EXPORT-DESTINATION NETWORK EFFECT ON ZAMBIA'S METAL EXPORTS PERFORMANCE (1995-2016)

BY

SOKO GERALD

A Dissertation Submitted to the University of Zambia in Partial Fulfillment of the Requirements of the Degree of Master of Arts in Economics

THE UNIVERSITY OF ZAMBIA

DIRECTORATE OF RESEARCH AND GRADUATE STUDIES

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DECLARATION

I, **Soko Gerald,** declare that this dissertation:

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APPROVAL

This dissertation of **Soko Gerald** has been approved as a partial fulfilment of the requirements for the award of the degree of Master of Arts in Economics by the University of Zambia.

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DEDICATION

This paper is dedicated to my lovely parents, Mr. Boldwin Soko and Mrs Matilda Banda Soko.

ABSTRACT

The study sought to understand the effect on Zambia's metal export performance of the geographical patterns of these exports. Particular focus was given to the role of China as an anchor of the destination network in terms of external demand shocks. The dimensions considered were the effect of partner GDP on metal exports demand, the response of metal exports to external demand shocks and the importance of partner GDP growth correlations in international trade risk. The Vector Error Correction framework and the Exponential Generalized Autoregressive Heteroskedasticity model of volatility were employed using quarterly data from 1995q1 to 2016q4. It was found that, in the long run, partner GDP has a positive effect on metal exports demand while in the short run, metal exports are sensitive to changes in real effective exchange rate and foreign (partner) GDP. In addition, metal exporters in Zambia perceived external demand shocks due to a network of metal exports destination as short run opportunities during the period under study. The study further finds that partner GDP growth correlations between China and Zambia's other metal trading partners were more important in explaining metal export volatility than individual output volatility in those partners. However, this risk tends to manifest itself through volatility in the exchange rate and barter terms of trade. In view of these findings, diversifying the geography especially through value addition to metals as well as developing a well-functioning derivatives market for hedging against exchange rate risk due to external demand shocks therefore become important dimensions of policy in Zambia.

Keywords: *Volatility, EGARCH, GDP Growth Correlations, Metal Exports, Cointegration, External Demand Shock*

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ACRONYMS

ADF	Augmented Dickey Fuller
BoZ	Bank of Zambia
COMESA	Common Market for Eastern and Southern Africa
ECA	Europe and Central Asia
EGARCH	Exponential Generalized Autoregressive Conditional Heteroscedasticity
FDI	Foreign Direct Investment
GARCH	Generalized Autoregressive Conditional Heteroscedasticity
GDP	Gross Domestic Product
IMF	International Monetary Fund
P-P	Phillips-Perron
REER	Real Effective Exchange Rate
SADC	Southern African Development Community
SSA	Sub-Saharan Africa
TOT	Terms of Trade
UNCTAD	United Nations Conference on Trade and Development
VAR	Vector Autoregressive
VEC	Vector Error Correction
WDI	World Development Indicators
WITS	World Integrated Trade Solutions
ZIPAR	Zambia Institute of Policy Analysis and Research

CHAPTER ONE
INTRODUCTION

1.1 Background

Globalization or market integration has been associated with increased market opportunities for commodities, finance and human expertise. Despite these opportunities, globalization has, however, exposed countries world over to a considerable degree of external shocks (Jansen et al., 2015; UNCTAD, 2016). The area of external shocks has received intense research especially in the wake of the 2007/2008 financial crisis (Erten, 2012).

There are two broad channels through which these external shocks are transmitted and these are based on the international finance trade relations among economies. For the financial channel, the effects of external shocks manifest through the fluctuations in capital flows and economic agents' balance sheet deterioration (Krugman, 1999), exchange rate fluctuations (Cespedes et al., 2004) and credit supply contraction (Auel and Mendonca, 2011; Peltonen et al., 2018).

On the other hand and with the importance of commodity and service markets in national and regional interactions, the role of international trade has been widely investigated both theoretically and empirically in external shock propagation. Under certain conditions and assumptions, several theoretical models exist which link movements in international business cycles to those in international trade.

Empirical studies based on such models have concluded that external shocks which affect core macroeconomic fundamentals such as economic growth of importer countries and commodity prices lead to international trade volatility (Easterly et al., 1993; Backus and Crucini, 2000; Kose and Yi, 2006, Burstein et al., 2008). For example, Giovanni et al (2014) show that sector shocks do covary in trading partners whose firms are interconnected through vertical production specialization.

In as much as these shocks can affect any economy via the trade channel, different economies have different capabilities when it comes to policy responses in times of such events. Developing countries which are reliant on commodity exports suffer the most and more so because exports play a relatively bigger role in driving their economic growth. Major negative effects include, among other things, slow growth in economic activity, high inflation levels, weakened fiscal and external positions as well as restrained capacity and resilience of the financial systems in the domestic economy (Gourinchas et al., 2012).

Therefore, understanding the sources of volatility is a key issue in these economies not only because they have failed to significantly diversify the export portfolio in the dimensions of products (Love, 1986; Koren and Tenreyro, 2007) and geography but because the capacity to hedge against such fluctuations still remains limited (Jansen et al., 2015).

Product and destination diversification if jointly pursued have, therefore, long been seen as fundamental in reaping the benefits of trade created by regional and global markets as it reduces exposure to adverse external shocks (UNCTAD, 2013). Despite policy pronouncements to diversify export portfolios, developing country governments have made little in this respect as new products are yet to contribute significantly to the export basket assuming that they survive a longer period. Exports still continue to be concentrated on a few primary commodities. Besides, according to Melitz (2003), new markets for exports are as well not easy to access due to high fixed costs of entry.

Zambia is one example of developing countries whose export basket is highly concentrated on minerals which, for a long time now, have averaged at least 70% of the total exports (Chipili, 2013). At the same time, Zambia's exports as a percentage of the country's Gross Domestic Product have been relatively high and are showing an increasing trend judging by the behavior in the recent past. Exports as a percentage of GDP increased from an average of 29.8% between 2000 and 2010 to 38.7% between 2011 and 2017.[1] This shows how important trade flows are to Zambia's growth prospects as well as other countries in Sub-Saharan Africa which are highly dependent on exports of primary commodities (BoZ, 2016). With this, one can easily anticipate that external shocks that significantly cause volatility in exports will also have important effects on an economy's economic growth.

Since 2009 Zambia had been experiencing single digit inflation on account of good macroeconomic management. However, at the end of the third quarter of 2015, it started rising

[1] According to UN's WDI data

and closed the year at 21.1% and remained relatively high above 18% until September 2016 and later returned to a single digit at the close of that year and has since stabilized (BoZ, 2017).[2] This development in inflation movements in the country was attributed to a sharp depreciation of the Kwacha against world major currencies in the third quarter of 2015 which was partly due to a slowdown in the growth of the global economy which led to the poor performance of commodity prices on the international market (UNCTAD, 2016). This experience serves as a classic example of how external demand shocks especially those affecting trade flows can impact on the macroeconomic performance of an economy.

1.2 Statement of the Problem

Zambia's trade as a percentage of GDP has increased from an annual average of 62.19% (of which 42.15% is exports share) between 1995 and 2003 to 80.86% (with exports accounting for 48.73% of the total percentage) between 2011 and 2015. This is an indication of how deeply integrated into the global economy Zambia has become. The country's exports are dominated by copper, which has accounted for an average of 70% of total export earnings since independence (Chipili, 2013). This is despite higher growth (from 8.8% in 1992 to 27.1% in 2016)[3] in Non-Traditional Exports (NTEs) share.

Efforts that started in the 1970s to diversify the export basket for Zambia seem to be slow in response and the mining sector still remains a highly significant driver of exports for the economy. In addition, Zambia has failed to significantly diversify traditional exports in terms of markets such that 13 metal trading partners[4] accounted for an annual average of about 84%[5] of total metal exports between 1995 and 2017. These key metal exports destinations for Zambia also account for over 23% of Chinese imports over the same period.[6] This market interdependence on economic dynamics in China creates conditions for shocks to growth and financial sector among others to generate amplified responses to shocks in the network of trading

[2] 2018 1st quarter Monetary Policy Committee statement
[3] According to Bank of Zambia's balance of payments data
[4] Switzerland, China (including Hong Kong), South Africa, Congo, Netherlands, Saudi Arabia, Singapore, Thailand, UK, USA, UAE, Australia, India.
[5] According to the World Bank's (World Integrated Trade Solutions) data
[6] According to the World Bank's (World Integrated Trade Solutions) data

partners. In short, the network of trading partners significantly exposes Zambia to external demand shocks.

However, it is not clear whether Zambia's portfolio of metal exports is well diversified or not in terms of geography. Studies such as Jansen et al., (2015) and Bachetta et al. (2009) have shown that correlations in trading partner business cycles matter in explaining export volatility and therefore GDP. The question of how Zambia's network of metal trading partners affects its internal dynamics then arises. Understanding the role of trade networks is important especially in countries aiming at reaping the benefits of export diversification by building resilience to external demand shocks.

Empirical research on the effect of trade partner networks in Zambia remains scarce amidst the increased integration of the country into the global economy. This is despite evidence that external GDP is key in determining exports (Houthakker and Magee, 1969; Bussiére et al., 2011; Mwito et al., 2015) and that increased trade intensity amplifies GDP co-movements among partner economies (Burstein et al., 2008; Di Giovanni and Levchenko, 2010; Gabaix, 2011; Foerster et al, 2011; Acemoglu et al., 2012). Acting together, these forces are capable of creating a shock contagion effect.

1.3 Objectives

1.3.1 General Objective

The general objective is to explore the effect and channels through which demand shocks in Zambia's metal export destination markets affect the country's metal export performance.

1.3.2 Specific Objectives

i. To identify the role of trading partner GDP on Zambia's metal exports demand.
ii. To determine the response of Zambia's metal exports to trading partner GDP fluctuations.
iii. To distinguish the importance of individual trading partner GDP growth volatility and their correlations among partners in explaining metal exports volatility.

1.4 Hypotheses

i. Trading partner GDP is not important in explaining Zambia's metal exports demand.
ii. Zambia's metal exports adversely respond to fluctuations in trading partner GDP.
iii. Individual trading partner GDP growth volatility matters more than their correlations among trading partners in Zambia's metal export volatility.

1.5 Justification

Robust economic growth and export diversification has been one of the policy objectives of successive Zambian governments since 1964. This policy is aimed at reducing the country's dependence on traditional exports (mainly metals dominated by copper) in the export basket. Although there has been some progress in doing so, the country's export basket remains concentrated on metals. There has been policy debate around this because this dependence has, on a number of occasions, threatened the economic performance especially in an event of negative external shocks affecting the performance of the export sector.

Zambia's top metal export destinations are highly connected to China especially from the dawn of the 21st century. External macroeconomic dynamics can affect Zambia directly and indirectly as these trading partners are in a trading network whose anchorage is China. The importance of the findings of this study cannot be overstated in terms of trade policy as it reveals information on whether Zambia's metal export destination (geography) are properly or poorly diversified in the midst of product diversification efforts.

1.6 Organization of the Dissertation

The rest of the paper is organized as follows. Chapter 2 gives the context of the study while in chapter 3, a review of literature in terms of theory and empirical studies is provided. The methodology used in the study is explained in chapter 4 while the findings of the study are presented in chapter 5. Finally, chapter 6 discusses the findings, draws conclusions and offers policy implications.

CHAPTER TWO

CONTEXT OF THE STUDY

1.7 Economic Growth

Zambia has enjoyed positive economic growth especially from the early 2000s and is among the world's top 10 largest producers of copper. The country's economic performance has been closely related to the performance of the mining sector, particularly copper. According to the IMF data, Zambia's GDP grew at an annual average of 1.29% between 1980 and 1990 before falling to 0.91% in the period (1991-2000) characterized by the privatization of the mining sector and other parastatal companies. Post the 20^{th} century, growth rebounded and grew at an average annual rate of 7.45% between 2001 and 2010 before being subdued to a rate of 4.88% (2011-2016). Recent past key drivers of this growth have been mining/quarrying, construction, agriculture, manufacturing and tourism.

1.8 International Trade

In terms of international trade policy and in the decades which followed political independence, the country sought to achieve industrial growth through a protective regime of import substitution while stimulating the agricultural sector. With the dawn of the third republic which gave birth to a multi-party political system, the emphasis was shifted to the liberalization of the trade sector at both bilateral and multilateral level. Notable reforms ranged from the abolishment of the fixed exchange rate regime to easing of both tariff and non-tariff barriers (Chipili, 2013).

Region	**1995**	**2000**	**2005**	**2010**	**2015**
East Asia & Pacific	43.52	0.69	4.09	21.18	28.42
Europe & Central Asia	7.45	66.75	52.83	55.48	45.91
Latin America & Caribbean	0.03	0.2	0.01	0.01	0.13
Middle East & North Africa	10.87	0.14	0.12	3.67	1.04
North America	6.11	0.75	0.8	0.1	0.06
Sub-Saharan Africa	11.48	30.46	40.54	19.24	24.1
Other	20.54	1.01	1.61	0.32	0.34

Data Source: UNCTAD

Table 1: Destinations of Zambia's Metal Exports

In the period 1995 to 2016, Zambia's metal trading partners were predominantly found in East Asia and Pacific (mainly dominated by China, Japan, Singapore, Australia and Thailand) and Europe & Central Asia (where Switzerland and UK belong). In the Sub-Saharan African region, key trading partners were South Africa and Congo. The rise of the SSA region as a significant export destination for Zambia exports is largely due to the existence of regional trade agreements with COMESA and SADC.

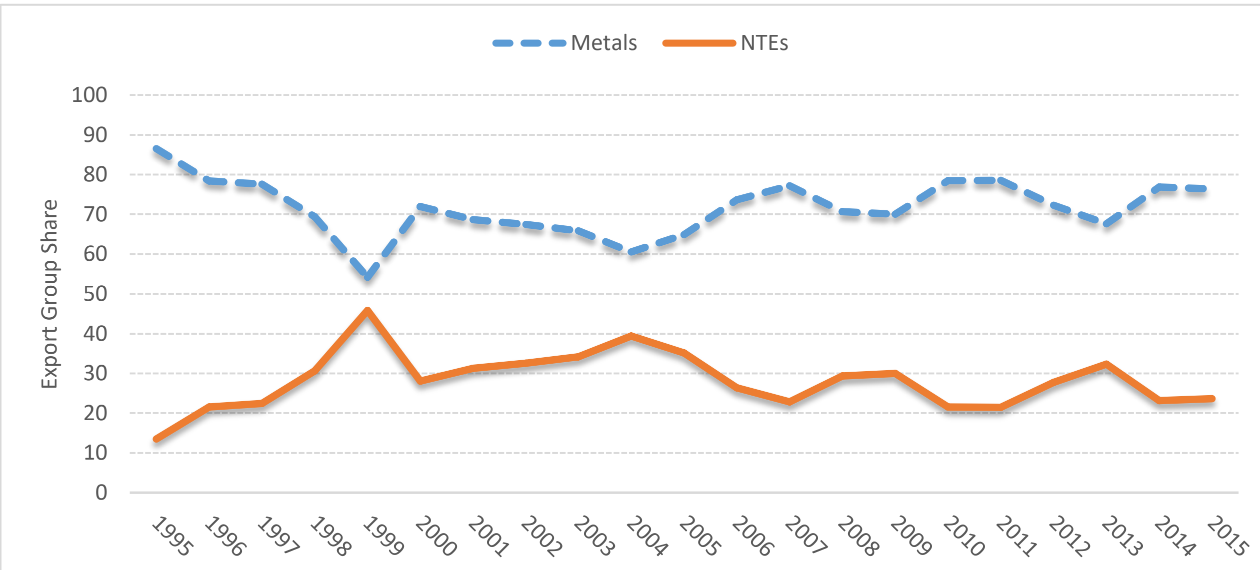

Figure 1: Export Basket Composition
Data Source: UNCTAD

In terms of the export basket, Figure 1 shows that traditional exports continue to dominate the country's export portfolio averaging around 70% of the total export revenues between 1995 and 2015. Non-Traditional Exports (NTEs) are mainly composed of primary agricultural commodities, agro-processed products like sugar, textiles and other manufactured goods and have grown from 8% in 1980[7] to about 23.6% of total exports in 2015.

Data on Zambia's export destinations has recently sparked debate in terms of their accuracy amid observation of significant discrepancies between what Zambian authorities report and the records in importer countries. For example, Table 2 shows that exports to Switzerland are almost entirely inflated while those to China and other Asian countries are significantly underreported by

[7] See Musonda (2008).

Zambia. There are various reasons which may lead to such variations ranging from re-exports (mainly by intermediary commodity traders) to differences in the valuation of imports and exports.

	Zambia's Exports			**Partner Reports**			***Extent of Miss Invoicing***	
Year	***2002***	***2010***	***2015***	***2002***	***2010***	***2015***	***2002***	***2015***
Switzerland	27.0	3332.2	3006.4	0.0	0.0	0.0014	100%	100%
China	0.1	1296.6	987.7	19.0	2415.0	1595.0	-24117%	-61%
South Africa	114.5	267.2	186.9	20.0	168.0	97.0	83%	48%
United Kingdom	300.7	105.3	15.7	0.0	19.0	1.0	100%	94%
Sub-Saharan Africa	57.0	41.3	65.4	4.0	112.0	170.0	93%	-160%
Europe & Central Asia	0.6	72.3	6.0	6.0	45.0	310.0	-863%	-5027%
Asia (East and Pacific)	0.6	40.0	866.0	121.0	525.0	630.0	-18859%	27%
Others	0.1	262.4	19.3	144.0	1522.0	1955.0	-134821%	10046%
Total	**500.7**	**5417.5**	**5153.4**	**314.0**	**4805.0**	**4758.0**	**37%**	**8%**

Table 2: Variations in Export Data between the Exporter and Importer Records

Source: Mudenda, Bulawayo and Ndulo (2018)

Zambia's trading profile in terms of metals since 1995 and more so in the 2000s has mirrored national exports because of the significantly high proportion in the national basket. China has become a major importer of Zambian metals not only based on Zambian records but especially so because of their own records.[8] On the other hand, Swiss commodity traders (with minerals being one of their core businesses) Glencore and Trafigura are behind the rise of Switzerland as Zambia's major trading partner.

These traders and even producers, also operating with a logistics business wing, buy commodities and then sell them at higher prices to cover their operating costs and make a profit in the process. Swiss commodity trading companies' transactions are not captured in their current because these companies are only involved in transit trade in which case they buy commodities abroad and sell them directly to their customers abroad without value addition (Berne Declaration, 2012). African commodities sold to Swiss companies are cited as an example of among those that are bought but shipped straight to China. Led by China and Switzerland, Figure 2 shows the concentration of Zambia's metal exports among 14 key markets during the 1995-2015 period.

[8] See Figure A6 in the Appendix

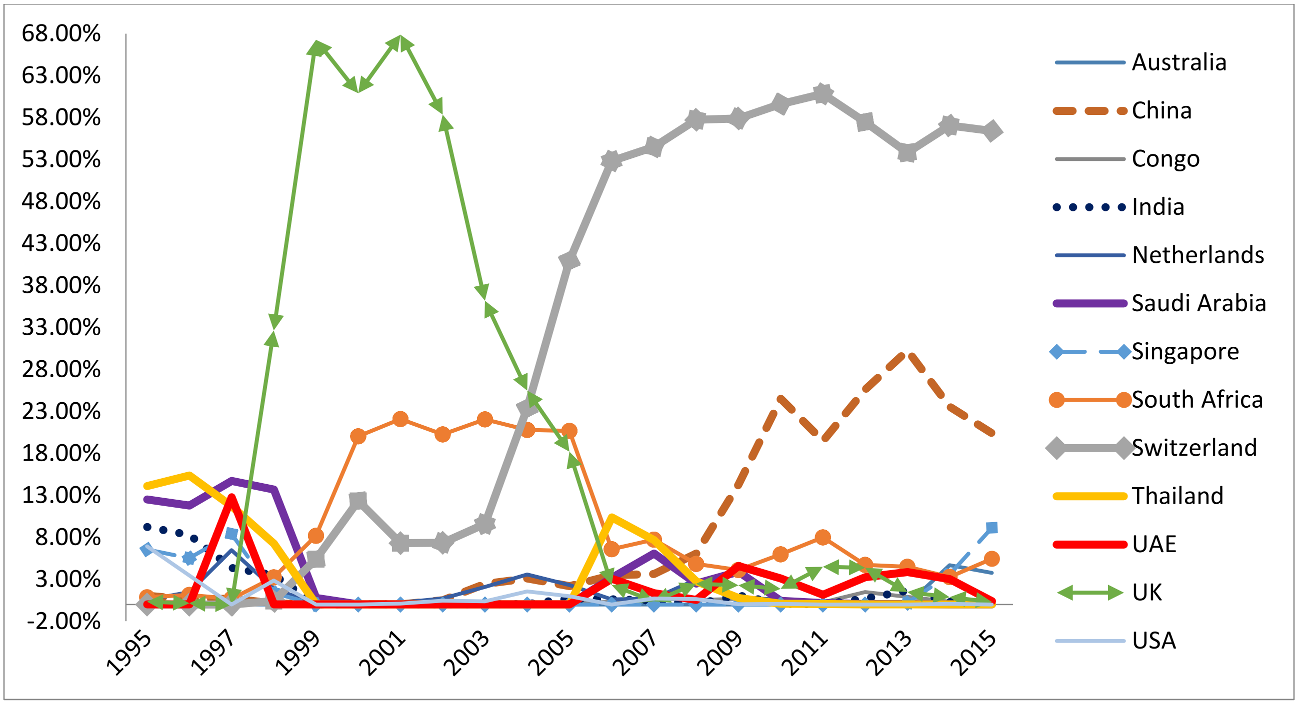

Figure 2: Zambia's Major Metal Exports Destinations as Reported by Zambia
Data Source: UNCTAD

As the world's leading importer of copper, China is involved in significant trade relations with Zambia's metal trading partner and trading intensity has gradually risen judging by the share of imports (see Figure 3). That is, Zambia's network of metal export destinations seems to share a cobweb-like relationship anchored on China through trade.

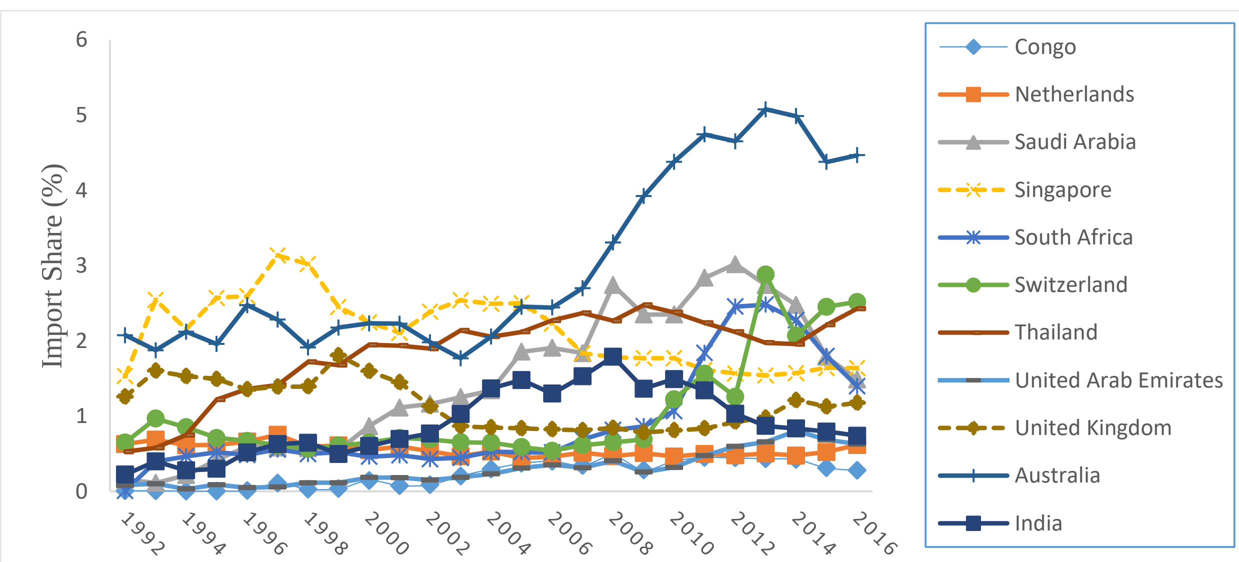

Figure 3: Chinese Imports from Zambia's Major Metal Trading Partners
Data Source: UNCTAD

While other large countries like the United States of America and the United Kingdom may also share significant trading relations with Zambia's other metal trading partners, the case of China provokes interest given its global dominance in mineral commodity imports in recent decades. Figure 4 shows that from 1995 to 2015, the share of Chinese imports from Zambia's other trading partners have averaged in excess of 20% on an annual basis.

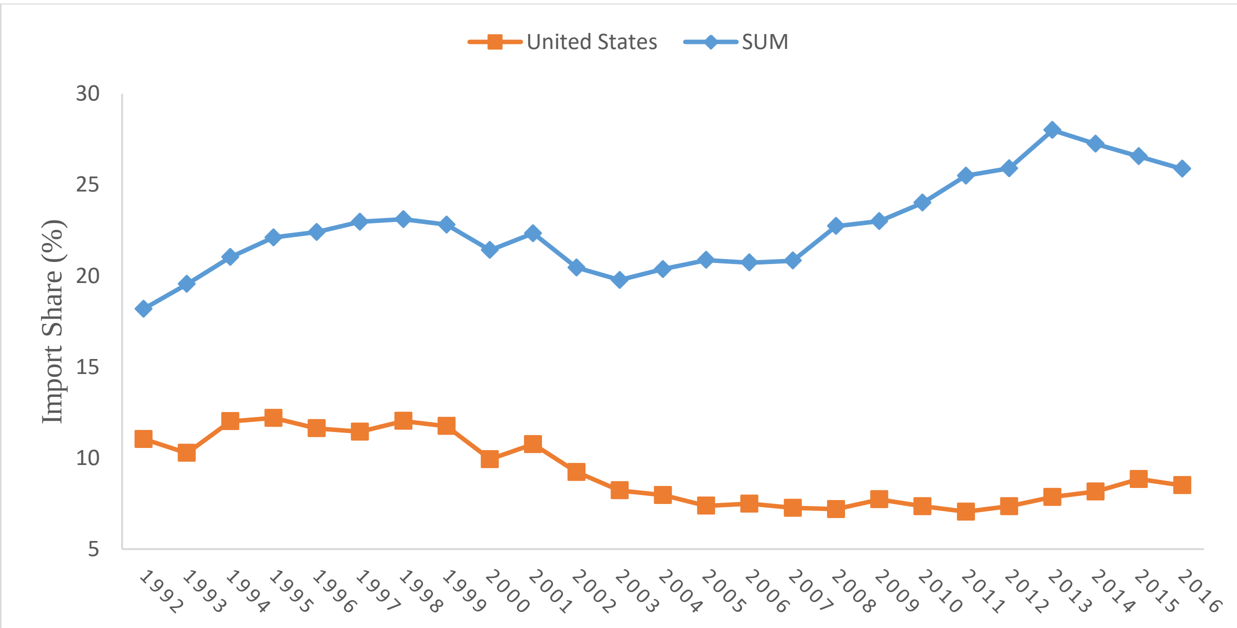

Figure 4: Aggregate Chinese Import Share from Zambia's Other Metal Export Partners
Data Source: UNCTAD

CHAPTER THREE

LITERATURE REVIEW

3.1 Introduction

This chapter reviews literature which is relevant to the study and this is split into theoretical and empirical reviews. In section 3.2, two trade theories are presented and one (Gravity model), which is in two versions explains the determinants of export flows while the other shows how production sharing between partners help in transmitting external shocks through trade. In section 3.3, an empirical review of the literature on similar studies is conducted.

3.2 Theoretical Models

3.2.1 The Gravity Model

Traditionally, trade among countries has been described on the basis of the concept of absolute and comparative advantage. These concepts date back to the times of Adam Smith and David Ricardo. Initially, trade was assumed to be beneficial if a nation exported more than it imported and this came to be known as the mercantilist view of trade (Salvatore, 2013). Over the years, the field of international trade has seen new/hybrid theories that try to explain trade flows among countries.

One of the most celebrated new theories is borrowed from the field of physics where it explains how the interactive force between two bodies is related to their masses and the distance existing between the two bodies. Named the Gravity Model, the model as used in international trade explains how trade flows between two countries is dependent on their sizes (income levels) and the distance between them and it is mathematically explained below. As used in physics, the gravity model is stated as follows:

$$GF_{ij} = \frac{M_i M_j}{D_{ij}}, i \neq j \tag{1}$$

GF_{ij} = gravitational force between objects i and j

M_i = mass of object i

M_j = mass of object j

D_{ij} = distance between objects i and j

Equation (1) states that the gravitational force between objects i and j is directly proportional to the masses of the objects and inversely proportional to the distance between them.

Traditional Gravity Model

Following Tinbergen (1962), the gravity model is used in explaining trade between two countries by replacing among many alternatives, export volume from country i to j in place of gravitational force, masses are replaced by the GDP values of the trading partners and the distance is maintained but now in the context of trading partners. With the foregoing, the gravity model of trade is stated as follows.

$$E_{ij} = \frac{GDP_i GDP_j}{D_{ij}}, i \neq j \qquad (2)$$

E_{ij} = Export volume between countries i and j

GDP_i = GDP of country i

GDP_j = GDP of country j

D_{ij} = distance between countries i and j

The gross domestic product is used as a measure of the size of an economy in the economic sense. Used in this sense, the traditional gravity model states that a country's exports are determined by the GDP of the trading partner and not her own GDP level. However, in economies where the import content in exports is quite high, domestic GDP can play a part in the determination of exports as a push factor (Rahmaddi and Ichihashi, 2011).

Structural Gravity Model

Over time, the gravity model has undergone a number of alterations to capture other features which characterize trade relations between/among nations. As explained here, this structural version is an extension of the traditional gravity model by Anderson and van Wincoop (2003) who incorporate multilateral resistance variables. Based on the Constant Elasticity of Substitution (CES) utility function first introduced by Armington (1969), the structural gravity model has been widely adopted in international trade studies. Applicable to a multi-country environment, the structural dynamic model assumes that each economy produces a variety of commodities which are tradable with the rest of the world and these commodities are differentiated by the country of origin.

It is assumed in this model that in any given period, the amount of products for trade a country can supply is fixed and each variety fetches a specific price. The model can be derived from either the demand or the supply side of the market but the solutions obtained are the same even in implication. Below, the model is explained from the demand side. Assuming that consumers have homothetic and identical CES preferences, the utility function for consumers in country j is given as below.

$$U = \left[\sum \alpha_i^{\frac{1-\sigma}{\sigma}} c_{ij}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \tag{3}$$

Where σ is the elasticity of substitution among products from different countries and it is greater than unit, α_i is a positive exogenous preference parameter while c_{ij} denotes consumption of a variety of products in country j imported from country i.

The model assumes that the price that consumers in the importing nation j pay comprise two components and these are the price at which one can buy the commodity at the point of production in country i (technically known as the factory gate price) and the bilateral trade costs which are at least unit. Denoting the former and the latter as p_i and t_{ij} respectively, the unit price is given as $p_{ij} = p_i t_{ij}$. As a result, the constraint facing consumers in the importing country j is as below.

$$\sum_i p_{ij} c_{ij} = E_j \tag{4}$$

With the above, consumers seek to maximize equation (3) subject to equation (4) and E_j is total expenditure on the imported goods as well as those that are domestically produced. The model assumes that the trade costs increases linearly with the distance over which products are transported following Samuelson (1952). The amount of expenditure (trade flows) that consumers in country j spend on imported goods from country i is found by solving the optimization problem above whose solution is

$$X_{ij} = \left(\frac{\alpha_i p_{ij}}{P_j}\right)^{1-\sigma} E_j \quad (5)$$

Where P_j is the CES price index in country j given by

$$P_j = \left[\sum_i \left(\alpha_i p_{ij}\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}} \quad (6)$$

Defining Y_i as the value of output in country i, this value of output is said to be equal to the amount of expenditure that the whole world (including country i itself) spends on all the varieties of products this country produces. As a result, Y_i can be expressed as in equation (7) below

$$Y_i = \sum_j \left(\frac{\alpha_i p_{ij}}{P_j}\right)^{1-\sigma} E_j \quad (7)$$

If $Y = \sum_i Y_i$, equation (6) can be written as equation (7) after dividing the former with Y throughout.

$$(\alpha_i p_i)^{1-\sigma} = \frac{Y_i/Y}{\prod_i^{1-\sigma}} \quad (8)$$

Where

$$\prod_i^{1-\sigma} = \sum_j \left(\frac{t_{ij}}{P_j}\right)^{1-\sigma} \frac{E_j}{Y} \quad (9)$$

When (7) is substituted into (5) as well as in (6), the amount of imports of country j from country i and the consumer price index thus obtained become

$$X_{ij} = \frac{Y_i E_j}{Y} \left(\frac{t_{ij}}{\prod_i P_j}\right)^{1-\sigma} \quad (10)$$

$$P_j^{1-\sigma} = \sum_i \left(\frac{t_{ij}}{\prod_i}\right)^{1-\sigma} \frac{Y_i}{Y} \tag{11}$$

The structural gravity model presented above has a number of implications in terms of trade relations among countries. Since $\sigma > 1$, it can be seen from equation (5) that exports from country i to country j conform to the law of demand in which case the quantity of exports demanded reduces with increasing prices. These prices are driven by both the cost of production in the export country and the distance (determining trading costs) between two trading partners and therefore the usual substitution effects of price dynamics apply.

When the cost of bilateral trading is set to equal unit and therefore products from a given country are sold at the factory gate prices to the rest of the world irrespective of the distance, and since consumption depends on the income level, larger economies (judged by their income levels) are predicted to import (demand) more than smaller ones and this is apparent in equation (10). This conclusion is very important in this study because of its emphasis on the role of external income (GDP) dynamics in influencing trade flows.

The component $\left(\frac{t_{ij}}{\prod_i P_j}\right)^{1-\sigma}$ captures the costs associated with international trade and they can be decomposed into three parts. Firstly, bilateral trade costs, t_{ij}, are shaped by many things among which are the distance between countries i and j as well as trade policy such as tariffs and trade agreements. The second and third components are aggregately referred to as multilateral resistance representing the ease with which countries can access markets. The structural term, P_j, represents inward multilateral resistance which indicates the ease with which the importer country can access other markets while $\prod_i$ is outward resistance measuring the exporter's market access ease. Based on this, Anderson and Wincoop's version of the gravity model predicts that the easier it is to access markets for countries i and/or j, the greater the trade volumes.

3.2.2 Production Sharing Model

Defining production sharing as trade in intermediate goods that are part of vertically integrated production networks that cross international borders, Burstein et al. (2008) developed a theoretical model explaining how such engagements help in propagating business cycles via trade and the model is presented as derived by the authors. Most commodity dependent economies especially in the developing world do not process their output into final products and therefore export them to be used as raw materials in the production processes of their trading partners.

The model assumes two economies (1 and 2) who are partners in trade with each specializing in the production of intermediate goods and these are then combined to produce two types of final goods – a vertically integrated good defining production sharing and a horizontally differentiated one. Both countries consume the latter but the former is only consumed by one economy. Apart from the difference in the consumption pattern of the two final goods, they also differ in their elasticities of input (home and foreign) substitution. Of particular interest in this model is that the vertically integrated final good has a very low elasticity of input substitution between the locally produced input and the one imported while the opposite is true of the horizontally integrated final good.

While the original model assumes that both countries produce both goods, in the use of this study focusing on an African economy which barely processes her metal extraction output into final products, it is assumed that only one country produces the vertically integrated composite final good. In what follows, the model is formally explained.

In each economy, a typical economic agent's preferences are characterized by the following expected utility function

$$U_i = maxE_0 \sum_{t=0}^{\infty} \beta^t u(c_{it}, 1 - \vartheta_{it}),\ i = 1,2 \qquad (12)$$

Where c_i and ϑ_i are the per capita consumption and employment in country i respectively, and

$$u(c, \vartheta) = \{1/(1 - \sigma)\}[c^{\mu}(1 - \vartheta)^{1-\mu}]^{1-\sigma} \qquad (13)$$

The production function of per capita output (z_i) of an intermediate input of its comparative advantage requires labour (ϑ_i)) and capital (k_i) which are both affected by country specific average productivity (A_i) which in itself stochastically changes over time and is stated as below.

$$z_{it} = A_i e^{s_{it}} (\vartheta_{it})^{\alpha} (k_{it})^{1-\alpha} \qquad (14)$$

$\alpha =$ value added labour share and $s_t = (s_{1t}, s_{2t})$ is a vector of aggregate productivity shocks.

Let the horizontally integrated composite final good be denoted as x and the vertically integrated good as v. As earlier stated, going forward the model is slightly modified to conform to the environment of the study such that x is produced by both countries but only country 2 (the developed country in this case) produces v.

The production function of x takes the following form

$$x_{it} = \left[\theta_i^{1-\rho}(x_{iit})^{\rho} + (1-\theta_i)^{1-\rho}\left(x_{ijt}\right)^{\rho}\right]^{1/\rho}, i = 1,2, \quad i \neq j \qquad (15)$$

Where x_{ijt} is the intermediate input imported from country *j* used in the production of the horizontally integrated composite good in country *i* at time *t* and therefore, x_{iit} is the domestically produced intermediate input in the production of *x* in country *i*. $1-\theta_i$ is a measure of the relative importance of the imported intermediate input in the production of *x* and the elasticity of substitution $[1/(1-\rho)]$ for the two inputs is, as per the earlier stated assumption, relatively high. The vertically integrated product is only produced in country two and its production function is as follows and interpretation of the parameters is similar to above but the only difference is that the elasticity of substitution $[1/(1-ב)]$ is lower than that of good *x*.

$$v_{2t} = [\lambda_2^{1-ב}(v_{22t})^{\rho} + (1-\lambda_2)^{1-ב}(v_{21t})^{ב}]^{1/ב} \qquad (16)$$

Both countries produce the tradable final product y_i^T and in country 2 (producing both the horizontally and vertically integrated final goods), the production function of the tradable final product is

$$y_{2t}^T = (x_{2t})^{\omega}(v_{2t})^{1-\omega}$$

Where ω is the weight attached to the horizontally integrated good. Assuming that country 1 does not engage in production sharing with other countries, its tradable composite good is $y_{1t}^T = x_{2t}$.

Further, the final manufactured tradable good, y_i^T, is assumed to be combined with the non-tradable good, y_i^N, to produce the final good which the economy either consumes or invests is produced as follows

$$y_{it} = (y_{it}^{T})^{\gamma}(y_{it}^{N})^{1-\gamma} \quad (17)$$

As already stated, the use of the final product imposes a resource constraint in each country stated as

$y_{it} = c_{it} + i_{it}$, where $i_{it} = k_{it+1} - (1-\delta)k_{it}$ and δ = capital depreciation rate

The resource constraint for intermediate goods in country 1 is

$$L_1 z_{1t} = L_1 x_{11t} + L_2 x_{21t} + L_2 v_{21t} + L_1 y_{1t}^{N}$$

Intermediate goods from country 1 are either used locally to produce x_1 and y_1^N or exported to produce x_2 and v_2.

On the other hand, the resource constraint for intermediate goods in country 2 is

$$L_{12} z_{2t} = L_2 x_{22t} + L_1 x_{12t} + L_2 v_{22t} + L_2 y_{2t}^{N}$$

Intermediate goods from country 2 are either used locally to produce x_2, $v_2$and y_2^N or exported to produce x_1.

Defining the tradable intermediate output as $z_{it}^{T} = z_{it} - y_{it}^{N}$, the share of the exportable output in country 1 is given by $s_1^X = L_2(x_{21} + v_{21})/L_1 z_1^T$ while that for country 2 is $s_2^X = L_1 x_{12}/L_2 z_2^T$. Country 1's share of exports accounted for in production sharing is $s_1^P = v_{21}/(x_{21} + v_{21})$ and therefore its share of production sharing in manufacturing GDP is $s_1^P s_1^X$.

Since it is assumed that v_{22} is not shipped from country 1, it is not included in the export measures described above. It should be noted that lowering ω while keeping s_1^X and s_2^X constant increasing the share of production sharing in s_1^P. When $\omega = 1$, then $s_1^P = 0$ and the model reduces to a standard two-country, the two-good model of Backus, Kehoe, and Kydland commonly referred to as the BKK model in trade literature.

By assuming the availability of complete contingent claims permitting economic agents to diversify country-specific risks across states of nature, the role of international trade in international business cycles is isolated. Pareto optimally allocations are also assumed where $L_1 U_1 + L_2 U_2$ is maximized subject to the resource constraints described above. Computing relative prices from the marginal rates of substitution across goods, the price of z_2 is considered a numeraire and p_t denotes the relative price of z_1.

Making use of the resource constraints, the GDP in country 2 in terms of the intermediate good z_2 is equal to $L_2 z_{2t}$ and the following national accounts identity holds:

$$L_2 z_{2t} = P_{2t}^{y} L_2 (c_{2t} + i_{2t}) + TB_{2t}$$

Where P_{it}^{y} is the price of the final good in country i and the trade balance TB_2 is

$$TB_{2t} = L_1 x_{12t} - L_2 p_t x_{21t} - L_2 p_t v_{21t}$$

Analogously, country 1's national accounts identity is

$$L_1 z_{1t} = P_{1t}^{y} L_1 (c_{1t} + i_{1t}) + TB_{1t}$$

And the trade balance is

$$TB_{1t} = L_2 p_{1t} v_{21t} + L_1 p_{1t} x_{21t} - L_1 x_{12t}$$

The price of the final product in country 2 is given by

$$P_{2t}^{y} = ฿_2 \left[\theta_2 + (1-\theta_2) p_t^{\rho/(\rho-1)}\right]^{\gamma\omega(\rho-1)/\rho} \left[\lambda + (1-\lambda) p_t^{\text{ב}/(\text{ב}-1)}\right]^{\gamma(1-\omega)(\text{ב}-1)/\text{ב}}$$

While that of country 1 is

$$P_{1t}^{y} = ฿_1 \left[\theta_1 p_t^{\rho/(\rho-1)} + (1-\theta_1)\right]^{\gamma(\rho-1)/\rho} p_t^{1-\gamma}$$

With $฿_1 = [\gamma^{\gamma}(1-\gamma)^{1-\gamma}]^{-1}$ *and* $฿_2 = ฿_1\left[\omega^{\gamma\omega}(1-\omega)^{\gamma(1-\omega)}\right]^{-1}$

Shock Transmission Mechanism

Examining the FOCs for the allocation of intermediate goods helps in gaining an understanding the shock transmission mechanism via trade in the model. Optimal allocation implies that country 2 allocates its intermediate output in such a way that

$\frac{(1-\theta_2)}{\theta_2}\frac{x_{22t}}{x_{21t}} = p_t^{1/(1-\rho)}$ in the production of x_2, and

$\frac{(1-\lambda)}{\lambda}\frac{v_{22t}}{v_{21t}} = p_t^{1/(1-\beth)}$ in the production of v_2

It is clear from a comparison of the two optimal conditions that for a given change in p, the model predicts that there should be larger reallocations between x_{22} and x_{21} than between v_{22} and v_{21} if $\rho > \beth$. This is a key mechanism which causes country 1's exports in v_{21} to be more correlated with country 2's output than country 1's exports in x_{21}.

In addition, optimality in the production of the horizontally differentiated composite good in country 1 implies that

$$\frac{\theta_1}{(1-\theta_1)}\frac{x_{12t}}{x_{11t}} = p_t^{1/(1-\rho)}$$

In the case that production sharing accounts for a higher fraction of trade (typical of most resource-based developing economies), more volatile prices imply that substitution between x_{11} and x_{12} (intermediate goods in country 1) partly offsets the positive cross country comovement in total final outputs.

Conclusions from the Theoretical Models Reviewed

This section has presented the theoretical predictions of how external trade stocks are likely to be propagated to domestic economies. The two variants of the gravity model show that the size of the economy, trade costs and multilateral resistance are important in explaining the dynamics in trade flows. The production sharing theory identifies trade relations between countries primarily based on intermediate materials (usually these flowing from a peripheral country to be used in the production processes of a core country) to be the key channel through which external shock contagion occurs.

3.3 Empirical Literature

Trade has become increasingly important in the growth potential and industrial development of economies around the globe. International trade enables economies to have a greater market for goods and services that are produced but cannot be wholly absorbed by the domestic market. However, international trade can pose a significant risk to an economy as increasingly open markets have also become one of the primary channels of the transmission of external shocks (UNCTAD, 2013). As such, there is extensive literature on understanding transmission of external shocks as well as key drivers of export demand.

Even before the time of the Keynesians who popularized the role of the external sector in the country's income components, trade has always been regarded as a significant driver of development. At global level, the world continues to open in many spheres including trade such that the dynamics of one economy's (especially bigger ones) macroeconomic fundamentals easily spill over to others. As a result, it has been argued that GDPs of countries with high trade intensities (have significantly high trade relations) commove. This hypothesis has widely been explored. In terms of commodity trade relations, raising output in an importer country has been found to have positive wealth effects in form of increased import demand (Bodenstein et al, 2011; Chen et al, 2012; Georgiadis, 2016).

In a seminal paper, Frankel and Rose (1998) investigate the role of trade intensity and business cycle correlations among members in formulating a currency union. Since then, several studies exploring the drivers of business cycle co-movements, mostly utilizing international real business cycle (IRBC) model, have found that cross country co-movements in output are pro-cyclical in response to shocks.

For example, Comin et al. (2014) find that between 1975 and 1990 when trade and FDI flows between Mexico and the US were relatively smaller than the 1990-2008 period, the co-movement in outputs for the two countries was non-existent. However, in the latter period (1990-2008), the expansions and contractions that the US economy underwent because of such events as the internet boom of the 1990s and the 2008 financial crises (including the dot.com bubble burst) are mirrored in the Mexican economy. This exemplifies the significance of trade intensity in business cycle correlations even in the presence of nominal rigidities (Huang and Lui, 2002).

Though attention in the literature is sometimes given to country level aggregates in terms of how events in one country may affect another through trade interaction, economies engage in trade through firms at significant scales. With commodities, international trade especially in developing-developed country setups, occur in firms which are connected by international production linkages vertically. This is more so with an increasing role of multinational companies (MNCs) operating subsidiaries in economies endowed with resources used as inputs in other country industrial processes. This has prompted some to study volatility in aggregates with particular focus on the role of firm level interactions especially between peripheral (primary commodity exporters) and core (primary commodity processing) countries.

Several studies (including those by Burstein et al., 2008; Di Giovanni and Levchenko, 2010; Gabaix, 2011; Foerster et al, 2011; Acemoglu et al., 2012) note that input-output linkages among firms are key in transmitting shocks from their sales to country level aggregates. For instance, Giovanni et al (2014) shows that firm shocks do covary in cases where the activities of the firms are interconnected and therefore diversification of exports across markets is important in reducing volatility of export revenue. While the foregoing does not indicate the degree to which production linkages influence aggregate (including output) co-movements, it highlights that a network of export destination can be important in export performance in an event of a shock.

The observation above has, however, been challenged by others such that there is controversy in the literature regarding the role of international trade in business cycle synchronization between/among trading partners. The controversy hinges on the fact that some (for example, Kose and Yi, 2006) say that it is hard to quantitatively attribute business cycle correlations to trade especially as found in studies which have been done with the theoretical underpinning of the standard international real business cycle models belonging to the BKK family.

The foregoing literature underscores the importance of international trade in economic activity integration especially among those countries whose firms are engaged in vertical production linkages as a basis for trade. Many studies which have focused on the determinants of exports have found that foreign income, which represents the size of the market, is a key driver of export performance on the demand side of the market (see for example, Houthakker and Magee, 1969, Chipili, 2010; Bussiére et al., 2011; Mwito et al., 2015). Since literature indicates that trade intensity among partners is important in explaining business cycle co-movements and foreign income is important in export demand, trading partner networks may have important implications on trade flows especially in the wake of a shock.

However, only a few studies focusing on trading partner networks have been done to explore the possible implications thus far. Utilizing trade-weighted annual GDP growth rates of all trading partners as a measure of external shock exposure, Bacchetta et al. (2009) find that low income countries that are less developed and therefore have less diversified exports in terms of products and markets (geography) are more exposed to partner income volatility. Recognizing that external shocks are sometimes not universal but rather country specific, Jansen et al. (2015) employed a measure of external shock exposure and methodology used by Bacchetta et al.

As regards the cycles and shock exposure, they decompose (unlike Bacchetta et al) the volatility (network risk) measure in the GDP growth rates of trading partners into the variance and covariance components. This allows them to distinguish between the risk countries face for trading with more or less volatile partners and the risk they face for choosing trading partners whose economic cycles are more or less correlated based on the trading profiles amongst themselves. They find that the correlation between trading partners' cycles is more important in explaining exporters' GDP volatility than the size of these cycles in individual trading partners.

That is, exposure to external demand shocks in partner countries is likely to be higher, the higher the GDP volatility in those partner countries. But a country's degree of exposure is also likely to depend on whether GDP changes move in the same or in opposite directions in different partner countries. In the latter case, demand changes in one country can balance out demand changes in other countries, reducing the exposure to partner country shocks in the exporting country. Key as media of transmitting these shock effects are significant trade relations (Easterly et al., 1993; Backus and Crucini, 2000; Melitz, 2003; Kose and Yi, 2006, Burstein et al., 2008; UNCTAD, 2016) and financial market integration (Krugman, 1999; Cespedes et al., 2004; Auel and Mendonca, 2011; Peltonen, Rancan & Sarlin, 2018).

The market concentration of exports only presents one side of the story as regards exposure to external shocks. Economies, especially those in the developing world also face external risk because of high concentration on a few products which are most likely primary commodities. Literature has shown that primary commodity export sectors are among the most volatile especially due to their price changes. The effect of high product concentration in exporter economies manifests themselves through experiencing stronger barter terms of trade (TOT) effect (Malik and Temple, 2009; Bachetta et al, 2009).

Baxter and Kouparitsas (2000), report that the effects of terms of trade are most severe in primary commodity exporters and the least in those exporting manufactured goods. The sources of these fluctuations are usually more pronounced in sufficiently larger partners than in smaller ones because of the former's ability to affect world prices. The effect of TOT fluctuations is minimal in developed and more diversified economies than in developing countries (Blattman et al., 2007; Jacks et al., 2011; Cavalcanti et al., 2014; UNCTAD, 2013).

The environment of operation of exporting firms, which is mainly shaped by the state of the macroeconomic fundamentals, also affects export performance. The state of the economy determines the competitiveness of the country's export sector and in the trade literature; the real effective exchange rate has been used widely to measure the competitiveness of the export sector especially. From a theoretical perspective, depreciation (devaluation in the case of the fixed exchange rate regime) of the currency makes an economy's exportable commodities more competitive because they become relatively cheaper. On the other hand, a significantly appreciating (devalued) currency is detrimental to export demand because of its effect on the export price.

In most studies involving aggregate export models, the real effective exchange rate has been said to capture the effects of the relative price dynamics on the basis of the purchasing power parity (both the absolute and relative versions) theory of exchange rate determination. As a result, the exchange rate has widely used in the estimation of price elasticity of export demand as well as a measure of the competitiveness of the export sector (Arize, 1997; Sousa and Bradley, 2009; Tan and Sousa, 2011; Raissi and Tulin, 2018). The use of the real exchange rate as a proxy for the price index of aggregate exports is because the former responds to changes in the latter especially in the case of commodity currencies (Chen et al., 2010).

More importantly, a number of studies have been conducted to determine the effect of exchange rate volatility on export performance. These studies have since gained popularity following the liberalization of the foreign exchange markets which started in the 1970s in some economies. Theoretically, high exchange rate volatility has been argued to have mixed impacts ranging from encouraging to discouraging international trade flows (Franke, 1991; Dellas and Zilberford, 1993). This is because the net effect is said to be dependent on the relative strengths of income and substitution effects of volatility.

In empirical work, volatility in the exchange rate had traditionally been measured by the standard deviation or variance of exchange rate changes. Based on these measures which have been deemed to inadequate (Engle, 1982; Arize, 1997), there is an ambiguity in literature regarding the effect of exchange rate volatility on trade flows and this is true for both developed and developing countries (Cote, 1994). Some argue that increased exchange rate volatility reduce export performance (Arize et al., 2000; Byrne et al., 2008, Musonda, 2008) while others have found that volatility is seen as an opportunity for profit making and therefore supports export growth (Chit et al., 2010; Hericourt and Nedoncelle, 2015, Tunc et al., 2018).

The criticism on the measure exchange rate volatility apparently does not seem to be the source of the divide in the conclusions of how trade flows relate to exchange rate risk. This is because, although the GARCH approach of measuring volatility has been said to be superior, the controversy still exists in this area. For example, in a study on Zambia's flows trade, Chipili (2013) finds that exchange rate volatility depresses exports in some commodities while promoting export growth in others. Focusing on non-traditional exports and with a GARCH measure of volatility, Musonda (2008) finds that increased exchange rate dampens export performance.

Empirical Literature Summary and Gap

The empirical literature reviewed above agrees that trade intensity plays a significant role in output co-movement especially during times of shocks. Given the role that external income plays in export demand, a network (anchored on trade) of export destinations may have significant implications on trade performance in the exporter nation. Terms of trade and the real exchange rate which capture export price movements and therefore competitiveness have significant influences on exports.

Although the literature is huge on export demand and the role of foreign income dynamics, only a few studies have been done on the effect of a network of export destinations on the exporter nation. Besides, a handful of the studies conducted thus far have explored effects on output or export level. In addition, trade policy in developing countries has emphasized product diversification, with little focus on destinations. That is, the area of the role of the geographical concentration of exports on export performance due to external shocks has not been adequately explored and is nonexistent in Zambia. This is despite a significant role which the export sector plays in economic development and that market diversification can foster export growth, stability and ultimately economic growth.

CHAPTER FOUR

METHODOLOGY

4.1 Model Specification

In order to do empirical analysis, the following equations explained below were used in the study. Equations 18 and 19 follow the approach utilized by Chipili (2013) and Musonda (2008) with slight alterations in terms of the variables included in addition to external GDP (Y^*) and export relative price (P).

$$ln(EX_t) = \alpha_0 + \alpha_1 ln(Y_t^*) + \alpha_2 ln(P_t) + \alpha_3 ln(TOT_t) + \alpha_4 ESEM + \varepsilon_t \quad (18)$$

The dependent variable EX is metal exports value and the extra independent variables TOT and ESEM in the above equation are the barter terms of trade and risk of external demand shock exposure due to export destination network. The latter variable is explained in detail in the next section. The signs of the coefficients α_1, α_2 and α_3 are all theoretically expected to be positive. On the other hand, α_4 can either be positive or negative depending on whether exporters are risk loving or averse respectively.

Presented in equations 19-21 below are the volatility models.

$$ln(EX_t) = \alpha_0 + \alpha_1 ln(Y_t^*) + \alpha_2 ln(P_t) + \alpha_3 ln(TOT_t) + \varepsilon_t \quad (19)$$

$$ln\left(\sigma_{EX,t}^2\right) = \varphi + \theta \frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{E,t-1}^2}} + \tau \frac{\varepsilon_{t-1}}{\sqrt{\sigma_{E,t-1}^2}} + \pi ln\left(\sigma_{E,t-1}^2\right) + \beta ESEM_t + \boldsymbol{\vartheta X_t} + \mu_t \quad (20)$$

$$ln\left(\sigma_{EX,t}^2\right) = \varphi + \theta \frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{E,t-1}^2}} + \tau \frac{\varepsilon_{t-1}}{\sqrt{\sigma_{E,t-1}^2}} + \pi ln\left(\sigma_{E,t-1}^2\right) + \beta_1 ESEM\_VAR_t + \beta_2 ESEM\_COV_t + \boldsymbol{\vartheta X_t} + \mu_t \quad (21)$$

Where $\sigma_{EX,t}^2$ is the conditional variance of the export function (equation 19 which is widely known as the mean equation) residuals measuring volatility in exports at time t. The coefficient π measure the persistence of shocks, τ is used to detect the possible existence of asymmetric effects in volatility while θ captures the shock effect magnitude. If the coefficient θ is negative (positive), it means that a negative (positive) shock increases (reduces) export volatility. It is important to note that with only the first four additive terms, equations 20 and 21 are adopted from Nelson (1991).

The addition of extra explanatory variable to the EGARCH model is meant to capture the role of those variables on volatility (Glosten, Jagannathan and Runkle, 1993) and **X** is a vector of controls. The vector **X** contains real effective exchange rate volatility (REER_VOL) and barter terms of trade volatility (TOT_VOL) following Jansen et al. (2015) and Bachetta et al. (2009). These controls are expected to, individually, have positive effects on export volatility.

Equations (20) and (21) are the Exponential Generalized Autoregressive Conditionally Heteroscedastic (EGARCH) models of volatility. Since both models include only one lagged term of the dependent variable (σ^2) and the residuals (ε) from model (19), they are specifically called EGARCH (1, 1). The use of the EGARCH model as opposed to the GARCH models is that the former takes into account of the possible asymmetries in terms of the effect of negative and positive shocks of the same magnitude on the volatility of the dependent variable. Literature indicates that a negative shock is most likely to lead to higher volatility than a positive shock of the same magnitude because most economic agents are said to be risk averse. Besides, with the EGARCH model, one needs not to impose sign restrictions on the parameters of the model (Brooks, 2008).

Of special interest in this study is the variable $ESEM$ which is a measure of external demand shocks constructed as explained in the next section. In equation (21), the measure of risk due to external demand shocks has been decomposed into the direct ($ESEM\_VAR$) and indirect ($ESEM\_COV$) components following Jansen et al. (2015) and they, respectively, represent partner business cycles and business cycle correlations. The decomposition is in the interest of knowing which of the two risk sources is more important in explaining metal export volatility for Zambia. The latter is special in determining how well a country's exports are diversified geographically.

4.2 The Measure of External Demand Shock Exposure (ESEM)

Literature has shown that changes in the gross domestic product for a given country tend to have an effect on that country's demand for imports. Specifically, volatility in GDP of a foreign nation is expected to explain the volatility in exports in the domestic economy (Jansen et al., 2015). To measure the exposure to external demand shocks, a variable as expressed in equation (22) below is constructed.

When the volatility in GDP of a trading partner is high, then the exposure to export demand shocks for a country is likely to be higher. Besides, a country's degree of exposure is likely to depend on whether GDP growth rates for two or more distinct partners are positively or negatively correlated. The latter case (negative correlation) is good for a country in an event of a negative external shock by reducing the exposure that a country is subjected to directly.

$$ESEM_{zt} = \sum_j \left(\frac{x_{zjt}}{X_{zt}}\right)^2 var\left(GDPgrowth_{jt}\right) + \sum_z \left(\frac{x_{zct}}{X_{zt}}\right)\left(\frac{x_{zk}t}{X_{zt}}\right) cov(GDPgrowth_{ct}, GDPgrowth_{kt}) \quad (22)$$

$k \neq c$;

x_{zjt} = the value of metal exports from Zambia to country j in quarter t

X_{zt}= Zambia's total value of metal exports to all of its export destinations in quarter t

x_{zkt} = the value of metal exports from Zambia to country k in quarter t

x_{zct} = the value of metal exports from Zambia to China in quarter t

The ESEM in equation (22) above is the variance of the weighted average of the annual GDP growth rate volatilities for Zambia's top metal export trading partners. The variance of the GDP growth rates are squared residuals of an autoregressive model of order one, AR(1), and the same framework is used in estimating the mean growth rate used in the computation of the covariance component. That is, the covariance is taken to be the product of the residuals of the two countries AR(1) processes of their GDP growth rates. This regression approach in measuring GDP volatility is similar to that employed by Lensink and Morrissey (2006) and was preferred here because of its ability to only capture the transitory variation in a time series variable.

The first term on the right hand side reflects the exposure to risk associated with volatility in the GDP growth rate of partner countries and the second term reflects the exposure to risk associated with the covariance of the partner's GDP growth rate volatility. Each of the variance and covariance terms for each trading partner is weighted by the importance of each of the individual countries in Zambia's export basket. This measure of external exposure risk and its computational approach is based on the corporate finance definition of portfolio risk proposed by

Markowitz and Tobin and has thus far been used by Jansen et al. (2015) and Bacchetta et al (2009) in modeling GDP volatility.

4.3 Estimation Techniques

Equation 18 is estimated using the Johansen cointegration technique while equations 20 and 21 are, each, simultaneously estimated with equation 19 using the Maximum Likelihood Estimation (MLE) method. The second approach in estimating the volatility models is on account that EGARCH models are not linear in nature. As usual, the pre-estimation tests for stationarity of the variables were done. EGARCH models of volatility are built on the three fundamental assumptions in terms of their adequacy and these are the normality of residuals, absence of serial correlation in the errors as well as the absence of the ARCH effect in the model. These assumptions, together with those of equation 18, were tested to ensure that the models were adequate.

4.4 Data Sources and Types

Covering the period 1995-2016, quarterly data used in this study were sourced from the Bank of Zambia (real exchange rate, metal exports), World Bank's World Development Indicators' excel spreadsheet (real GDP in US$ for Zambia's metal trading partners) and World Integrated Trade Solution database of the UNCTAD (country level metal export shares).

As explained in the context of the study and according to the Zambia Institute for Policy Analysis and Research (ZIPAR), most of Zambia's copper reported to being exported to Switzerland actually go to China.[9] This is also cited by Berne Declaration (2012) in reference to Africa's commodities bought by Swiss commodity trading companies. In this regard, trading shares for China and Switzerland were mirrored from those countries' current accounts and adjusted (deflated) by a factor of 1.06 used by the IMF to account for differences in the valuation methods of imports and exports.

The choice of the period of consideration is necessitated by lack of trading partner metal export shares as well as lack of disaggregated trade data before 1995. Exports were measured in value

[9] www.daily-mail.co.zm/discrepancies-copper-trade-records/

terms with the US$ used as a valuing currency. In order to capture the competitiveness of the metal export sector in Zambia, the relative metal export price was proxied by the real effective exchange rate (REER), an approached previously used by Chipili (2013). External demand volatility is measured by ESEM as defined above.

The construction of external GDP and the ESEM variables required that GDP and the associated growth rates for each partner, respectively, be used and these variables were weighted using their yearly demand share in Zambia's metal export basket so as to give representative importance of each trading partner. Unlike Chipili (2013) who uses static weights in computing external GDP, this study employed dynamic weights because trade shares vary with time.[10] However, even if some economies compute GDP on a quarterly basis, this variable was only adequately available annually in the countries considered in this study. To ensure data compatibility as a result, GDP was interpolated from annual to quarterly data using the cubic-last-match previously used by others in the literature (Chipili, 2013; Baum and Caglayan, 2010).

[10] See Figure 4 in chapter 2 on how trading shares for the partners considered in the study evolved

CHAPTER FIVE
PRESENTATION OF FINDINGS

5.1 Descriptive Statistics

Table 3 shows the descriptive statistics of all the variables used in this study. The data series have 85 observations and none of the variables (except external GDP) was normally distributed individually as confirmed by the Jarque-Bera test statistic of normality. Specifically, EX, REER, GDP and TOT are fat tailed while the rest of the variables are long tailed since the former variables have Kurtosis values less than 3 while the converse is true for the latter (Gujarati, 2004). It is, however, important to note that non-normality (skewness) of individual variables does not have implications on times series estimations but that of the model error term does (Fox, 2016; McDonald and Michelfelder, 2017).

	EX	REER	GDP	TOT	REER_VOL	TOT_VOL	ESEM	ESEM_VAR	ESEM_COV
Mean	831.14	81.32	1389114	152.96	47.36	0.03	0.09	0.08	0.01
Median	714.98	88.09	1351772	169.34	28.98	0.03	0.03	0.02	0
Maximum	2011.99	115.84	2799286	210.82	270.01	0.09	0.98	0.88	0.1
Minimum	105.76	50.72	138406	87.13	2.02	0.02	0	0	-0.03
Std. Dev.	616.3	19.68	702850	42.21	51.88	0.02	0.19	0.18	0.02
Skewness	0.38	-0.04	0.34	-0.29	2.03	1.24	3.28	3.31	2.76
Kurtosis	1.79	1.41	2.2	1.54	7.62	4.03	12.92	13.04	11.04
Jarque-Bera	7.23	8.94	3.9	8.75	134.09	25.41	501.48	512.57	336.7
Probability	0.03	0.01	0.14	0.01	0.00	0.00	0.00	0.00	0.00
Observations	85	85	85	85	85	85	85	85	85

Table 3: Variable Descriptive Statistics

5.2 Unit Root

The traditional approach in modeling time series data requires that before data analysis is done, a test for stationarity of variables be conducted on the variables of interest first. This is to ensure that the relationships that are estimated are not spurious. The results for the unit root tests are presented in Table 4. These results are confirmed by the ADF and backed by P-P tests of stationarity.

	ADF				P-P		
	Level	1st Diff.	Lag(SIC based)	Assumption	Level	1st Diff.	Band-width
Log(EX)	-2.63	-8.29***	0	C&T	-2.64	-8.30***	3
Log(P)	-2.61	-6.75***	1	C&T	-2.12	-6.75***	3
Log(GDP)	-2.19	-3.62**	4	C&T	-2.39	-3.61**	3
Log(TOT)	0.31	-2.45**	7	None	-0.25	-2.85***	3
REER_VOLATILITY	-4.91***		0	C	-4.99**		3
TOT_VOLATILITY	-4.04***		0	C	-3.94***		3
ESEM	-2.30**		6	None	-2.86***		3

Notes: Assumption refers to the deterministic terms included where C=constant and T=linear trend.
The asterisks *, ** and *** imply significance at 10%, 5% and 1% levels respectively

Table 4: Unit Root Tests

The results show that logs of metal exports (EX), relative exports price (P), external gross domestic product (GDP) and barter terms of trade (TOT) are all integrated of order 1. On the other hand, volatility in the real effective exchange rate (REER_VOLATILITY), volatility in the barter terms of trade (TOT_VOLATILITY) and the measure of external demand volatility (ESEM) are all stationary in level form.

5.3 Cointegration

Having found that the variables of the mean equation (equation 1) are integrated of order (1) except for ESEM, a Johansen test of cointegration to determine the possible existence of the long run relationship among the variables was conducted. The cointegration test results are shown in Table 5. It is important to note that in this test, barter terms of trade (TOT) and ESEM entered as exogenous variables and doing so does not affect the critical values of the test.

	TRACE			MAX		
	None	At Most 1	At Most 2	None	At Most 1	At Most 2
Log(EX)	49.42***	21.07	9.68	28.82**	11.39	9.68

Notes: The Trace 5% critical values for None, At Most 1 and At Most 2 are 42.92, 25.87 and 12.52 respectively while those for the Max are 25.82, 19.39 and 12.52 in the same order. The asterisks *, ** and *** imply significance at 10%, 5% and 1% levels respectively.

Table 5: Johansen Cointegration Test

The test was based on both the Trace statistic and the Maximum Eigenvalue approaches with the assumption of the linear intercept but no trend. As can be seen in the results table, both approaches agree that there was only one cointegrating equation indicating the existence of a stable long-run equilibrium relationship between the variables. The existence of only one cointegrating vector is also obtained with the assumptions, though not used in the study, of intercept and trend (both linear and quadratic).[11]

5.4 Long Run Elasticity Estimates

The presence of cointegration relationship among variables allows for the estimation of the model with non-stationary level variables without worrying of spurious estimates (Gujarati, 2004). Before the long run model was estimated, a lag selection test based on the unrestricted Vector Autoregressive (VAR) model was conducted. The Akaike Information Criterion (AIC) was used in the selection of the lag leading to optimal lag value of 5 as indicated in Table A2 in the appendix.

The Vector Error Correction (VEC) model was then estimated and long run model results are shown in Table 6. The output indicates that foreign income is important in the long run and Zambia's metal exports' external income elasticity was about 0.59%. That is, a 10% increase (decrease) in external income led to an increase (decrease) of 5.9% in metal exports, holding all other factors constant. However, the relative price of exports was found to be statistically insignificant in influencing metal exports in the long run despite having the expected sign.

Variable	**Log(P)**	**Log(GDP)**
Coefficient	0.65	0.59~
Test Statistic	[1.00]	[4.46]

~ implies significance at a minimum of 5% level based on the 2-t rule of thumb

Table 6: Long Run Elasticity Estimates

5.5 Short Run Model Estimates and Granger Causality

Table 7 shows the results for the short run metal export model and to ensure that the standard errors are heteroscedastic-robust, the estimation is done with the Newey-West HAC option

[11] See Table A1.0 in the Appendix

(Chipili, 2013). To ensure adequacy of the model, diagnostic tests of serial correlation, normality and heteroscedasticity were conducted.

Variable	Coefficient	Std. Error	T-Statistic	Prob.
ECT	-0.311121	0.067321	-4.62144	0.0000
D(LOG(EX(-1)))	0.121618	0.105481	1.152983	0.2535
D(LOG(EX(-2)))	0.093753	0.103481	0.905999	0.3686
D(LOG(EX(-3)))	-0.072886	0.095739	-0.761298	0.4495
D(LOG(EX(-4)))	0.038513	0.128461	0.299803	0.7654
D(LOG(EX(-5)))	-0.118321	0.114565	-1.032785	0.3058
D(LOG(P(-1)))	0.751335	0.384912	1.951967	0.0556
D(LOG(P(-2)))	-0.904611	0.448939	-2.014995	0.0484
D(LOG(P(-3)))	0.172054	0.40866	0.421021	0.6752
D(LOG(P(-4)))	-0.776333	0.332561	-2.334407	0.0229
D(LOG(P(-5)))	0.046668	0.355727	0.13119	0.8961
D(LOG(GDP(-1)))	-1.985616	0.259872	-7.640734	0.0000
D(LOG(GDP(-2)))	3.034839	0.467847	6.486815	0.0000
D(LOG(GDP(-3)))	-2.761581	0.61164	-4.515041	0.0000
D(LOG(GDP(-4)))	1.3069	0.574509	2.274814	0.0265
D(LOG(GDP(-5)))	-0.649442	0.332549	-1.952922	0.0555
C	-3.589853***	0.894827	-4.011783	0.0002
LOG(TOT)	0.723924***	0.179183	4.040127	0.0002
ESEM	0.233261**	0.11002	2.120169	0.0381
Diagnostic test	Normality (JB)	Serial Co (LM)	Het (BPG)	Adj $R^2 = 0.36$
Test Stat [P-Value]	JB=1.69 [0.43]	F=1.30 [0.28]	F=1.19 [0.30]	

The asterisks *, ** and *** imply significance at 10%, 5% and 1% levels respectively

Table 7: ECM Results Adjusted by Newey–West HAC Standard Errors and Covariance

The model is found to be free of serial correlation in the errors and the variance of the error term is homoscedastic in addition to passing the normality test. Figures A2.0 and A3.0 in the appendix also indicate that the model is dynamically stable using both the CUSUM and CUSUM of squares tests thereby supporting statistical conclusions.

As theoretically expected, the error correction term (ECT) indicates that when there is a disturbance in the long-run equilibrium between metal exports, relative price and external income, it corrects back at a rate of about 31% per quarter. That is, metal exports take slightly below 10 months to adjust (restoring long run equilibrium) to changes in relative export prices and external income once disequilibrium occurs. The study also found that in the short run, increased barter terms of trade and economic growth volatility dynamics (ESEM) in the trading partner network boost metal exports level. Interestingly, the short run positive effect of external exposure is driven by economic growth volatility in individual partner economies outweighing the negative effect of business cycle correlations as shown in Table A3.0 in the appendix.

To determine whether metal exports were sensitive to own past changes, past changes in relative price and external GDP, granger causality tests were conducted using the Ward coefficient restriction test.[12] The direction of causality was determined by the pairwise granger causality test. The Granger causality test results are presented in Table 8. It can be seen that metal exports were found not to be sensitive to own past changes. However, they are sensitive to both joint and individual past changes in relative export price and external GDP.

Null Hypothesis	Test Statistic	P-Value	Direction
Metal Exports do not granger-cause themselves	$F = 1.41$ $\chi^2 = 7.06$	0.23 0.22	
P does not granger-cause metal exports	$F = 4.73$ $\chi^2 = 23.63$	0.00 0.00	Uni-Directional
GDP does not granger-cause metal exports	$F = 12.22$ $\chi^2 = 61.12$	0.00 0.00	Uni-Directional
P and GDP do not jointly granger-cause metal exports	$F = 11.31$ $\chi^2 = 113.13$	0.00 0.00	

Table 8: Granger Causality Tests

[12] See Table A4.0 in the Appendix

5.6 Metal Exports Volatility

In what follows, metal export volatility was modeled using the Exponential Generalized Autoregressive Conditional Heteroscedastic (EGARCH) model. Two sets of parsimonious models were estimated and the first one made use of the total measure of external demand shock exposure constructed as explained in the preceding chapter. The second set is one in which ESEM is decomposed into risk due to volatility in individual partner countries (ESEM_VAR) and risk due to GDP growth volatility correlations between the Chinese economy and that of other metal trading partners of Zambia (ESEM_COV).

Table 9 reports results for the first four models with an aggregated measure of external demand risk exposure in the variance equation. From the mean equation, we see that relative export price, external GDP and terms of trade all have significant short run individual positive effects (except for GDP in model 3 and the significance in model 4 is significant at 10% level) on Zambia's metal exports in the short run. The change in the signs and magnitudes of the mean equation coefficients across models indicate that the twin equations (mean and variance) are not orthogonal and this is common (Brooks, 2008)

The variance models are stable (converge to the long run unconditional variance once disturbed) since the volatility persistence (GARCH) coefficient is less than unit (Nelson, 1991). Besides, the models pass diagnostic tests of normality, no remaining ARCH effects and absence of serial correlation and the results are in the appendix.

All the four volatility models show that information about last quarter's volatility tends to dampen volatility in the current quarter and in the first three models, there are indications that negative shocks tend to affect volatility more than a positive shock of the same magnitude. In addition, the persistence of shocks seems to be moderate as the GARCH coefficients are all individually less than 0.5 across all models.

Variables	Model 1	Model 2	Model 3	Model 4
Mean Equation				
C	-0.0258***	-0.0438***	-0.0078***	-0.0086
D(LOG(P))	1.1447***	0.8453***	1.2968***	1.0601***
D(LOG(GDP))	0.1766***	0.2294***	-0.0453***	0.0622*
D(LOG(TOT))	1.0704***	2.3462***	0.7263***	1.4312***
Variance Equation				
C	-1.0539***	-1.9765***	-2.6488***	-2.8183***
SHOCK_MAGNITUDE	-1.5406***	-2.0663***	-2.2177***	-2.1134***
ASYMMETRIC_EFFECT	-0.2147**	-0.1919*	-0.0040***	-0.2453
VOLATILITY_PERSISTENCE	0.3982***	0.1226***	0.0970***	0.1274***
ESEM (PARTNER_NETWORK_EFFECT)	1.1654***	0.2955	1.4307***	0.3630
REER_VOLATILITY		0.0078***		0.0058***
TOT_VOLATILITY			28.2906***	25.9351***

The asterisks *, ** and *** imply significance at 10%, 5% and 1% levels respectively.

Table 9: Metal Export Volatility (Pre-Network Effect Decomposition)

Of interest in this study was to determine whether a network of Zambia's metal trading partners anchored on China have a significant effect on export volatility. In model 1, the measure of external demand volatility was added to the variance equation as an additional explanatory variable besides the ARCH and GARCH terms and it was observed that the trading partner network risk positively affects the volatility of metal exports. That is, when external demand risk increases, the volatility in Zambia's metal tend to increase too. In model 2, volatility in the real effective exchange rate (REER_VOLATILITY) was added and interestingly, exchange rate volatility captured the effect of the export destination network risk.

In model 3 on the other hand, volatility in barter terms of trade (TOT_VOLATILITY) was added. The observation with this was that despite TOT_VOLATILITY positively affecting metal export volatility, network risk still remains a significant factor in the model. Finally, model 4 includes both volatility in the real effective exchange rate and barter terms of trade. The results show that with the two controls, the network does not affect metal exports volatility. The results in the foregoing volatility models indicated that the effect of the network of Zambia's metal exports destinations tends to be transmitted through the exchange rate.

Jansen et al. (2015) identify two ways in which countries can be exposed to external shocks (external demand volatility) through trade. The first is because each of the trading partners is susceptible to economic growth volatility and the second is so because these growth volatilities may be correlated in their occurrence among partners of a given exporter nation. In the results shown in Table 10, models are similar to those in the preceding table but in the current case, the destination network risk measure was decomposed into risk due to GDP growth volatility in individual trading partners (ESEM_VAR) and their correlations (ESEM_COV) between China and Zambia's other metal trading partners.

The coefficients (including significance) for the ARCH, asymmetric, GARCH terms and the variables in the mean equations are similar to those observed in Table 9. Models 1 and 2 investigated whether ESEM_VAR and ESEM_COV, respectively, are individually important and the results show that GDP growth volatility in individual partner countries as well as their correlations with Chinese economic growth pose a significant risk by amplifying volatility in Zambia's metal exports. Most importantly, it was observed that GDP growth volatility correlations among trading partners have a higher magnitude of influence on metal exports volatility than economic growth volatilities in individual partner economies.

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Mean Equation					
C	-0.0217***	-0.0171***	-0.0093	-0.0066	-0.0078
D(LOG(REER))	1.1689***	1.3053***	1.0767***	1.0855***	1.0628***
D(LOG(GDP))	-0.0266	0.0656	0.0580	0.0732**	0.0672*
D(LOG(TOT))	1.1763***	0.9812***	1.4406***	1.5058***	1.3251***
Variance Equation					
C	-0.6374***	-0.7622***	-2.7941***	-2.8148***	-2.8133***
SHOCK_MAGNITUDE	-0.9330***	-1.0815***	-2.1224***	-2.0617***	-2.1657***
ASYMMETRIC_EFFECT	-0.4751***	-0.3564***	-0.2572	-0.2611	-0.1977
VOLATILITY_PERSISTENCE	0.6251***	0.5643***	0.1299***	0.1518***	0.1063***
ESEM_VAR	0.7465**		0.3484		0.5466
ESEM_COV		8.7236***		3.6595	-0.1726
REER_VOLATILITY			0.0056***	0.0064***	0.0054***
TOT_VOLATILITY			26.2919***	26.4531***	24.5587***

Notes: The asterisks *, ** and *** imply significance at 10%, 5% and 1% levels respectively. ESEM_VAR=Volatility in trading partner GDP growth; ESEM_COV=Business cycle correlations between China and other trading partners.

Table 10: Metal Export Volatility (Post Network Effect Decomposition)

After partialling out the effect of the real effective exchange rate and barter terms of trade volatilities in models 3 and 4, it was observed that the two measures of external risk exposure no longer explain metal exports volatility individually. Finally, model 5 is complete with all the variables of interest in the variance equation included. Just like in the preceding case, the network of trading partners does not pose any significant risk to Zambia's metal exports after controlling for the effects of volatility in the real effective exchange rate and barter terms of trade. This result reinforces the above observation that the effect of the export destination network in as far as exposing the economy to external shocks manifests itself through exchange rate volatility and terms of trade volatility.

CHAPTER SIX
DISCUSSION, IMPLICATIONS AND CONCLUSION

6.1 Introduction

In the preceding chapter, an analysis meant to understand the role of trading partner GDP in Zambia's metal exports, as well as the level and volatility effect of the export-destination network on the country's metal exports, was provided. This chapter discusses and presents the policy implications of the study findings in sections 6.2 and 6.3 respectively. In the end, the overall conclusions of the study based on the objectives are drawn in section 6.4 before highlighting the limitations and suggestions for future research.

6.2 Discussion of Study Results

The performance of the export sector is of particular interest to policymakers because of the role it plays in the growth of economies. Lacking or having inadequate production capacity, a significant number of countries in the developing world, in particular, export their commodities, in raw form. Their performance in terms of export revenue and therefore foreign reserves significantly depend on the price dynamics of those commodities. Hugely if not wholly determined on the international market, prices of commodities are susceptible to events which affect the economic performance of the major importers (usually larger countries) of the commodities and therefore export demand.

In the case of Zambia, which has seen an increasing role of the Asian economies in importing the country's metal exports especially at the dawn of the 21st century, the study found that external income (trading partner GDP) is a key determinant of demand in the long run. The finding in this study that the response of metal exports for Zambia is less proportionate to changes in external income is in contrast to previous findings (Houthakker and Magee, 1969, Chipili, 2010; Bussiére et al., 2011; Mwito et al., 2015). These authors find that external income elasticity of export demand is elastic.

One possible factor accounting for the inelastic foreign income elasticity of metal exports demand may lie in the fact that smaller weights were given to the GDP of Switzerland (reported to be the major importer of Zambia's copper which dominates metal exports). This is the case in this study because trade data in terms of export shares were mirrored as reported by the Swiss authorities in their current account. Besides, increased financialization of commodity markets and the increasing role of commodity traders found in non-commodity consuming economies may weaken the effect of external income in consuming economies on commodity exports.

By and large, the importance of external income in domestic metal export performance lies in the fact that these commodities are exported in the semi-finished form with little value added post-mining (Chipili, 2013). With positive growth in external income, the consumption demand also increases for all products including those produced from primary metals such as copper. Since demand for copper and cobalt in its primary form is derived, increases in external income (partly due to a thriving industrial sector in the importer nation) stimulate the demand for these exports (Stuermer, 2017).

In the short run, the study found that metal exports for Zambia are stimulated with increasing demand risk. There are a number of explanations in literature as to why this may be the case and the first of which pertains to how commodities such as copper are traded. Most commodity exporters enter into long term selling contractual arrangements with international buyers whose terms may not significantly change in the short run and therefore will be committed to supplying as stipulated in the contracts as long as they are able to cover their variable costs (Chipili, 2013).

Secondly, the response of exporters to external demand shocks depends on their behaviour towards risk. With increased utilization of commodity financial derivatives on the commodity exchanges, commodity traders, see opportunities for profit gains in commodity price fluctuations caused by external demand shocks through their speculative motives. As a result, their desire to make a profit after recovery pushes them to pursue a buy and hold strategy and therefore stimulating exports for exporters who are willing to sell even at depressed prices.

Thirdly, exporters may actually increase the volume of their exports by countering the negative price effect because they want to maintain certain levels of revenue targets they set (De Grauwe, 1988). The cost or opportunity loss associated with such decisions may be hoped to be recouped during good times in the market.

Since demand volatility can both be upward or downward, one ought to be careful in interpreting this finding, however. The time period covered by the study coincides with the years of unprecedented growth in the Chinese economy which is of particular focus in this study as regards external demand volatility. This growth, especially in the industrial sector, could have spurred export stimulation not only for Zambian metals but also trade between China and Zambia's other trading partners, which apparently was upward trending on average. The latter effect could have indirectly benefitted Zambian metal exporters through spill over wealth effect of good years of robust growth in China.

Although the exposure to external demand shocks stimulates Zambia's metal exports in the short run, it was found that this exposure due to the network of metal exports destination posed significant risk (more so because of economic growth volatility correlations among partners) by amplifying metal exports volatility. However, the effects of external demand shocks due to the network of metal trading partners for Zambia manifest through the volatility in the real effective exchange rate and terms of trade.

Metals exports in Zambia are the major earners of the foreign exchange and therefore events that significantly affect metal prices on the international market are expected to have a significant bearing on the country's foreign exchange market. For instance, Chileshe et al (2018) explain that copper price movements, mostly due to external demand dynamics, are the most important source of exchange rate volatility in Zambia. As a result of this, the Zambian Kwacha has been said to be partially a commodity currency[13] (Bova, 2009; Chipili, 2015; Roger et al., 2017).

This result is not surprising because, under the flexible exchange rate regime, the role of the exchange rate during external shocks is well documented in the literature. That is, with the exchange rate mainly left to be determined by the dynamics of demand and supply, which is the case for Zambia, the exchange rate acts as a buffer or automatic external shock absorber especially with the flexibility of international relative prices (Friedman, 1953; Mundell, 1961; Edwards and Yeyati, 2005; Raissi and Tulin, 2018).

[13] A currency is said to be commodity if it is significantly influenced by the price of the major export commodity

6.3 Conclusion

The study sought to understand the effect on Zambia's metal export performance of the geographical patterns of these exports. Particular focus was given to the role of China as an anchor of the destination network in terms of external demand shocks. Specifically, the dimensions considered were the role of trading partner GDP in metal exports demand, the response of metal exports to external demand shocks and the importance of partner GDP growth correlations in international trade risk. The Vector Error Correction (VEC) framework and the Exponential Generalized Autoregressive Heteroskedasticity model of volatility were employed using quarterly data from 1995q1 to 2016q4.

It was found that in the long run, trading partner GDP has a positive effect on demand for metal exports while in the short run, metal exports are sensitive to changes in real effective exchange rate and foreign (partner) GDP. In addition, metal exports respond favorably to improvements in barter terms of trade and that metal exporters in Zambia and/or commodity traders seemed to perceive external demand shocks due to the network of metal exports destination as short run opportunities in the period under study. The study further finds that GDP growth correlations between China and Zambia's other metal trading partners are more important in explaining metal export volatility than output volatility in those partners. However, the demand risk due to this network manifests itself through volatility in the exchange rate and barter terms of trade.

6.4 Policy Implications of the Study Findings

Given the importance of the metal export sector in Zambia and the effect that its exposure to external shocks may have, the results of the study have a number of implications in terms of the policy. Firstly, as the country continues to step up efforts in diversifying the export sector in terms of products, there is need to also consider the geographical patterns of these trade flows so as to reap the maximum possible benefits coming with such initiatives.

However, continuing to export metals in their raw/primary form does not offer the country significant control in terms of where these exports should be directed because the demand is determined by the input needs of importing nations. That almost all economies consume the finished products of Zambia's metals (copper and cobalt) presents a huge potential for geographical diversification in this case. Therefore, there is a need to step up efforts which are aimed at establishing conditions that appeal to firms that are into metal processing and create products which have strong domestic and regional command.

Metal Fabricators of Zambia's (ZAMEFA) success story in metal processing thus far stands out as a classic model of what direction Zambia has to take in ensuring value addition to metal concentrates. It is important that geographical diversification of metal exports cannot be achieved in a short time span and therefore there is need of strong will from politicians to formulate policies that go beyond their political tenure especially in promoting investment and infrastructure development in the creation of the broad industrial base for this purpose.

Secondly, with the increased integration of Zambia into the global economy, opportunities and risks arising from the country's interaction with the rest of the world in terms of trade will continue coming forth. However, policymakers should always remain alert in monitoring growth developments in the country's trading partners especially in formulating well informed expectation of external demand risks. Particular attention should be given to having better judgment on how the long run outlook of bigger (especially those with significantly larger industrial sector for metal processing) may affect the outlook of other trading partners as the study has shown that the effect of GDP growth volatilities correlations among trading partners on metal export volatility is greater than that of individual partner growth volatilities.

Thirdly, the role that the exchange rate in Zambia plays especially under the flexible regime in acting as an automatic shock absorber in periods of external shocks as found in this study puts is of vital importance. However, excessive exchange rate volatility tends to be detrimental to economic activities. With the constrained capacity to build enough reserves for managing exchange rate volatility, the policymakers should consider the role that the financial derivatives market can play in helping economic agents hedge themselves against exchange rate risk. However, the market for financial derivatives remains underdeveloped. As a result, there is a need of a deliberate policy on financial sector development especially as far as a sound derivatives market is concerned to help economic players hedge against exchange rate associated risks.

6.5 Limitations and Suggestions for Future Research

The readership is warned to interpret the findings with caution as the study has two shortcomings. Firstly, the GARCH family of models used in modelling volatility usually perform better with longer and highly frequent data but this study was constrained because of lack of data on the destination (at individual importer/country level) of metal exports before 1995.

Secondly, partner GDP data which were key in the study are mainly reported at an annual basis and therefore had to be interpolated to the next higher frequency form (quarterly) which may not be the best but was adopted in order not to further lose information contained in the original data. In further studies, it may be interesting to understand the role of the geographical pattern of non-traditional exports (possibly at product level) in explaining exposure to external demand shocks especially as they continue to gain importance in the national export basket.

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APPENDIX

Table A1.0: Johansen Cointegration Test

Date: 08/20/18 Time: 11:21
Sample: 1995Q4 2016Q4
Included observations: 82
Series: LOG(EX) LOG(P) LOG(GDP)
Exogenous series: LOG(TOT) ESEM
Warning: Rank Test critical values derived assuming no exogenous series
Lags interval: 1 to 2

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	0	0	1	1	1
Max-Eig	0	0	1	1	1

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

Table A2.0: Model Lag Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-108.1874	NA	0.003896	2.965906	3.14854	3.038958
1	203.0703	582.0923	1.52E-06	-4.884943	-4.428357	-4.702313
2	240.9512	67.89052	7.18E-07	-5.635097	-4.90456	-5.342889
3	271.0436	51.58695	4.17E-07	-6.182951	-5.178463*	-5.781165
4	289.3741	29.99536	3.29E-07	-6.425302	-5.146863	-5.913938*
5	302.4103	20.31611*	2.99e-07*	-6.530138*	-4.977747	-5.909195
6	311.1922	13.00175	3.05E-07	-6.524472	-4.69813	-5.793952
7	318.1353	9.738375	3.29E-07	-6.471046	-4.370753	-5.630948
8	321.757	4.79755	3.88E-07	-6.33135	-3.957105	-5.381673

* indicates lag order selected by the criterion

Table A3.0: Short Run Model with Decomposed ESEM

Dependent Variable: D(LOG(EX))
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 08/20/18 Time: 11:43
Sample (adjusted): 1997Q2 2016Q4
Included observations: 79 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)
D(LOG(EX)) = C(1)*(LOG(EX(-1)) - 0.636791814226*LOG(P(-1)) - 0.529230580374*LOG(GDP(-1)) + 3.9120915075) + C(2)*D(LOG(EX(-1))) + C(3)*D(LOG(EX(-2))) + C(4)*D(LOG(EX(-3))) + C(5)*D(LOG(EX(-4))) + C(6)*D(LOG(EX(-5))) + C(7)*D(LOG(P(-1))) + C(8)*D(LOG(P(-2))) + C(9)*D(LOG(P(-3))) + C(10)*D(LOG(P(-4))) + C(11)*D(LOG(P(-5))) + C(12)*D(LOG(GDP(-1))) + C(13)*D(LOG(GDP(-2))) + C(14)*D(LOG(GDP(-3))) + C(15)*D(LOG(GDP(-4))) + C(16)*D(LOG(GDP(-5))) + C(17) + C(18)*LOG(TOT) + C(19)*ESEM_VAR + C(20)*ESEM_COV

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECT(-1)	-0.355187	0.064949	-5.468729	0.0000
D(LOG(EX(-1)))	-0.024261	0.108052	-0.224534	0.8231
D(LOG(EX(-2)))	0.075639	0.107355	0.704566	0.4839
D(LOG(EX(-3)))	0.045148	0.094183	0.479366	0.6335
D(LOG(EX(-4)))	0.128114	0.112443	1.139368	0.2592
D(LOG(EX(-5)))	-0.075794	0.091126	-0.831749	0.4089
D(LOG(P(-1)))	0.775396	0.347997	2.228169	0.0297
D(LOG(P(-2)))	-0.536895	0.373565	-1.437220	0.1559
D(LOG(P(-3)))	0.128695	0.385094	0.334191	0.7394
D(LOG(P(-4)))	-0.937523	0.382719	-2.449638	0.0173
D(LOG(P(-5)))	-0.385304	0.322617	-1.194306	0.2371
D(LOG(GDP(-1)))	-1.741032	0.283380	-6.143803	0.0000
D(LOG(GDP(-2)))	2.349198	0.535200	4.389383	0.0000
D(LOG(GDP(-3)))	-1.968425	0.689070	-2.856642	0.0059
D(LOG(GDP(-4)))	1.014545	0.597403	1.698260	0.0947
D(LOG(GDP(-5)))	-0.624614	0.284428	-2.196035	0.0320
C	-4.388670	0.855966	-5.127158	0.0000
LOG(TOT)	0.885420	0.172080	5.145394	0.0000
ESEM_VAR	0.686626	0.107067	6.413060	0.0000
ESEM_COV	-5.160396	1.370879	-3.764296	0.0004

R-squared	0.609058	Mean dependent var	0.010525
Adjusted R-squared	0.483161	S.D. dependent var	0.214250
S.E. of regression	0.154028	Akaike info criterion	-0.688951
Sum squared resid	1.399746	Schwarz criterion	-0.089091
Log likelihood	47.21356	Hannan-Quinn criter.	-0.448629
F-statistic	4.837755	Durbin-Watson stat	2.035814
Prob(F-statistic)	0.000002	Wald F-statistic	37.29932
Prob(Wald F-statistic)	0.000000		

Table A4.0: Pairwise Granger Causality Tests

Pairwise Granger Causality Tests
Date: 11/14/18 Time: 13:09
Sample: 1995Q4 2016Q4
Lags: 5

Null Hypothesis:	Obs	F-Statistic	Prob.
LOG(REER) does not Granger Cause LOG(EX)	80	2.61430	0.0318
LOG(EX) does not Granger Cause LOG(REER)		1.29927	0.2744
LOG(GDP) does not Granger Cause LOG(EX)	80	5.19796	0.0004
LOG(EX) does not Granger Cause LOG(GDP)		1.13419	0.3507
LOG(GDP) does not Granger Cause LOG(REER)	80	0.77404	0.5717
LOG(REER) does not Granger Cause LOG(GDP)		0.73153	0.6022

Figure A1.0: Residual Normality Test

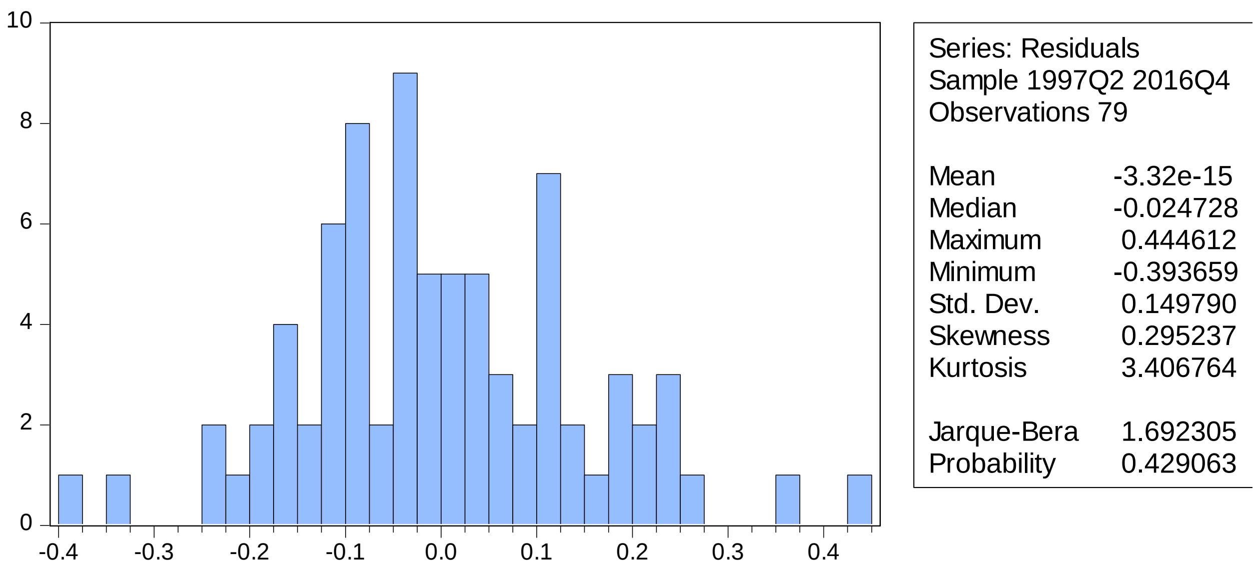


Figure A2.0: CUSUM Coefficient Stability Test

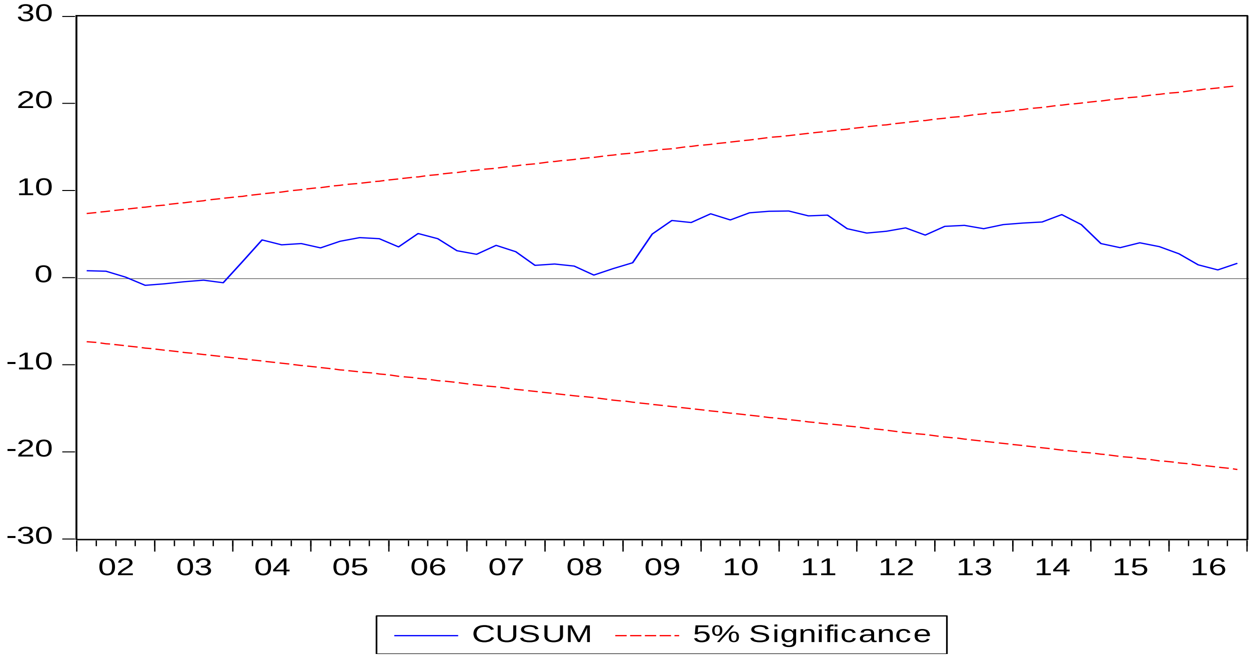
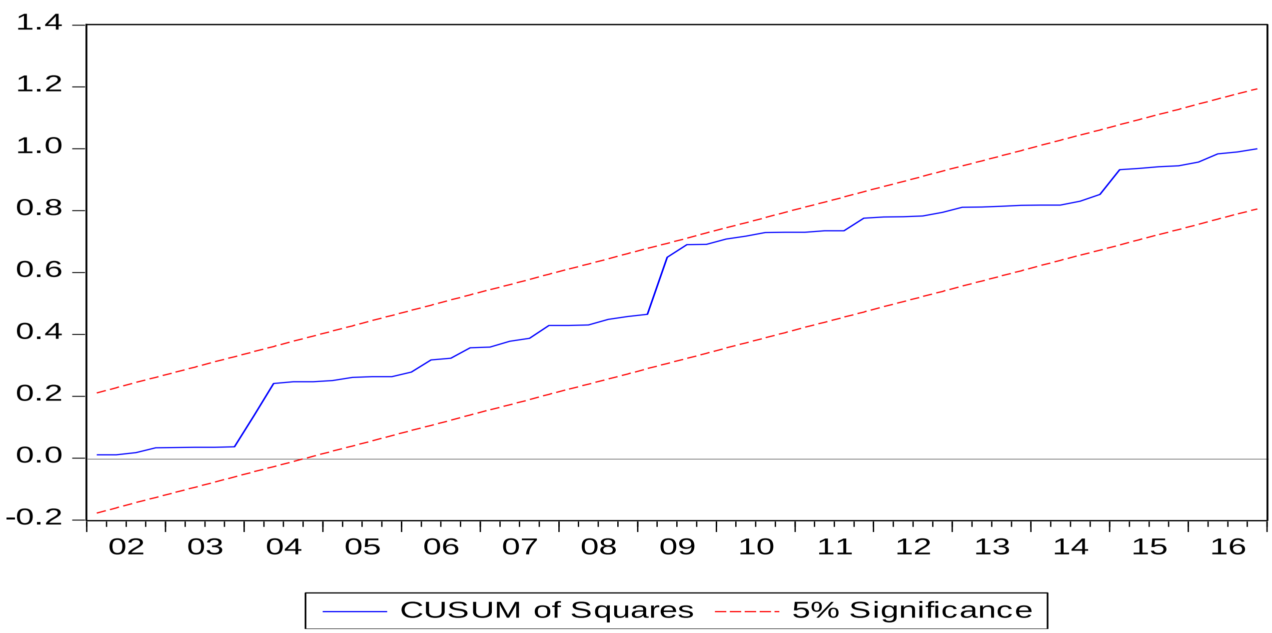


Figure A3.0: CUSUM of Squares Coefficient Stability Test



VOLATILITY MODELS DIAGNOSTICS

Figure A4.0: EGARCH Residual Normality Test (Pre-Decomposition)

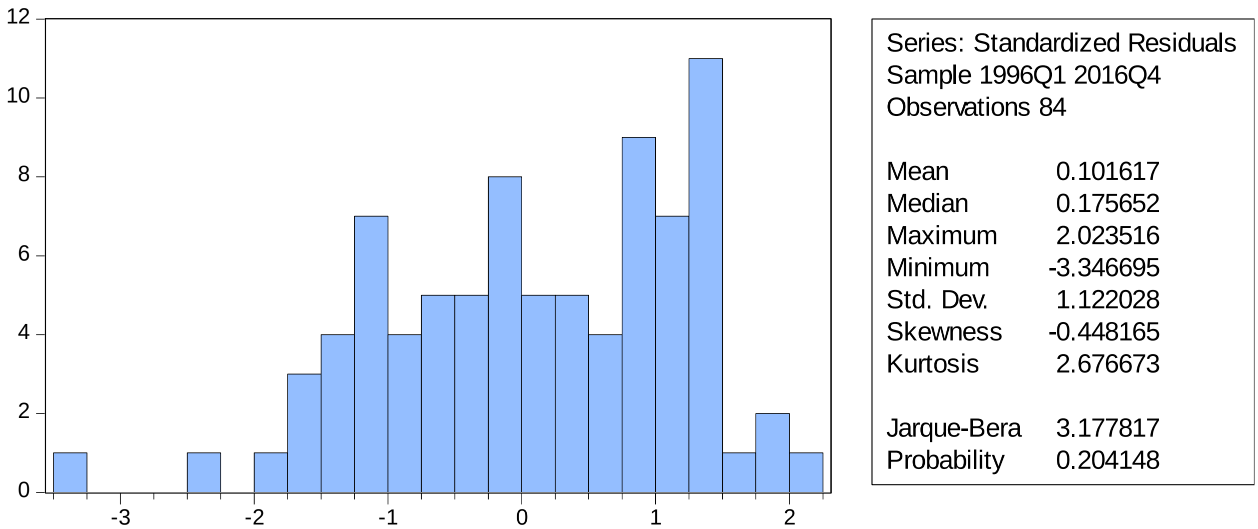


Table A5.0: Remaining ARCH Effects Test (Pre-Decomposition)

Heteroskedasticity Test: ARCH

F-statistic	1.675281	Prob. F(5,73)	0.1514
Obs*R-squared	8.131793	Prob. Chi-Square(5)	0.1491

Test Equation:
Dependent Variable: WGT_RESID^2
Method: Least Squares
Date: 08/20/18 Time: 16:27
Sample (adjusted): 1997Q2 2016Q4
Included observations: 79 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.321396	0.438515	5.293771	0.0000
WGT_RESID^2(-1)	-0.079630	0.115822	-0.687518	0.4939
WGT_RESID^2(-2)	-0.170336	0.113933	-1.495058	0.1392
WGT_RESID^2(-3)	-0.232546	0.112762	-2.062266	0.0427
WGT_RESID^2(-4)	-0.182245	0.113978	-1.598943	0.1142
WGT_RESID^2(-5)	-0.088599	0.115019	-0.770299	0.4436

R-squared	0.102934	Mean dependent var	1.329905
Adjusted R-squared	0.041491	S.D. dependent var	1.574767
S.E. of regression	1.541751	Akaike info criterion	3.776626
Sum squared resid	173.5208	Schwarz criterion	3.956584
Log likelihood	-143.1767	Hannan-Quinn criter.	3.848722
F-statistic	1.675281	Durbin-Watson stat	2.051167
Prob(F-statistic)	0.151351		

Table A6.0: Serial Correlation Test (Pre-Decomposition)

Date: 08/20/18 Time: 16:32
Sample: 1995Q4 2016Q4
Included observations: 84

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.032	0.032	0.0866	0.769
		2	-0.104	-0.105	1.0322	0.597
		3	-0.192	-0.187	4.3148	0.229
		4	-0.140	-0.148	6.0820	0.193
		5	-0.022	-0.065	6.1281	0.294
		6	-0.088	-0.168	6.8432	0.336
		7	0.077	0.005	7.3975	0.389
		8	-0.022	-0.101	7.4421	0.490
		9	0.074	0.020	7.9719	0.537
		10	0.068	0.035	8.4228	0.588
		11	-0.008	-0.013	8.4289	0.674
		12	-0.058	-0.054	8.7646	0.723

*Probabilities may not be valid for this equation specification.

Figure A5.0: EGARCH Residual Normality Test (Post-Decomposition)

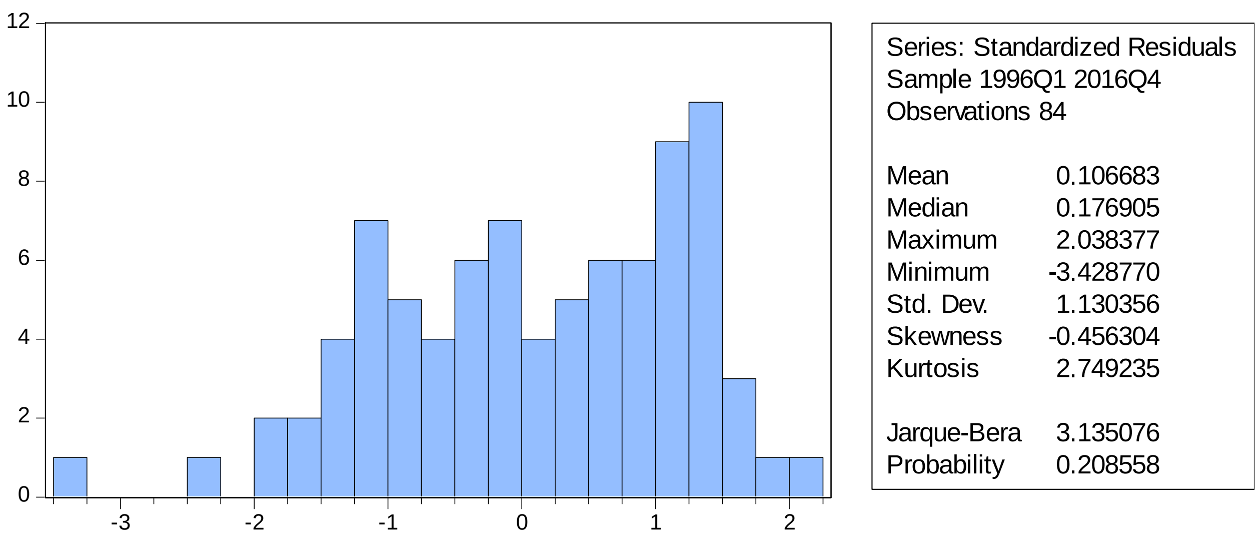


Table A7.0: Remaining ARCH Effects Test (Post-Decomposition)

Heteroskedasticity Test: ARCH

F-statistic	1.619618	Prob. F(5,73)	0.1656
Obs*R-squared	7.888583	Prob. Chi-Square(5)	0.1625

Test Equation:
Dependent Variable: WGT_RESID^2
Method: Least Squares
Date: 08/20/18 Time: 16:38
Sample (adjusted): 1997Q2 2016Q4
Included observations: 79 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.317628	0.440629	5.259810	0.0000
WGT_RESID^2(-1)	-0.060677	0.115744	-0.524236	0.6017
WGT_RESID^2(-2)	-0.162690	0.114009	-1.426989	0.1578
WGT_RESID^2(-3)	-0.228174	0.112769	-2.023379	0.0467
WGT_RESID^2(-4)	-0.169183	0.114054	-1.483361	0.1423
WGT_RESID^2(-5)	-0.103433	0.114995	-0.899463	0.3714

R-squared	0.099855	Mean dependent var	1.350417
Adjusted R-squared	0.038202	S.D. dependent var	1.633155
S.E. of regression	1.601656	Akaike info criterion	3.852864
Sum squared resid	187.2671	Schwarz criterion	4.032822
Log likelihood	-146.1881	Hannan-Quinn criter.	3.924961
F-statistic	1.619618	Durbin-Watson stat	2.054590
Prob(F-statistic)	0.165579		

Table A8.0: Serial Correlation Test (Post-Decomposition)

Date: 08/20/18 Time: 16:40
Sample: 1995Q4 2016Q4
Included observations: 84

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.044	0.044	0.1711	0.679
		2	-0.101	-0.103	1.0620	0.588
		3	-0.195	-0.187	4.4376	0.218
		4	-0.138	-0.140	6.1484	0.188
		5	-0.044	-0.082	6.3237	0.276
		6	-0.090	-0.166	7.0672	0.315
		7	0.077	0.006	7.6176	0.368
		8	-0.001	-0.086	7.6178	0.472
		9	0.082	0.025	8.2719	0.507
		10	0.069	0.040	8.7308	0.558
		11	-0.013	-0.016	8.7476	0.645
		12	-0.060	-0.045	9.1032	0.694

*Probabilities may not be valid for this equation specification.

Figure A6: Zambia's Metal Exports Destinations based on Partner Reports