation costs, which include geography and

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physical infrastructures. On the other hand, internal/domestic factors refer to supply side conditions or factors affecting supply capacity such as domestic policies.

Several studies have been conducted so far towards determining drivers of exports for various agricultural commodities in SSA and have yielded quite interesting findings in economic, business and trade literature. As a key supply side determinant, higher level of production has been found as an important factor for stimulating exports in many studies on export trade (Bertil, 1968). In an open economy, increased production offers an opportunity for export development through surpluses, which consequently earn foreign exchange, revenue and taxes for the exporting country. The rich and cultivable land availability (factor endowment) enables BFA to specialize in tropical products exportation (e.g. sesame seed) in which it has advantage comparative in the production. BFA having adopted a more liberal trading environment (open economy), increased production of sesame seed a priori expected to yield beneficial implications for exports performance. This expectation is in line with Ngeno (1966), Boansi (2013) and Boansi et al. (2014) which revealed that the production is a key factor affecting significantly export supply.

In the same vein, Boansi et al. (2014) conducted a study on Chad cotton exports by using the VECM. The author used external and supply side factors for a period of 31 years and discovered that, world export (proxy of world demand) volume of the commodity under study and the export competiveness (measured by comparative export performance index) of the product significantly determine cotton lint exports from Chad and Mali. Anwar et al. (2010) using the VECM on cotton lint exports in Pakistan including similar variables as Boansi et al. (2014). The study revealed that the export of cotton lint is positively driven by increasing world demand for cotton and export competitiveness of the country. Similarly, Kumar et al. (2007) in a study using the same variables as Anwar

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et al. (2010) concluded that a one percent increase in volume of world export volume of the commodities under study leads to a 5.96 percent increase in demand for exports from India.

As stated by Dercon (1993), prices generally serve as conduct through which relevant economic policies can affect agricultural variables such as production, exports supply and income. In investigating the determinants of export growth in Uganda for the period 1987-2006, using the co-integration analysis, Agasha (2009) found a positive effect of foreign export prices on export performance in the short-run. However, an unexpected sign was found between foreign prices level and exports in the long-run. Edward (2004) studied on the determinants of agricultural exports using the gravity model in South Africa. The author found significant and positive effect of foreign export prices on export supply of South Africa. In addition, Allaro (2011) conducted a study on oilseed exports performance in Ethiopia using the VECM and the author ended with a positive effect of foreign export prices on oilseed exports in the short and long-run. Ndulu and Lipumba (1990) in Tanzania revealed that foreign prices of primary commodities significantly affect the export performance of country's involved in their production.

Moreover, a good producer price matching with foreign export price has a positive impact on the agricultural export earnings. Tijani et al (1999) conducted a study on export supply in Nigeria using the co-integration approach. The empirical finding revealed that producer price has a long-run equilibrium relationship with the cocoa exports in Nigeria, and high producer price leads to accumulation of ample revenue to producers. The author concluded that high price induces producers to increase production of the given product and thus assures the supply and availability of products to export.

Likewise, various studies have also shown domestic exchange rate depreciation (foreign exchange rate appreciation) makes export products cheaper in the international

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market resulting into their increased demand. Fang et al (2006) analyzed the impact of exchange rate depreciation on exports for eight Asian economies and they found that depreciation contributes to exports performance for most countries. In addition, the study of Edward (2004) on the determinants of agricultural exports using the gravity model in South Africa found a positive association between nominal exchange rate and agricultural exports. The study conducted by Allaro (2011) using the VECM in Ethiopia found a positive effect of nominal exchange rate on oilseed exports in the short and long-run. Contrary, Amoro et al (2012) in a study on the determinants of agricultural exports in Cote d'Ivoire using the Ordinary Least Square, found a significant and negative effect of nominal exchange rate on cocoa and rubber exports in Cote d'Ivoire. This means that a devaluation of the nominal exchange rate of a country produces the same effects as the depreciation and enable an increase of its export products. For this reason, WAEMU[2] in 1994 devaluated the Union's currency, which aimed to stimulate the exports and competitiveness of the member States.

So far, in the literature, various variables have been identified as factors affecting agricultural exports in developing countries. In as much as some of the findings conform with economic and trade theories, others either are mixed signals or tend to disprove existing theories. However, in either case, knowing the factors that affect agricultural exports is key to drafting and implementing appropriate policy measures to further stimulate exports and boost social and economic development in SSA and particularly in BFA.

[2] West African Economic and Monetary Union (Benin, Bissau Guinea, Burkina Faso, Ivory Coast, Mali, Niger, Senegal and Togo are member States)

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Chapter IV: Research Methodology and Data

4.1 Analytical Framework

After trade liberalization, numerous actions and studies have been taken to estimate the responses of production and export supply in various industries, aiming to frame policy decisions in developing countries and worldwide. Throughout such analytical works, the co-integration approach has received an important attention in economic, business and trade literature. Contrary to other techniques used to estimate supply and production responses such as panel and gravity model, the co-integration technique is superior and helping to estimate both short-run and long-run dynamics of changes in relevant development variables (C. J. Granger, 1986). The Engle-Granger two-step estimation technique (Engle & Granger, 1987), the Phillips-Ouliaris residual-based test (Phillips & Ouliaris, 1988) and the Johansen Full Information Maximum Likelihood test (Johansen & Juselius, 1990) are three principal approaches suggested in the literature for executing co-integration analysis. However, the Engle-Granger two-step estimation technique is unperfected by small-sample biases even though it is proven simple. This imperfection is partly due to the fact that, estimating long-run coefficients in the first stage, the technique nearly ignores short-run dynamics, thus performing short-run coefficients that are unguided by long-run estimates (Stock, 1987). Despite the many variables that a system might have, the Engle-Granger two-step estimation technique and the Phillips-Ouliaris residual-based test cling to the assumption of a single co-integrating equation between variables. This does not consider the reality since the relations between economic variables can exhibit n-1 number of co-integrating equations among n variables. The Johansen Full Information Maximum Likelihood test through its approach of co-

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integration addresses suitably the drawbacks of the Engle-Granger two-step estimation technique and the Phillips-Ouliaris residual-based test.

In empirical studies, the VECM through Johansen co-integration technique is theoretically driven approach useful for estimating both short and long-run effects. Allaro (2011) used the Johansen co-integration technique to study on export performance of oilseeds and its determinants in Ethiopia for the period 36 years. The author found evidence of long-run equilibrium between the system's variables. Karim (2015) in modeling factors constraining sesame exports in the Sudan used the Johansen co-integration approach for the period of 44 years, and the author found evidence of long-run equilibrium between the system's variables. Other studies such as Boansi et al. (2014) in Mali; Idsardi (2010) in South Africa; J Kingu (2014) in Tanzania also used the VECM through Johansen co-integration technique to analyze agricultural commodities exports. The Johansen Full Information Maximum Likelihood estimator requires specification of the complete model and the basis of asymptotic theory; it appears to be the best estimator (Goldstein & Khan, 1978). Since the main interest of this study is to determine empirically the factors that explain the exports of sesame seed in BFA, the Johansen co-integration approach suitably will be adopted.

4.2 Empirical Model Specification and Definition of Variables

This study focuses on investigating the factors that determine the export earnings of sesame seed in BFA. Lütkepohl et al. (2004) propose to use relevant variables when using the co-integration technique even if the system will contain few variables Therefore, from the literature; possible factors have been identified relevantly according to data availability. The export supply models for the various crops are modelled following from Goldestien and Khan (1978) adopted and used in numerous studies such as Islam et al.

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(1989), Lukonga (1994), Anagaw et al. (2001), Allaro (2011) and J Kingu (2014) . Suitably, the model used in this paper is expressed as fallow:

Xearnings = f (Exchrate, Prod, Pdprice, Wexprice, Wexpvol) (1)

At estimation stage, taking log-linear of the variables in equation (1) and differentiating with respect to time gives as:

$$logXearnings_t = \beta_o + \beta_1 logExchrate_t + \beta_2 logProd_t + \beta_3 logPdprice_t + \beta_4 logWexprice_t + \beta_5 logWexpvol_t + \varepsilon_{it} \quad (2)$$

Where β are parameters, ***t*** is time, ε_{it} the error term and:

- ***logXearnings$_t$*** (export earnings of sesame seed, measured in USD) is the log of export earnings. It is the dependent variable since the research intends to investigate the factors that determine BFA's export earnings of sesame seed. Karim (2015) and J Kingu (2014) specified export earnings as dependent variables for studies on export determinants of sesame and cotton in Ethiopia and Tanzania respectively. In addition, the variable, export earnings of sesame seed is preferred (and not export quantity) to measure systematically the performance of the sesame sector.

- ***logExchrate$_t$*** is the log of the nominal exchange rate (USD to FCFA) and the more the local currency (FCFA) depreciates (or appreciation of international currency, USD), the more exports performance improves. In other words, the nominal exchange rate captures the average effect of the dollar variations on sesame export earnings. Edwards et al. (2004); Amoro et al. (2012) and Allaro (2011) included nominal exchange rate to investigate the determinants of agricultural exports respectively in South Africa, Cote d'Ivoire and Ethiopia. A positive correlation ($\beta_1 > 0$) is expected between sesame seed export earnings and the nominal exchange rate.

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- ***logProd$_t$*** is the log of the production (quantity produced of sesame seed measured in ton). Being a key variable, it is included to measure the effects of the supply on export earnings of sesame seed. Following Ngeno (1966), Boansi (2013) and Amoro et al. (2012) it is expected that an increase in quantities produced (through yields or area) will have a positive effect on export earnings ($\beta_2 > 0$)

- ***logPdprice$_t$*** (log of producer average price, measured in USD/ton) and ***logWexprice$_t$*** (log of world export price or foreign price, measured in USD/ton) are included to measure the effect of prices' variation on export earnings of sesame seed. Allaro (2011) included producer price and foreign price as world export price in evaluating the factors that affect sesame export performance in Ethiopia. Ceterus paribus, it is anticipated that any increase either in producer average price or in world export price will increase export earnings of sesame seed ($\beta_3, \beta_4 > 0$). World export price is calculated as it follows:

$$\text{Wavprice} = [(\text{world export value}) / (\text{world export volume})] \times 1000 \tag{3}$$

- ***logWexpvol$_t$*** is the log of world export volume (a proxy of world demand of sesame seed). Following Anwar et al. (2010), Kumar et al. (2007), Edwards et al. (2004) and Boansi et al. (2014); world export volume of sesame seed stands to capture the effects of international trade or world demand of sesame seed on BFA's export earnings. An increasing world demand of sesame seed is anticipated to positively affect export earnings ($\beta_5 > 0$).

4.3 Regression Technique: Johansen Co-integration approach

In adopting the Johansen co-integration approach, two requirements must be satisfied for variables to be co-integrated, i.e. an equilibrium relationship exists. First, the time series data for each variable involved should exhibit similar statistical properties, that is, be integrated to the same order; and second, a stationary linear combination must

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exist (Malik, 2010). These requirements must be satisfied because most economic time series data are flawed by non-stationarity and time volatility; and any regression on these series may produce spurious, meaningless and irrelevant results (C. W. Granger & Newbold, 1974).

i) Stationarity test

A stationary time series (free of unit root) is thus a series in which the mean, variance and covariance remain constant over time or in other words do not change or fluctuate over time and there may be an equilibrium relation between these series (Wooldridge, 2015). Moreover, a non-stationary time series can become stationary after differentiated *p* times; and is said to be integrated of order *p*, noted *I(p)* (Gujarati, 2009). To test for stationarity, this study uses the Augmented Dickey-Fuller (ADF) (1979, 1981) test, which is most notable and commonly used. The general regression equation in performing the stationarity test is stated in the following form:

$$\Delta Y_t = \beta_0 + \beta_1 t + \rho Y_{t-1} + \sum_{i=1}^{m} \gamma_i \Delta Y_{t-i} + \varepsilon_{it} \quad (4)$$

Where, β_0 and *t* are respectively the constant and the time trend, *m* is the lag order of the autoregressive process, $\Delta Y_t = Y_t - Y_{t-1}$ are first differences of Y_t, Y_{t-1}, ΔY_{t-i} are changes in lagged values, and ε_{it} is the white noise. In practice, the ADF test can be carried out either with a constant and trend, or with constant and drift on the variable in level or differentiated form. The unit root is tested by setting:

H_0: $\rho = 0$; the time series Y_t is not stationary (presence of unit root) and

H_1: $\rho < 0$; the time series Y_t is stationary (absence of unit root)

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The ADF is a lower-tailed test; so if the test statistic is less than the chosen critical value, then the null hypothesis of unit root is rejected and the series is stationary. If the test statistic is greater than the chosen critical value, then the null hypothesis cannot be rejected and the series has unit root.

ii) Johansen's Test of co-integration

The Johansen approach to co-integration analysis begins with the definition of a vector auto-regression given as follows:

$$Y_t = \sum_{i=1}^{p-1} \Gamma_i Y_{t-i} + \varepsilon_t \tag{5}$$

Where *Yt = (Kx1)* vectors of I *(1)* variables. Γ_i represents *(KxK)* matrix of parameters, and ε_t is a *(Kx1)* vector of normally distributed errors that is serially uncorrelated but has contemporaneous covariance matrix *π*. Johansen's procedure relies on the rank of Γ and its characteristics roots. However, in practice, the test for the number of co-integrating equations is performed using the two Johansen's likelihood ratio (LR) test. These are the Trace test statistic and the Maximal-eigenvalue test. The Trace test statistic is expressed as follows:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{k} ln(1 - \lambda_i) \tag{6}$$

Where $\lambda_{r+1} \ldots \lambda_n$ are the *(K-r)* smallest estimated Eigen values, and *T* the number of observations. The trace test attempts to determine the number of co-integrating vectors between the variables by testing the null hypothesis (H_0) that $r \leq 0$ against the alternative (H_1) that $r > 0$ or $r \leq 1$ (*r* equals the number of co-integrating vectors).

The Maximal-eigenvalue test statistic is expressed as follows:

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$$\lambda_{max}(r, r+1) = -T \ln(1-\lambda_{r+1}) \qquad (7)$$

The Maximal-eigenvalue test separates tests on the individual eigenvalues for a null hypothesis that the number of co-integrating vectors is *r*, against an alternative of *r+1*.

iii) The Error Correction Model

Once the co-integrating relationships between variables is confirmed, the vector auto-regression (VAR) model as specified in equation (5) is inappropriate. A special parameterization that supports analysis of Johansen co-integration structures must be considered. The resulting model after subtracted Y_{t-1} on both side of equation (5) is called vector equilibrium model or Vector Error Correction Model (Lütkepohl et al. (2004)), and is stated as fallow:

$$\Delta Y_t = \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \prod Y_{t-p} \ \varepsilon_t \qquad (8)$$

Where the series Y_t and the matrix $\prod Y_{t-p}$ are stationary at level *p (p = 1, 2...n)* in order for the equation to be valid and meaningful. Moreover, the matrix $\prod$ can be decomposed into two sub-matrices i.e. α and β' . The term α is the Error Correction Term or the rate at which deviations from long-run equilibrium are adjusted and β' contains r co-integrating vectors. In equation (8), Γ_i contains short-run dynamic terms while $\prod$ represents long-run estimates.

4.4 Sources and Descriptive Statistic of the data

This study uses quantitative and qualitative data that are time series data covering 47 years, from 1970 to 2016. These series are secondary yearly data collected from various sources. Export earnings of sesame seed, world export price of sesame seed,

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world export volume of sesame seed data are entirely collected from FAO open data. Data on producer price are compiled from FAO data. However, data on producer price are completed from the Statistical Yearbook of INSD (Institute of National Statistics and Demography, INSD BFA). Moreover, data on nominal exchange rate are gathered from World Bank Indictor open data.

Before we provide the econometric analysis, the study gives a brief statistical description of the data. The **table 9** below reports the descriptive statistic of the data used. The average export earnings of sesame seed is 20.27 million USD, and from 2009 to 2016 export earnings have been above its mean value. The mean value of producer price is USD 538/ton, and since 2006, producer price is above its mean value. On average, the official exchange rate (USD to FCFA) is 416.10 FCFA annually. However, from 1994 onward, exchange rate value evolved above its mean value. This could attributed principally to the devaluation of the national currency (FCFA), which happened in January 1994. Sesame production in BFA averages 36000 tons per year over the period. From 1970 to 2007, production has been below its mean value, but after that period onward, the production of sesame seed experienced tremendous increase above its mean value. This drastic increase in production can be attributed to the fall in international prices of cotton, which led farmers to switch in producing more sesame seed in order to secure their income. In fact, farmers' decisions to extend sesame production is likely to be affected by the cotton price level of the last period. In addition, the increased production is a response of the increasing world demand and its price. On average, world export volume of sesame seed (proxy of world demand of sesame seed) is 663393 tons annually. The global demand evolved above its mean value since 2000s, while world price of sesame seed averages 826 USD per ton. Over the period, both world demand and world price have been increasing steadily. Since BFA is a major producer and exporter

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of sesame seed, the increasing world demand affected tremendously the country production and its exports of sesame seed.

Table 9. Statistical Description of the data

	Xearnings	**Exchrate**	**Prod**	**Pdprice**	**Wexprice**	**Wexpvol**
Mean	20270021.00	416.09	35895.32	538.04	825.94	663393.85
Max	169857000.00	733.03	321837.00	2451.15	2059.36	1895582.00
Min	318000.00	211.27	1676.00	108.53	232.60	183008.00
Std. Dev	42464717.44	152.65	67013.62	588.83	361.71	473696.02
Skewness	2.50	0.24	2.87	2.06	1.60	1.10
Kurtosis	7.85	1.87	10.83	6.37	4.85	3.21

Source: Author, computed from Eviews 10

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Chapter V: Empirical Results and Discussion

5.1 Empirical Results

In this study, it was our purpose to identify and analyze factors determining sesame export performance in BFA. In this section, we will examine the empirical results obtained from the Johansen co-integration technique. In testing for stationary, co-integration and estimating the model, this study used STATA 15 and Eviews 10 software (English window). Following the definition of the VAR model, the optimal choice of one (1) lags order is selected by the use of Schwarz Criterion (SC) and the Hannan-Quinn Information Criterion (HQ) (see appendix, A1). This study uses 47 years of observations; therefore, a unit root test with structural change (break) is applied in order to detect possible breaks in the data. For that purpose, the study used Zivot-Andrews unit root test with structural change. The results (see in appendix) show that the series have unit root with break points. In order to control for short-run structural change, the study created four dummy variables (d1-d4) which take one at the break point time. These dummies are included as exogenous variables in the co-integration test specification and in the VECM.

The Augmented Dickey-Fuller (ADF) test of stationarity applied on the series at level revealed that none of the variables is stationary at raw level (**Table 10**). After first difference of all series, the null hypothesis of the non-stationary test is rejected, meaning that all variables are integrated of order one I (1) (**Table 11**). Therefore, there is a possibility for these variables to exhibit an equilibrium in the long-run. The application of Johansen co-integration test on the series revealed that the system contains one co-integrating vector. In empirical work, the use of the trace test statistic according to Harris (1995) shows more robustness to both skewness and excess kurtosis in the innovations than the maximal-eigenvalue test. The trace statistic of 54.35 is less than 5% critical value

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of 60.06 **(Table 12**). The null hypothesis of zero co-integrating vector is rejected. Thereby, the system exhibits long-run relationship and the equation (8) stated above as VECM is fittingly regressed.

In order to check the accuracy of the results, this study has checked for residuals autocorrelation by using the Breusch-Godfrey serial correlation LM test. The null hypothesis of no autocorrelation at lag order is accepted. In all our results, the null hypothesis of homoskedasticity is accepted; therefore, the errors are homoscedastic. In addition, the residuals test for normality is performed. The null hypothesis of normality distributed is accepted, meaning the residuals are independent and normally distributed. The study also checked the model stability through the CUSUM test and the CUSUM squares. These tests have been validated meaning that the model's coefficients are stable over time (Tables and graphs of residuals diagnostic tests are in the appendix).

5.2 Interpretation of the VECM Results and Discussion

i) Interpretation of Short-run Dynamics and Discussion

The short-run coefficients of the VECM have expected signs for all the variables. (**Table 13**). As equation (2) is specified in log form, therefore the coefficients are elasticities.

The log of nominal exchange rate has the expected sign (+) and is significant. It can be projected that a 1% depreciation in nominal exchange rate (or 1% increase in the value of the USD) will increase export earnings by 2.30% in the short-run. Although quite elastic, this finding is in line with Diakosavvas et al. (1990). Allaro (2011) also found positive and significant short-run effect of nominal exchange rate on oilseed exports in Ethiopia. Similarly, log of producer average price has expected sign (+) and is statistically significant. For producer price, a 1% increase in farm gate price will increase export

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earnings by 0.58% in the short-run. Allaro (2011) found also a significant short-run effect of producer price but negative on oilseed exports in Ethiopia. At the same time, the production of sesame seed is positively associated with export performance. A 1% in the production of sesame seed increases export earnings by 0.1%; however, the effect is statistically insignificant.

The log of export price (foreign price) of sesame has expected sign (+), statistically significant and quite elastic. Based on the findings, a 1% increase in world price of sesame seed increases export earnings of BFA by 1.30% in the short-run. This result is in line with Boansi et al. (2014) which found that, in short-run; world price causes cotton exports performance in Mali. This result also reinforces supply theory of which a higher price causes higher supply, and therefore will cause higher gain ceterus paribus. According to the principles of trade theory, an inverse association is usually expected between prices and world exports volume (proxy of world demand for commodity under study). Thereby, whenever prices in the international market increase, international consumers are expected to demand less, while exporting countries on the other hand are expected to export more. Having stated all factors constant, an elastic, positive and significant effect of world demand of sesame seed on the performance of sesame exports is observed in this study. This is an indicator of the country short-run competiveness in sesame exports. A 1% increase in world demand of sesame seed will increase export earnings of BFA by 2.11% in the short-run. Once again, this confirms the undying world demand of sesame seed and relatively higher demand for exports from BFA; and the finding is in line with Boansi et al. (2014) and Anwar et al. (2010) which found positive and significant effect of world demand (of the product under study) on exports performance, respectively in Mali and in Pakistan. The outcome also reinforces the international trade theory for which, and without any inefficiency in the supply side, an increasing international demand or

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trade volume for a specific product presents an opportunity to increase export earnings for the exporting countries. In other words, the positive effect of world demand on export earnings reflects a good standing of the commodity involved in the international market as pointed out by Kumar et al. (2008). However, BFA should work efficiently and effectively in developing the sesame sector while addressing principally the existing inefficiencies both in the production (mostly related to yield) and in export side (norms and quality) in order to keep its competiveness, attracting higher prices and expand more its tentacles in the world sesame markets. Ultimately, the performance of sesame seed in BFA is affected in the short-run by external factors i.e. world demand, international price and the exchange rate, and by internal factors i.e. the production and producers average price.

The structural changes are captured by the dummy variables, which are treated as exogenous variables in the VECM. The results indicate that none of them is statistically significant. The most important change occurred in BFA over the period is the devaluation, which happened in 1994. This structural change is represented by the dummy variable "d1" is negative and statically insignificant. The others break point time (2007 and 2008) observed world export price and world demand of sesame seed could be attributed to the financial crisis of 2008, which affected international demand and prices. Based on the adjusted R-squared figure, about 50.78% of the variation in export earnings is explained by the dynamic of the included explanatory variables. In addition, the P-value of the Fisher statistic (0.000) is less than 1%, which indicates that all short-run coefficients jointly are statistically significant at 1% critical level and best explain export earnings. Moreover, the Error Correction Term (ECT) of the VECM is negative and significant, confirming the existence of long-run equilibrium relationship and causality between the system's variables. The ECT induces positive change in the export earnings

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back toward the equilibrium, and will act to correct any shocks from the long-run by 36.86% within a year or last-period's deviation from the long-run equilibrium is fully adjusted in 33 months.

ii) Interpretation of Long-run Results and Discussion

The long-run coefficients of the VECM have expected signs for the most part with the exception of the world price variable (**Table 14**).

The log of nominal exchange rate has expected sign (+) in the long-run and is significant. A 1% depreciation in nominal exchange rate (or 1% increase in the value of the USD) will increase the export earnings by 1.13%. In terms of magnitude, the long-run effect of nominal exchange rate on sesame export earnings is less elastic than in the short-run (2.30%). This finding supports the economic theory of which a country's currency depreciation/devaluation can have beneficial long-run effects on its exports, however can have less impact compared at the early stage of the devaluation. Allaro (2011) found also positive and significant effect of nominal exchange rate on oilseed exports performance in Ethiopia. Likewise, the short-run effect was greater compared to the long-run.

In the long-run, the log of production is positively significant. A 1% increase in the production of sesame seed leads to an increase in BFA's performance for sesame seed exports by 1.43%. This finding is in line with Ball et al. (1966) and Bertil (1968) who reported that production is a key supply side determinant of exports, thus increased production stimulates exports expansion and performance. Given the openness of BFA's economy, and where sesame is principally for exports, increased production facilitates effective meeting of international demand. However, to increase sesame seed production in BFA pertain principally to increase yield per hectare in order to enhance export

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performance. As mentioned in chapter 2, yield per hectare is low in BFA. The average yield per hectare in BFA nears 600kg, while this average reaches 800kg in Nigeria, Ethiopia and 900kg in Tanzania between 2008 and 2017. Strengthening the productive capacities through a strong improvement in yields per hectare is essential for the sesame sector to maintain its competitiveness, and to provide consequent income to farmers in the long-run.

The effect of producer price on export earnings, in the long-run, has expected sign (+) and is statistically insignificant. In the long-run, a 1% percent increase in producer price increases export earnings of sesame by 0.20%. In BFA and on individual level, sesame seed is channeled from producers, collectors, traders before it reaches the importers. Therefore, because of that, prices are rigid and it takes time for farm's prices to respond to the trend of international prices. This result is in line with Okoruwa et al. (2003) who reported that an increase in producer's price of rubber will lead to an increase in export of rubber in Nigeria. For the case of BFA, strengthening producers' associations in general with training on price negotiation, providing relevant and timely information on foreign prices could be beneficial in increasing the effects of domestic price on producer's revenue. This also will incentivized producers to increase production, thereby boost exports volume and competitiveness.

Unlike to the short-run, world export price of sesame seed has a negative unexpected sign and is significant. In the long-run, a 1% increase in world export price decreases export earnings by 1.14%. Exporters are motivated to export more and to expect higher gain when there is positive response in price increments. However, in equilibrium they are hindered in doing so by the downward pressure on world prices, which makes sesame seed in the international market and other sources cheaper than the one offered by BFA. In the long-run, as longer as others important exporting countries may induce downward

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pressure on prices in the world market along with distortionary measures to protect their domestic industries, these implications largely affect lower market shareholders like BFA.

Moreover, a positive association is observed between increasing international trade of sesame seed or world demand and performance of BFA in sesame exports in the long-run. A 1% increase in world demand of sesame seed induces an increase in export earnings by 0.05%; however, this effect is small and statistically insignificant. For the case of BFA, it implies that the exports dimension of BFA's sesame sector could be in a disadvantageous standing in the long-run since the effect is small and insignificant. It clearly indicates the decrease in competiveness that the sesame sector will face in the long-run if the existing short-run inefficiencies (in the production and export supply side) are not properly addressed. For instance, inefficiencies related to the supply side and both producers and exporter's lack of knowledge or expertise on market requirements and quality standards, lack of traceability that does not meet international standards may hinder the responsiveness of the domestic supply to meet world demand in the long-run. These inefficiencies could lower export earnings of the sector in the long-run. Therefore, it is already opportune to critically identify all relevant inefficiencies in both the production and exports side while addressing them effectively. Ultimately, this will help anticipatively to place the sector in a competitive position to exploit sesame trade opportunities in the long-run. Ultimately, nominal exchange rate, production, producer price and international trade of sesame seed affect positively the performance of sesame exports in the long-run, while world price affects negatively that performance.

5.7 Granger Causality-Wald Test within the VECM

The finding of stationarity of the variables and co-integration between export earnings of sesame seed and the explanatory variables immediately implies that there is

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causality from the explanatory variables to the export earnings either in the short-run or in the long-run. Therefore, it would be useful to test for causality in order to induce more policy recommendations. The results displayed in **table 15** traduce the causal relationship between export earnings and the independent variables. The null hypothesis of no causality is rejected if the p-value is less than the chosen critical value. From the table, it indicates a significant short-run bi-directional causality from nominal exchange rate to export earnings, and from export earnings to exchange rate. However, there is no evidence of short-run causal relationship either from the production to export earnings of sesame seed or in reverse. Unidirectional short-run causality is found from producer to the export earnings at 10% level. A short-run causality is found from world export price to export earnings, but the reverse causality is inexistent. Similarly, there is evidence of unidirectional short-run causality going from world demand of sesame seed to BFA's export earnings of sesame. Moreover, the evidence of long-run causality is found going from each of the explanatory variables to export earnings of sesame.

Table 10. Stationary test at level form I (0)

Augmented Dicky-Fuller stationary Test ((Ho: The series is not stationary)

We reject Ho of non-stationarity if the P-value < 5%

Include intercept			
Variable	**critical value 5%**	**t-statistic**	**p-value**
logXearnings	-2.229	1.123	0.997
logExchrate	-2.928	0.238	0.972
logProd	-2.229	1.123	0.997
logPdprice	-2.926	-1.288	0.627
logWexprice	-2.929	-2.498	0.122
logWexpvol	-2.929	-1.038	0.996
Include trend and intercept			
Variable	**critical value 5%**	**t-statistic**	**p-value**

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logXearnings	-3.315	-1.473	0.824
logExchrate	-3.51	-2.207	0.474
logProd	-3.515	-0.541	0.977
logPdprice	-3.51	-2.078	0.534
logWexprice	-3.515	-2.896	0.173
logWexpvol	-3.51	-3.55	0.045

Source: Author, computed from Eviews 10

Table 11. Stationary test result at first difference I (1)

Augmented Dicky-Fuller stationary Test ((Ho: The series is not stationary)

We reject Ho of non-stationarity if the P-value < 5%

Include intercept				
Variable	**critical value 5%**	**t-statistic**	**p-value**	**Integration order**
logXearnings	-2.928	-9.951	0.000	I (1)
logExchrate	-2.928	-5.963	0.000	I (1)
logProd	-2.229	-7.290	0.000	I (1)
logPdprice	-2.928	-6.370	0.000	I (1)
logWexprice	-2.229	-6.181	0.000	I (1)
logWexpvol	-2.229	-6.435	0.000	I (1)
Include trend and intercept				
Variable	**critical value 5%**	**t-statistic**	**p-value**	I (1)
logXearnings	-3.513	-10.089	0.000	I (1)
logExchrate	-3.515	-5.895	0.000	I (1)
logProd	-3.515	-7.732	0.000	I (1)
logPdprice	-3.513	-6.302	0.000	I (1)
logWexprice	-3.515	-6.243	0.000	I (1)
logWexpvol	-3.518	-5.783	0.000	I (1)

Source: Author, computed from Eviews 10

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Table 12. Results of Johansen's Co-integration test (no deterministic trend)

Trace Test (Ho: rank (r) ≤ 0)		
Rank	**trace statistic**	**critical value at 5%**
None	103.833	83.937
At most 1	54.353	60.061*
At most 2	27.958	40.174
Maximum Eigen value (Ho: rank (r) = 0)		
Rank	**trace statistic**	**critical value at 5%**
None	49.479	36.630
one	26.395	30.439*
Two	15.843	24.159

Source: Author, computed from Eviews 10

Table 13. The short-run dynamics of the VECM

(Assumption: no trend in the data)

Dependent variable $\Delta logXearnings_{t-1}$	Coefficient	Std.Error	t-statistic	P>t
$\Delta logExchrate_{t-1}$	2.309	0.576	4.008	0.000***
$\Delta logProd_{t-1}$	0.014	0.155	-0.091	0.927
$\Delta logPdprice_{t-1}$	0.583	0.310	1.877	0.069*
$\Delta logWexprice_{t-1}$	1.302	0.528	2.465	0.018**
$\Delta logWexpvol_{t-1}$	2.115	0.577	3.661	0.000***
D1	-0.174	0.484	-0.360	0.720
D2	-0.443	0.491	-0.903	0.372
D3	0.379	0.336	1.128	0.267
D4	-0.125	0.510	-0.246	0.807
ECT_{t-1}	- 0.368	0.150	-2.443	0.019**

*** Significant at 1% ** Significant at 5% * Significant at 10%

R-squared = 61.96% Adjusted R-squared = 50.78% DW = 2.30

F-statistic = 5.53 Prob (F-statistic) = 0.000 AIC = 1.49

Source: Author, computed from Eviews 10

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Table 14. Long-run results of the VECM

Dependent variable logXearnings$_t$	Coefficient	Std.Error	t-statistic	P>t
logExchrate$_t$	1.135	0.306	3.710	0.000***
logProd$_t$	1.438	0.142	10.113	0.000***
logPdprice$_t$	0.200	0.221	0.905	0.372
logWexprice$_t$	-1.141	0.280	-4.067	0.000***
logWexpvol$_t$	0.057	0.220	0.259	0.800

***Significant at 1%   **Significant at 5%

Source: Author, computed from Eviews 10

Table 15. Granger Causality-Wald Test results

Null Hypothesis	**Short-run Causality**	**Long-run Causality**
	Prob(Chi-Sq)	**Prob(Fisher)**
logExchrate does not cause logXearnings	0.000 *	0.000 *
logXearnings does not cause logExchrate	0.004 *	
logProd does not cause logXearnings	0.927	0.030 *
logXearnings does not cause logProd	0.837	
logPdprice does not cause logXearnings	0.06 **	0.010 *
logXearnings does not cause logPdprice	0.515	
logWexprice does not cause logXearnings	0.013 *	0.023 *
logXearnings does not cause logWexprice	0.263	
logWexpvol does not cause logXearnings	0.003 *	0.000 *
logXearnings does not cause logWexpvol	0.103	
***** Means that the null hypothesis of no causality is rejected at the 5% level ** Means that the null hypothesis of no causality is rejected at the 10% level		

Source: Author, computed from Eviews 10

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Chapter VI: Conclusions and Policy Recommendations

6.1 Concluding remarks

The central purpose of this study was to identify and analyze factors affecting export performance of sesame seed in Burkina Faso. First, the study showed that the world demand of sesame seed remains on the rise. Specially, it showed that BFA has a competitiveness in sesame exports, and the country can earn more from exports by increasing its production and identifying other attractive markets. The empirical results from the VECM have shown evidence that factors such as the nominal exchange rate, producer price, world export price and world demand of sesame seed are key variables affecting export earnings in the short-run.

In addition, this study also noted the key role of nominal exchange rate (USD to FCFA) in determining sesame sector performance both in the short and in long-run, which is in line with the literature. Equally, the study stressed the significant positive effect of the production, producer price and world export volume on export earnings in the long-run. However, producer price and world export volume effects are statistically insignificant. The country could earn more foreign currencies by improving yield of sesame and strengthening producers' knowledge in doing business with buyers. Moreover, the study revealed that world export price is a factor hindering exports performance in the long-run.

6.2 Policy Recommendations

Considering the qualitative substantial and the empirical support for this study on sesame exports, through the identification and the analysis of various factors affecting sesame seed exports, the present study makes the following policy recommendations:

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1- Firstly as a small open economy in relation to the rest of the world, BFA economic performance is sensitive to international market shocks. Consequently, stabilization policies that will enhance productivity and export promotion be implemented and sustained.

2- The effect of producer price is positive and significant on export performance; therefore, the idea of producer's associations and cooperatives should be promoted and reinforced among sesame seed producers. The state and its partners might provide training on price negotiation to enhance producers' knowledge in doing business with buyers. Providing relevant and timely information on foreign prices could be beneficial to orient production's decisions and increase the effects of domestic price on producer's revenue.

3- In addition, they should ensure that there is only an acceptable margin between the producer prices and world price of sesame so that the farmers can benefit substantially from international market. This will incentivized producers to increase production. Since producer price does granger cause production and export earnings does cause production; it is important to assure a good producer price that affects significantly export earnings. There will be a double positive effect from producer price and export earnings on production, thereby boosting exports volume and competitiveness.

4- In light of the significant effect of the production on sesame exports, it is imperative for BFA to increase its production of sesame especially in the long-run. It could be achieved through increasing significantly yields; by supporting farmers in diverse ways, including provision of adapted financial credits, input distribution (modern technologies, fertilizers, pesticides, improved seed). These inputs should be economically accessible and available in time, while ensuring appropriate transmission of price increments to

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farmers, and creating favorable marketing environment for their product in terms of access and information.

5- The findings revealed that the performance and the competiveness of sesame exports could be hindered in the long-run by prevailing short-run inefficiencies and developmental constraints. Anticipating and addressing that situation require not only increasing production and improving the quality of exports, but also appropriately identifying and effectively addressing these short-run inefficiencies and developmental constraints in the sector. This will help the country, in the long-run, to keep and stand in a competitive position in the international market of sesame seed exports.

6.3 Limitation of the study and Areas for future research

This study identified and analyzed the factors influencing sesame exports in BFA using an advanced econometrical technique for the period of 47 years (1970-2016). The dimension of adjusted R square showed, statistically, that 49% of variation in export earnings are explained by other factors not included in this model. This was the constraint of data availability on some relevant factors such as the state's budget allocated to investments in infrastructure (agricultural infrastructure and others), among others. This factor widely is seen in the literature as a key factor that can determine agricultural exports especially in developing countries. In addition, in a context of climate change, the variable of rainfall might have an impact on the sector performance. However, data on rainfall for BFA are not accurately available for the temporal length used in this study. Moreover, it is clear that farmers have switched to sesame production due the downward pressure on cotton prices, therefore including cotton price in the model could help to capture that effect. Nevertheless, as the rainfall data, producer price of cotton are not accurately available.

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As some key factors affecting sesame exports have been identified, future studies can further investigate the trade flow of sesame between BFA and its major trade partners (Japan, Singapore, China...). In addition, further comparative studies between BFA performance and other African exporting countries could help to learn experience from these countries or policies that could enhance the country performance. These outcomes could help to prescribe appropriate trade policies and further strategies aiming to enhance exports and the country's competiveness in the international markets.

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Appendix

A1. Lag length selection criteria

VAR Lag Order Selection Criteria
Endogenous variables: LOGXEARNINGS LOGEXCHRATE LOGPROD LOGPDPRICE LOGWEXPRICE LOGWEXPVOL
Exogenous variables: C D1 D2 D3 D4
Date: 03/19/19 Time: 22:25
Sample: 1970 2016
Included observations: 44

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-107.5114	NA	2.10e-05	6.250517	7.467010	6.701651
1	88.85094	294.5435*	1.52e-08*	-1.038679	1.637606*	-0.046184*
2	125.6894	45.21083	1.77e-08	-1.076790	3.059286	0.457066
3	163.6593	36.24396	2.50e-08	-1.166330*	4.429538	0.908888

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

A2. Zivot-Andrews Unit Root test with Structural break

Zivot-Andrews Unit Root Test
Date: 03/25/19 Time: 12:03
Sample: 1970 2016
Included observations: 47
Null Hypothesis: LOGEXCHRATE has a unit root with a structural break in the intercept
Chosen lag length: 0 (maximum lags: 4)
Chosen break point: 1994

	t-Statistic	Prob. *
Zivot-Andrews test statistic	-3.695406	0.001015
1% critical value:	-5.34	
5% critical value:	-4.93	
10% critical value:	-4.58	

* Probability values are calculated from a standard t-distribution and do not take into account the breakpoint selection process

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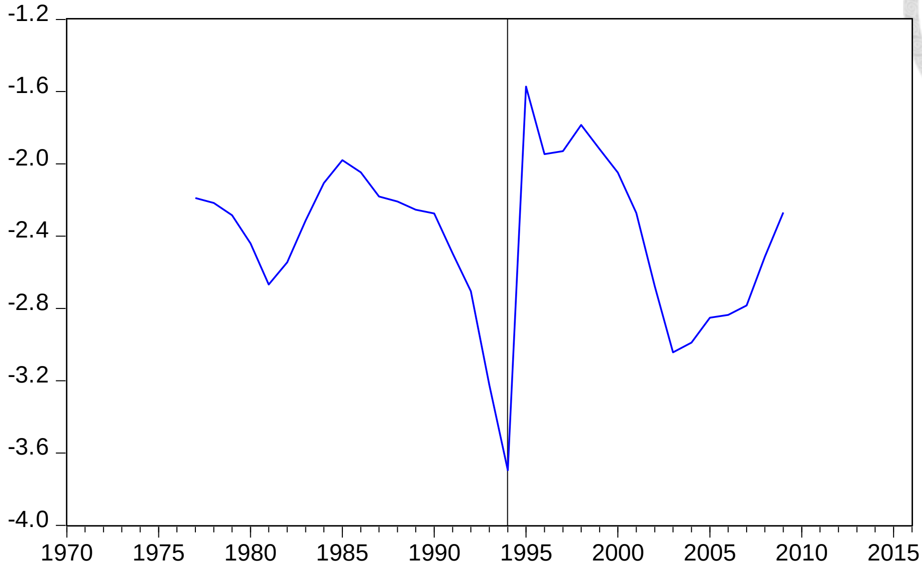
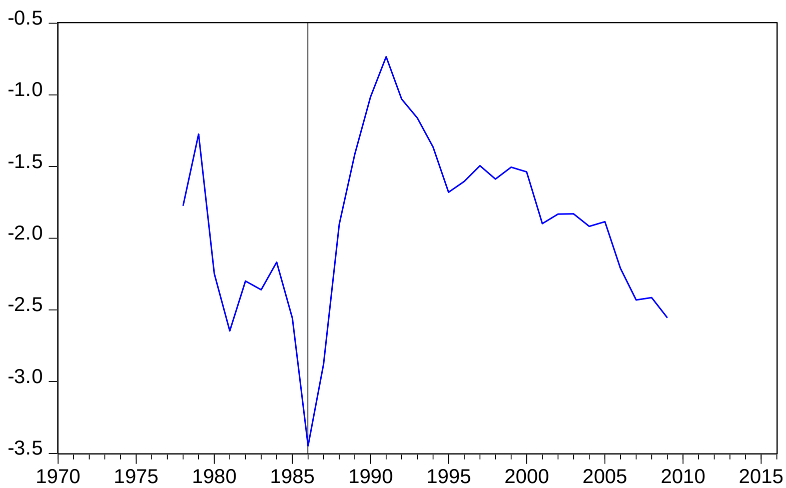
Zivot-Andrew Breakpoints



Zivot-Andrews Unit Root Test
Date: 03/18/19 Time: 14:03
Sample: 1970 2016
Included observations: 47
Null Hypothesis: LOGXEARNINGS has a unit root with a structural break in the intercept
Chosen lag length: 1 (maximum lags: 4)
Chosen break point: 1986

	t-Statistic	Prob. *
Zivot-Andrews test statistic	-3.447123	0.000662
1% critical value:	-5.34	
5% critical value:	-4.93	
10% critical value:	-4.58	

Zivot-Andrew Breakpoints



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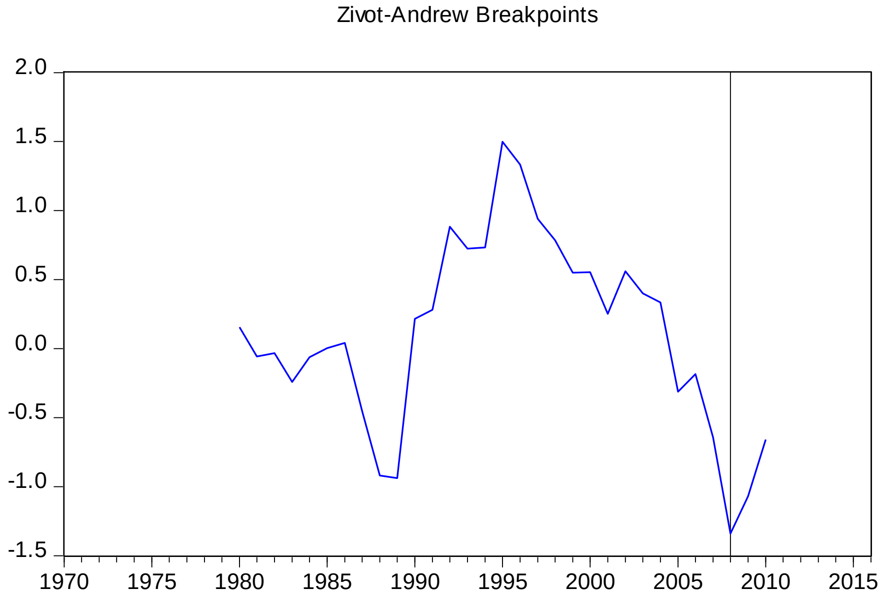
Zivot-Andrews Unit Root Test
Date: 03/18/19   Time: 14:03
Sample: 1970 2016
Included observations: 47
Null Hypothesis: LOGPROD has a unit root with a structural
break in the intercept
Chosen lag length: 4 (maximum lags: 4)
Chosen break point: 2008

	t-Statistic	Prob. *
Zivot-Andrews test statistic	-1.339854	0.018617
1% critical value:	-5.34	
5% critical value:	-4.93	
10% critical value:	-4.58	



Zivot-Andrews Unit Root Test
Date: 03/18/19   Time: 14:03
Sample: 1970 2016
Included observations: 47
Null Hypothesis: LOGWEXPRICE has a unit root with a structural
break in the intercept
Chosen lag length: 2 (maximum lags: 4)
Chosen break point: 2007

	t-Statistic	Prob. *
Zivot-Andrews test statistic	-3.947765	0.000719
1% critical value:	-5.34	
5% critical value:	-4.93	
10% critical value:	-4.58	

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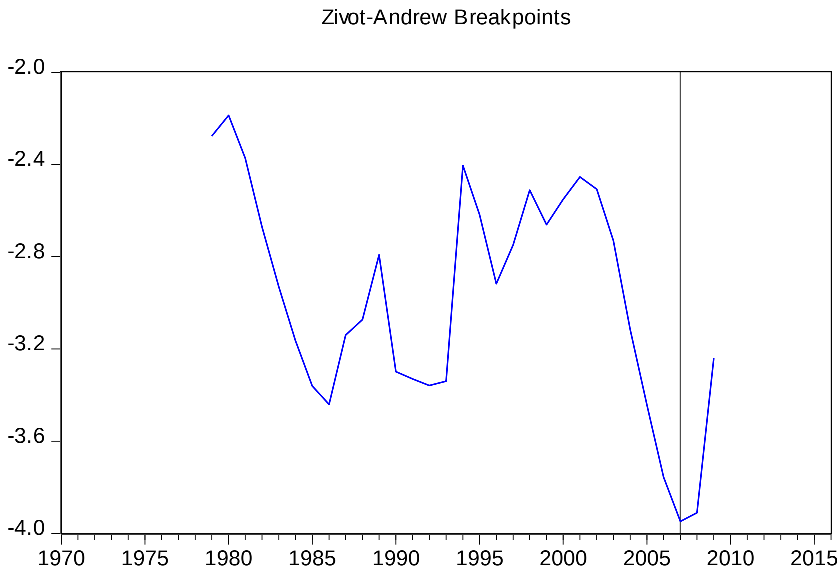

A3. Co-integration output

Date: 03/19/19 Time: 22:32
Sample (adjusted): 1972 2016
Included observations: 45 after adjustments
Trend assumption: No deterministic trend
Series: LOGXEARNINGS LOGEXCHRATE LOGPROD LOGPDPRICE LOGWEXPRICE LOGWEXPVOL
Exogenous series: D1 D2 D3 D4
Warning: Critical values assume no exogenous series
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.666979	103.8335	83.93712	0.0009
At most 1	0.443762	54.35378	60.06141	0.1382
At most 2	0.296769	27.95866	40.17493	0.4682
At most 3	0.193592	12.11550	24.27596	0.6959
At most 4	0.052266	2.433068	12.32090	0.9121
At most 5	0.000386	0.017394	4.129906	0.9142

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**

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None *	0.666979	49.47975	36.63019	0.0010
At most 1	0.443762	26.39512	30.43961	0.1470
At most 2	0.296769	15.84316	24.15921	0.4348
At most 3	0.193592	9.682433	17.79730	0.5192
At most 4	0.052266	2.415674	11.22480	0.8724
At most 5	0.000386	0.017394	4.129906	0.9142

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Date: 03/19/19 Time: 22:36
Sample: 1970 2016
Included observations: 45
Series: LOGXEARNINGS LOGEXCHRATE LOGPROD LOGPDPRICE LOGWEXPRICE LOGWEXPVOL
Exogenous series: D1 D2 D3 D4
Warning: Rank Test critical values derived assuming no exogenous series
Lags interval: 1 to 1

Selected (0.05 level*)
Number of Cointegrating
Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	1	1	1	1	1
Max-Eig	1	1	1	1	1

*Critical values based on MacKinnon-Haug-Michelis (1999)

A4. VECM output

Vector Error Correction Estimates
Date: 03/21/19 Time: 13:32
Sample (adjusted): 1972 2016
Included observations: 45 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LOGXEARNINGS(-1)	1.000000
LOGEXCHRATE(-1)	-1.135464 (0.30605) [-3.71010]
LOGPROD(-1)	-1.438120 (0.14220)

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	[-10.1132]
LOGPDPRICE(-1)	-0.200442
	(0.22146)
	[-0.90509]
LOGWEXPRICE(-1)	1.141306
	(0.28062)
	[4.06709]
LOGWEXPVOL(-1)	-0.057073
	(0.22004)
	[-0.25938]

Error Correction:	D(LOGXEARNINGS)	D(LOGEXCHRATE)	D(LOGPROD)	D(LOGPDPRICE)	D(LOGWEXPRICE)	D(LOGWEXPVOL)
CointEq1	-0.368635	0.107492	0.352447	-0.035178	-0.068315	0.093225
	(0.15085)	(0.02814)	(0.14671)	(0.09251)	(0.05584)	(0.03889)
	[-2.44379]	[3.81927]	[2.40232]	[-0.38027]	[-1.22335]	[2.39726]
D(LOGXEARNINGS(-1))	-0.160563	-0.082422	-0.030615	0.061157	0.063421	-0.064389
	(0.15333)	(0.02861)	(0.14913)	(0.09403)	(0.05676)	(0.03953)
	[-1.04717]	[-2.88107]	[-0.20529]	[0.65039]	[1.11730]	[-1.62891]
D(LOGEXCHRATE(-1))	2.309831	0.082665	0.484755	-0.237539	-0.032304	-0.185352
	(0.57625)	(0.10752)	(0.56046)	(0.35340)	(0.21333)	(0.14856)
	[4.00836]	[0.76886]	[0.86493]	[-0.67216]	[-0.15143]	[-1.24767]
D(LOGPROD(-1))	0.014220	0.111595	-0.245692	-0.171136	-0.182560	0.062873
	(0.15546)	(0.02900)	(0.15120)	(0.09534)	(0.05755)	(0.04008)
	[0.09147]	[3.84746]	[-1.62500]	[-1.79508]	[-3.17223]	[1.56881]
D(LOGPDPRICE(-1))	0.583160	-0.030054	0.125450	0.017345	0.146921	0.067390
	(0.31059)	(0.05795)	(0.30207)	(0.19047)	(0.11498)	(0.08007)
	[1.87760]	[-0.51862]	[0.41530]	[0.09106]	[1.27782]	[0.84164]
D(LOGWEXPRICE(-1))	1.302969	-0.171321	-0.005212	0.188043	0.223072	-0.050773
	(0.52845)	(0.09860)	(0.51396)	(0.32408)	(0.19563)	(0.13623)
	[2.46566]	[-1.73760]	[-0.01014]	[0.58024]	[1.14029]	[-0.37269]
D(LOGWEXPVOL(-1))	2.115835	-0.080939	0.531527	0.260276	0.179186	-0.040864
	(0.57783)	(0.10781)	(0.56200)	(0.35437)	(0.21391)	(0.14897)
	[3.66166]	[-0.75074]	[0.94578]	[0.73448]	[0.83766]	[-0.27432]
D1	-0.174687	0.703159	-1.500468	0.006852	0.156874	0.159301
	(0.48445)	(0.09039)	(0.47117)	(0.29710)	(0.17934)	(0.12489)
	[-0.36059]	[7.77931]	[-3.18455]	[0.02306]	[0.87472]	[1.27551]
D2	-0.443515	-0.354113	0.220793	-0.026289	-0.154322	0.077441
	(0.49106)	(0.09162)	(0.47760)	(0.30115)	(0.18179)	(0.12660)
	[-0.90317]	[-3.86493]	[0.46229]	[-0.08729]	[-0.84890]	[0.61171]

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D3	0.379237	-0.075375	0.173352	0.456882	0.222916	-0.082590
	(0.33609)	(0.06271)	(0.32688)	(0.20611)	(0.12442)	(0.08664)
	[1.12838]	[-1.20202]	[0.53033]	[2.21666]	[1.79166]	[-0.95321]
D4	-0.125537	-0.077484	-0.225653	0.205193	0.075885	-0.251267
	(0.51012)	(0.09518)	(0.49614)	(0.31284)	(0.18885)	(0.13151)
	[-0.24609]	[-0.81409]	[-0.45482]	[0.65590]	[0.40183]	[-1.91063]
R-squared	0.619676	0.729534	0.554048	0.214504	0.365289	0.191655
Adj. R-squared	0.507816	0.649986	0.422885	-0.016524	0.178609	-0.046094
Sum sq. resids	7.236872	0.251928	6.845571	2.721768	0.991779	0.480975
S.E. equation	0.461356	0.086079	0.448710	0.282935	0.170792	0.118938
F-statistic	5.539746	9.170909	4.224134	0.928477	1.956767	0.806124
Log likelihood	-22.73408	52.81645	-21.48337	-0.731163	21.98342	38.26634
Akaike AIC	1.499293	-1.858509	1.443705	0.521385	-0.488152	-1.211838
Schwarz SC	1.940921	-1.416880	1.885334	0.963014	-0.046523	-0.770209
Mean dependent	0.110055	0.017048	0.089995	0.049221	0.031371	0.049838
S.D. dependent	0.657616	0.145498	0.590656	0.280626	0.188449	0.116288

Determinant resid covariance (dof adj.)	3.85E-09
Determinant resid covariance	7.16E-10
Log likelihood	90.66335
Akaike information criterion	-0.829482
Schwarz criterion	2.061178
Number of coefficients	72

A5. Granger causality test within the VECM

VEC Granger Causality/Block Exogeneity Wald Tests
Date: 03/22/19 Time: 12:07
Sample: 1970 2016
Included observations: 45

Dependent variable: D(LOGXEARNINGS)

Excluded	Chi-sq	df	Prob.
D(LOGEXCHRATE)	16.06694	1	0.0001
D(LOGPROD)	0.008367	1	0.9271
D(LOGPDPRICE)	3.525390	1	0.0604
D(LOGWEXPRICE)	6.079503	1	0.0137
D(LOGWEXPVOL)	13.40778	1	0.0003
All	42.21633	5	0.0000

Dependent variable: D(LOGEXCHRATE)

Excluded	Chi-sq	df	Prob.
D(LOGXEARNINGS)	8.300565	1	0.0040
D(LOGPROD)	14.80297	1	0.0001

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D(LOGPDPRICE)	0.268971	1	0.6040
D(LOGWEXPRICE)	3.019238	1	0.0823
D(LOGWEXPVOL)	0.563610	1	0.4528
All	18.79604	5	0.0021

Dependent variable: D(LOGPROD)

Excluded	Chi-sq	df	Prob.
D(LOGXEARNINGS)	0.042146	1	0.8373
D(LOGEXCHRATE)	0.748098	1	0.3871
D(LOGPDPRICE)	0.172472	1	0.6779
D(LOGWEXPRICE)	0.000103	1	0.9919
D(LOGWEXPVOL)	0.894509	1	0.3443
All	2.105610	5	0.8343

Dependent variable: D(LOGPDPRICE)

Excluded	Chi-sq	df	Prob.
D(LOGXEARNINGS)	0.423003	1	0.5154
D(LOGEXCHRATE)	0.451797	1	0.5015
D(LOGPROD)	3.222303	1	0.0726
D(LOGWEXPRICE)	0.336677	1	0.5618
D(LOGWEXPVOL)	0.539461	1	0.4627
All	3.353309	5	0.6457

Dependent variable: D(LOGWEXPRICE)

Excluded	Chi-sq	df	Prob.
D(LOGXEARNINGS)	1.248370	1	0.2639
D(LOGEXCHRATE)	0.022930	1	0.8796
D(LOGPROD)	10.06307	1	0.0015
D(LOGPDPRICE)	1.632817	1	0.2013
D(LOGWEXPVOL)	0.701681	1	0.4022
All	12.08328	5	0.0337

Dependent variable: D(LOGWEXPVOL)

Excluded	Chi-sq	df	Prob.
D(LOGXEARNINGS)	2.653357	1	0.1033
D(LOGEXCHRATE)	1.556670	1	0.2122
D(LOGPROD)	2.461165	1	0.1167
D(LOGPDPRICE)	0.708360	1	0.4000
D(LOGWEXPRICE)	0.138897	1	0.7094

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All	9.299992	5	0.0977

A6. Autocorrelation LM test output

VEC Residual Serial Correlation LM Tests
Date: 03/21/19 Time: 15:44
Sample: 1970 2016
Included observations: 45

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	37.56640	36	0.3973	1.051731	(36, 103.8)	0.4096

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	37.56640	36	0.3973	1.051731	(36, 103.8)	0.4096

*Edgeworth expansion corrected likelihood ratio statistic.

A7. White test for heteroskedasticity

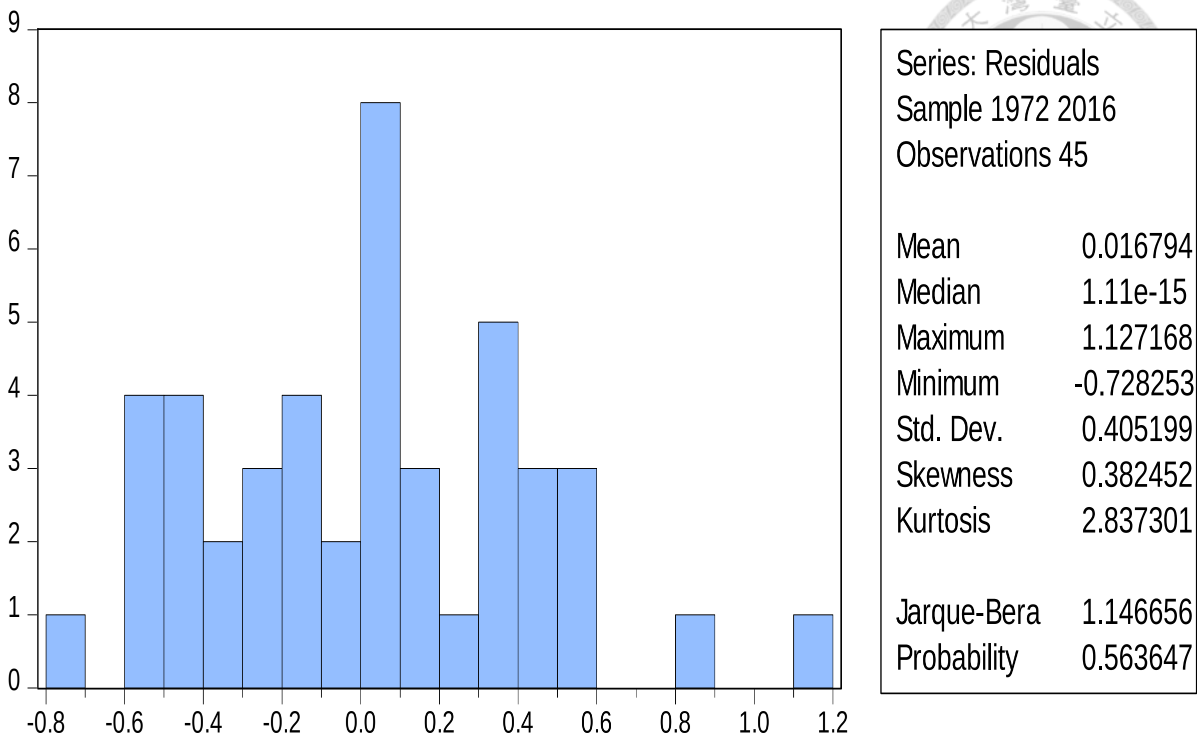
VEC Residual Heteroskedasticity Tests (Levels and Squares)
Date: 03/21/19 Time: 15:49
Sample: 1970 2016
Included observations: 45

Joint test:

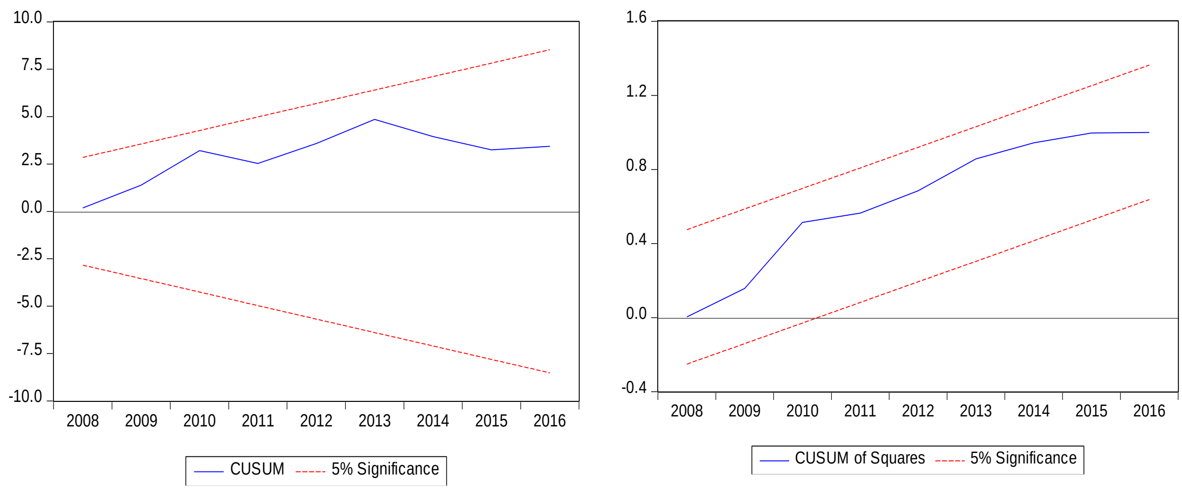
Chi-sq	df	Prob.
344.3130	378	0.8924

A8. Test for normality: Skewness/Kurtosis and Jarque-Bera

doi:10.6342/NTU201900674



A9. Model stability through CUSUM test



A10. Wald test (null hypothesis rejected)

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	8.443265	(5, 34)	0.0000
Chi-square	42.21633	5	0.0000

Null Hypothesis: C(3)=C(4)=C(5)=C(6)=C(7)=0
Null Hypothesis Summary:

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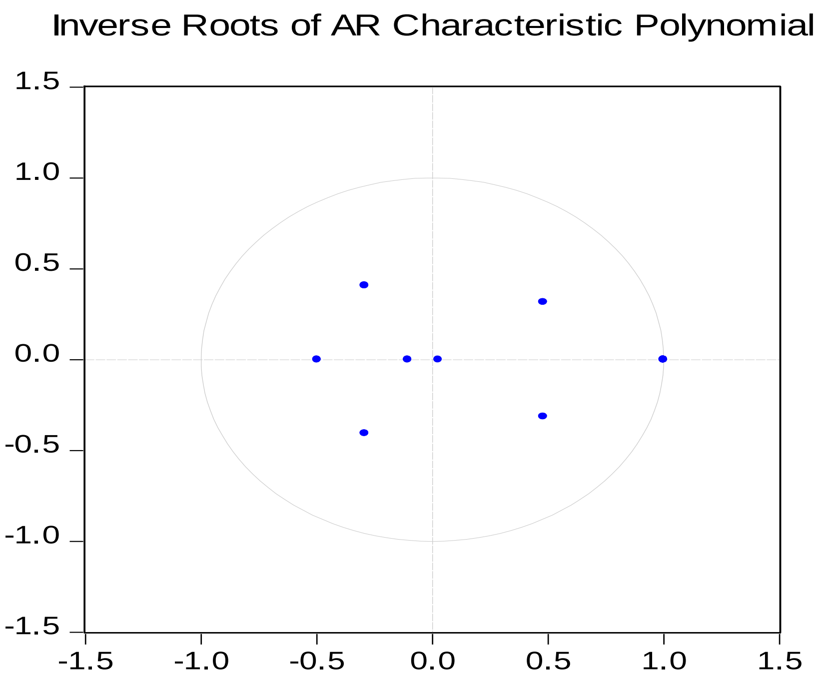
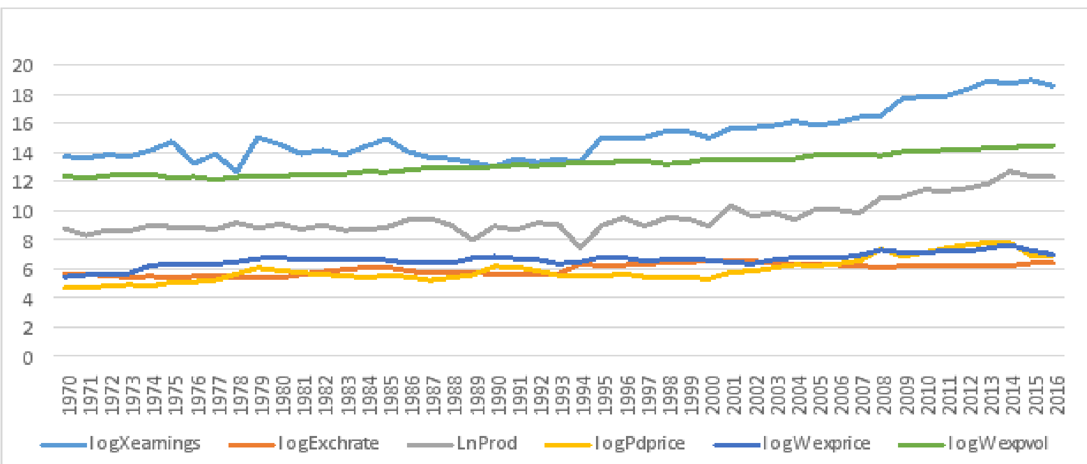
Normalized Restriction (= 0)	Value	Std. Err.
C(3)	2.309831	0.576254
C(4)	0.014220	0.155456
C(5)	0.583160	0.310587
C(6)	1.302969	0.528445
C(7)	2.115835	0.577834

Restrictions are linear in coefficients.

A11. Stability



A12. Endogenous graphs



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