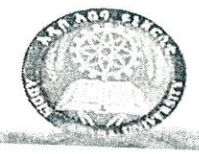

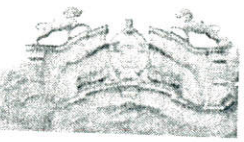

Faculty of Business and Economics
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EXPORT SUPPLY MODELING: THE CASE FOR ZAMBIA

BY

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A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF ADDIS ABABA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN ECONOMICS (INTERNATIONAL ECONOMICS)

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"Export Supply Modeling: The Case for Zambia."

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Dedication

I dedicate this thesis to my adorable daughter, Michelle, who may look at this thesis some day and understand why I wasn't there the day she was born. I also wish to dedicate this thesis to my amazing wife and supportive parents.

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Abstract

This study has shown the dependence of the Zambian economy on copper exports for a large proportion of its foreign exchange earnings. Against this background, the study has further attempted to model copper export supply in the framework of a cointegration and error correction model representation. The copper export supply function is estimated using annual data spanning the period 1970-2004. The general static long-run cointegration equation reveals that price as well as non-price factors are important determinants of copper export supply. However, when lags are incorporated, non-price factors better explain the supply of copper exports. Conversely, with and without lags, in the short-run, only non-price factors are seen as important determinants of copper export supply. These results show that emphasis on price factors in affecting exports may not be of essence to the Zambian case. Finally, these findings raise a range of issues that may guide policy assertion such as the overall goal of government and policy makers being one that seeks to diversify exports away from dependence on copper.

Key Words: Copper, Export Supply, Cointegration, Error Correction Model, Price Factors, Non-price factors

CHAPTER ONE

INTRODUCTION

1 Introduction

1.1 Background

Primary commodities and the forces which determine their prices raise a range of issues which are of concern to economists and policy-makers. Most obviously food, fuels and raw materials account for around half the export earnings of the developing countries as a whole and around 90 % of those of sub-Saharan Africa (Winters and Sapsford, 1990). In view of the importance of primary products in world trade in general, and in the trading activities of developing countries in particular, the determinants of primary commodity exports has been a subject of much debate.

Moreover, for many individual countries, exports are highly concentrated in one or a few specific commodities. For example, around half of developing countries earn over 50 % of their export revenues from a single primary commodity, while around 75 % earn at least 60 % from three or fewer primary products (Winters and Sapsford, 1990). Further, it is believed that the quantities traded of most primary commodities tend to grow less rapidly than those of other traded goods, including manufacturers. Thus in the long run the only effective response to adverse price trends in primaries is export diversification, and export prices are a vital consideration in developing countries' economic well-being and policy-making.

Primary prices are also critical in the short run for they appear to fluctuate substantially more than do manufactures' prices. Arguably, price variability results in large swings in export earnings which can be disruptive of investment and growth. The evidence of a long run link between export fluctuations and the level of economic growth is actually rather ambiguous, but the widespread perception that there is an adverse relationship is sufficient to place the issue firmly on the economist's agenda.

Zambia has not been spared in the light of its dependence on a single primary product for a large proportion of its export earnings. A close look at the Zambian economy quickly reviews that the cornerstone of its economic prosperity lies in its possession and export of mineral resources. For example, as at October 2007, according to the Central Statistical Office of Zambia, copper exports earnings accounted for about 75 % of Zambia's total exports earnings (CSO, 2007). This in itself is a significant proportion. This issue coupled with the observation that the core of Zambia's development strategy vis-à-vis trade policy is one that hinges on export-led growth, it is interesting to take on this matter further by examining factors behind the performance of exports. Additionally, owing to the fact that export-led growth will bring in technology transfer, efficient allocation of resources due to international competition and cost-efficient allocation of resources, it is highly intriguing to ascertain factors behind export performance.

In the same vein, Melesse (2004) notes that the arguments the International Monetary Fund (IMF) and World Bank put forward in relation to the problems developing countries face vis-à-vis their exports of primary products are not related to external factors like decline in demand,

but domestic policy problems and to a great extent supply constraints. The underlying assumption behind the International Monetary Fund (IMF) and World Bank's programmes such as the Structural Adjustment Programmes (SAPs) is the small country assumption[1]. This observation remains very much to be subjected to empirical validation.

1.2 Statement of the Problem

The economy of Zambia has since time immemorial danced to the tune of copper prices where flourishing copper prices on the international market usually reflect a sound and healthy economy with the converse holding true. Thus it has been upon the shoulders of government and various stakeholders to find ways and means to relieve the country from this significant dependence on copper exports for a large chunk of foreign exchange earnings and/or while enjoying benefits from high copper prices, find sustainable means to cushion the economy in times of economic distress when copper prices are low.

In so doing, the economy has fallen prey to a catalogue of economic adjustments and reforms intended to diversify the economy and consequently reduce this heavy dependence on copper exports. For instance, during the period 1964-1974, the main thrust of the trade policy was the import substitution industrialization strategy. However, with the observation that Zambia's Balance of Payments remained in deficit throughout the 1990s, pressure mounted on policy makers and as a consequence they resorted to outward-oriented growth strategy where exports growth and expansion is the core. Currently, export led growth is being pursued in Zambia.

[1] The underlying truth about the small country assumption is that the country in question is too small to affect world supply and price; hence, it can only increase its export revenue by increasing supply at the going price (Melesse, 2004).

This study attempts to model Zambia's export function. Inevitably, this implies seeking to examine and explore factors that are alleged to influence exports of Zambia. However, Zambia's export sector is disaggregated into many components but for precise and indeed comprehensive analysis it is worth noting that different sub-sectors are likely to respond differently to given stimuli. Based on the initial observation that copper exports in Zambia constitute a large chunk of total exports, the latter is decomposed into two major categories: Copper exports and other exports. An immediate consequence of so doing makes it possible to weigh the commodities export supply response. Note that, however, only the modeling of copper export supply will be done.

1.3 Objectives of the Study

General Objective

- To ascertain factors that influence the supply of copper exports

Specific Objectives

i. To ascertain the role played by import compression on copper exports

ii. To determine the role played by gross domestic investment in affecting copper exports

iii. To determine the influence of the real exchange rate on copper exports

iv. To ascertain the role of the trade regime in affecting copper exports

v. To draw policy implications for copper exports supply from the empirical findings

1.4 Hypothesis

The hypothesis of this study is:

- Price as well as non-price factors have a bearing on the supply of copper exports

1.5 Significance of the Study

Some studies focusing on exploring determinants of exports, in general, use aggregated export supply data. By using disaggregated exports data (i.e. copper exports and other exports), this study will convey substantial information to recipient economic agents.

Notwithstanding that no attempt has been made to model copper export supply for Zambia by using both price and non-price factors, this study is the first to tackle this. Bearing in mind that there is a general consensus that price and non- price factors affect the export supply of primary commodities, no formal approach has been taken to document the degree by which these different forces act, at least in Zambia. Furthermore, considering the role of exports in development, the contribution to literature on the Zambian case cannot be overemphasized.

Moreover, this study employs econometric techniques; by utilizing time series properties such as stationarity tests, cointegration and error correction modeling. The findings of this study are therefore significant in the sense that they will contribute to the literature of primary export supply modeling by use of the latest innovations in econometric analysis.

1.6 Limitations of the study

This study only considers the factors behind the supply of copper exports and the small country assumption is maintained throughout the analysis. Logically, this implies that global effects are not considered. This does not, however, affect our results because the essence of the study lies in determining different factors that influence copper exports supply. Another limitation lies in the difficulty of quantifying variables from the data in the sense that determining the right proxy for a given economic variable may prove problematic.

1.7 Structure of the Study

This study is structured as follows: next to this introduction is Chapter two which provides background descriptive information relating to Zambia's macro economy, structure and composition of Zambia's exports and the political economy of the copper sector of Zambia with a brief outlook of the global copper market. Chapter three goes a step further by reviewing both theoretical and empirical literature that may help explain the information derived from chapter two. Chapter four outlines the model to be used and at the same time dwells on estimation and discussion of results thereof. Finally, chapter five concludes the study by giving policy recommendation in the light of the findings obtained.

CHAPTER TWO

OVERVIEW OF THE ZAMBIAN ECONOMY

2.1 Introduction

This section of the paper follows a descriptive approach as it seeks to examine the factors that essentially influence exports of Zambia. This is premised on the acknowledgement of the role of exports in economic development.

2.1.1 An overview of the Zambian Economy: 1964 – 2006

In order to comprehend the evolution of the Zambian economy, it is important to attach importance to some historical standpoints which will eventually help put the current economic trends into context. Therefore, the period under review will run from around 1964 onwards.

It should be noted at this juncture that Zambia's economic performance can be classified into four distinct episodes on the basis of major political and/or economic changes (Mwanawina and Mulungushi, 2003):

- Free market economy – Early 1960s to 1969
- Mixed economy, state control and management – 1970 to 1984

- Economic transition, stabilization and introduction of structural adjustment policies – 1985 to 1991
- Full implementation of the structural adjustment policies – 1991 to date

A few years after independence (i.e. after 1964), Zambia was considered as one of the most thriving nations in Africa. This success was mainly attributed to her possession of mineral wealth, endowment of arable land, among others, which in turn provided as a vehicle for potential sustainable economic development. This is evidenced by the Weeks et al. (2006) who point out that Zambia had, in 1964, one of the highest per capita incomes in Africa. Zambia experienced moderate growth in the real per capita gross domestic product (GDP) in the period 1960 to about 1972. The highest performance was recorded in 1965 which stood at 13.2 % and was mainly attributed to higher levels of investment and relatively buoyant copper prices (Mwanawina and Mulungushi, 2003). However, the new government under the United National Independence Party (UNIP) faced a daunting task in that it inherited a low and hence inadequate human capital stock, infrastructure that was in a definite bad shape from the colonial regime.

The main feature of the first episode was the Import Substitution Industrialization (ISI) strategy. During this period, the economy experienced significant growth rates brought about largely by rising copper prices albeit erratically (Musonda, 1998). In the years immediately after independence, copper appeared as the vehicle to development and modernization, and to these ends the government took fifty-one percent ownership of the sector and wholly nationalized a substantial part of the manufacturing sector, all public utilities, and key elements of transport and communications. Financial institutions were underdeveloped, catering to mining and the rest of

the formal sector. The ISI though well intended was undermined by increased government participation and continued protection of the manufacturing sector through tariffs. Therefore, given the lack of skills and, essentially, translated planning institutions, it was not surprising that political interference, managerial inefficiency, and lack of accountability undermined the potential for diversification and consequently led to inefficient allocation of resources (Musonda 1998; Weeks et al., 2006).

However, since the type of investment to be undertaken in order to propel economic growth in the right direction was capital intensive and dependent on imported inputs, this stood as a weakness for the import substitution industrial strategy. Mwanawina and Mulungushi (2003) further note that the major weakness of the import substitution industrial strategy the government pursued was its weak linkages among sectors.

A fall in world copper prices around early to mid-1970s marks the advent of the second phase of Zambia's economic performance. These systemic problems reinforced an economic decline rooted in the poor performance of the mining industry and government's weak policy reaction to this decline (Mwanawina and Mulungushi, 2003).

With dwindling foreign exchange reserves, Zambia had to borrow from external sources in order to finance consumption investment. Consequently, the country accumulated huge international debts and debt servicing became even more difficult.

In a nutshell, the slow growth of the Zambian economy between the late 1960s and mid-1970s can, to a great extent, be explained by a politically-motivated[2] disruption of export products, which resulted in low investment in mining, a growing trade deficit and heavy indebtedness (Mwanawina and Mulungushi, 2003).

The economic decline the country experienced in the previous two periods continued even in the third period. The government was faced with much worry and it is during the 1985 – 1991 period that it re-introduced market based policy changes and policy reversals. Thus, the Zambian government in-conjunction with the International Monetary Fund (IMF) introduced policies aimed at helping the economy recover from its economic malaise. During this period, Structural Adjustment Programmes (SAP) had been introduced but as the Weeks et al. (2006) further notes, the SAP brought profound changes to a country ill structured to accommodate them. Trade liberalization introduced competition, which the state enterprises were unprepared to meet. Further, previous tests in economic policies exposed the macro economy to volatility which in turn worked against it as both the macroeconomic and political economy where not considered conducive for serious long-term investment (Mwanawina and Mulungushi, 2003).

In addition, during 1985 – 1991 the government introduced market based policies in the framework of the multilateral loan conditionality (i.e. the IMF economic liberalization program which was subsequently dropped in 1987). However, this was met with discontentment throughout the country since the economic performance in general was on a brisk decline partly due to rapidly declining incomes, rising prices and the problem of continued capacity underutilization (Mwanawina and Mulungushi, 2003).

[2] This will be made clear below

Consequently, there was a change of government in 1991 with the new government pursuing market based policies. This also marked the advent of privatization of state enterprises. The government initiated the divestiture process with the Privatization Act of 1992. The act established the Zambia Privatization Agency (ZPA) as an autonomous agency of the government to plan, implement and monitor the privatization of state enterprises. The privatization of state owned enterprises progressed quickly with the salient exception of the programme's keystone, the mining sector (Mwanawina and Mulungushi, 2003).

Ndulu (1986, 1991), as quoted in Alemayehu, Weeks and McKinley (2006), points out that balance of payments pressures on African economies have resulted in policies of import compression in that the balance of payment crisis sets a limit on the level of imports. Thus import compression occurs either when domestic goods are imperfect substitutes for the imported ones, or as a consequence of low capacity of African countries. Alemayehu, Weeks and McKinley (2006) observe that the latter typically results from low levels of export earnings and foreign savings, which, in turn, will depend on external terms of trade, net foreign resource inflows, and weather conditions in economies dominated by rain-fed agriculture and discovery and exhaustion of mineral resources. The last factor fits the Zambian case well since the country depends on mineral resources for a large chunk of its export earnings.

Despite an implementation of privatization and liberalization policies, a snapshot of Zambia's balance of payments indicates that Zambia remained in deficit throughout the 1990s and this essentially put pressure on the authorities to change the economic policies, in general, and trade

policies, in particular. To that effect, the trade regime had been liberalized to a great extent and there had been substantial decentralization and deregulation in other spheres of economic activity. Since late 1991, it has moved decisively away from import substitution to outward orientation as the base of its growth strategy.

In line with this, the Zambian government has since emphasized the need to pursue such outward-oriented policies which have a desired positive impact on the economy. The trade regime has been considerably liberalized and tariffs are now the main instrument of trade policy. The government promoted exports through creating market awareness. The objective was to create a dynamic trade promotion programme with the involvement of the private sector. The strategy also included enhancing market development activities. However, negative economic performance continued even by 1992 despite intensification of the SAP. Overall economic performance remained sluggish as manifested by real GDP growth decline by 0.9 %.

By 2002, Zambia experienced a significant economic growth of 3.9 %. This performance relied mainly on external factors, such as favorable weather and high international metal prices, and does not seem to be based on internal policies or existent convincing development strategy. The government, particularly, has been unsuccessful on several fronts, which include: promoting a diversification of the country's export base away from its heavy dependency on copper, managing its expenditure – more efficiently. Even more intriguing is that in 2006, Zambia's GDP grew by an estimated 5.8 % mainly as a result of increased copper production, buoyant copper prices, an exceptionally good agricultural performance and a strong expansion in construction. To a great extent, this accomplishment can be accredited to macroeconomic

fundamentals that have improved in recent years – which include government's achievement of a major fiscal consolidation and undertook public-sector reforms that triggered the cancellation of US$3.9 billion of external debt in 2005. Restored donor confidence seemingly translated into larger inflows of aid, increasingly as direct budgetary support. The sharp appreciation of the Kwacha experienced in late 2005 and early 2006, coupled with the 2006 bumper harvest, eased inflationary pressure, which averaged 9 % – the first time in about 30 years that Zambia has achieved single-digit inflation (Organization for Economic Cooperation Development (OECD), 2004; 2007).

Table 1.0 Zambia: Sector contributions to real GDP growth, in percentage points

	1991-94	1995-2000	2001-03	2004-06
GDP growth %	-3.0	1.8	4.0	4.6
Agriculture	-0.1	0.9	0.0	0.6
Mining	-1.0	-1.5	0.8	0.7
Manufacturing	-0.1	0.3	0.5	0.6
Construction	-0.7	0.1	0.8	0.8
Trade	-0.5	0.9	0.9	0.9
Other	-0.6	1.1	1.0	1.0

Source: African Forum and Network on Debt and Development (AFRODAD), (2006)

However, because the economy has not been diversified to a desirable level, the economy lingers in its susceptibility to climatic and terms of trade shocks which may trigger another episode of worry and a blurry economic outlook.

2.1.2 Evolution of the exchange rate policy in Zambia

Zambia's exchange rate policy has been subjected to many changes since independence to date as a tool to achieve both internal and external balance in the economy.

Table 2.0 below summarizes the exchange rate policy regimes as cited in Musonda (2001).

Table 2.0 Exchange rate policy regimes

Period	Exchange Rate Policy Description
1964 – 1971	Rates fixed to the British Pound Sterling
1972 – 1976	Rates fixed to the US dollar
1977 – 1982	Rates pegged to the SDR with occasional devaluations
1983 – 1984	Rates pegged to a basket of major trading partners' currencies
1985 – 1987	Foreign exchange Dutch auction system Introduced
1988 – 1989	Fixed parity to the US dollar re-introduced with occasional devaluations
1990 – 1991	Dual exchange rate system (managed float)
1991 – 1992	Open General License (OGL) system, rate unified
1992 – to date	Fully liberalized exchange rate policy

Source: Bank of Zambia – Annual Reports – in Musonda (2001)

As table 2.0 indicates, the exchange rate policy has undergone marked changes from 1964 to date. The period 1964 to the mid-1980s marked period under which the exchange rate was fixed. In 1985, the foreign exchange Dutch auction system was introduced were the value of the currency was to be determined by the highest bid of the week. During first week of the auction, the Kwacha was devalued by at least 100 percent. Mwanza (1992) as cited in Musonda (1998) notes that the auction system was ended on 1 may 1987 when Zambia broke away from the IMF programme.

Following this break away, the auction system was replaced by a fixed exchange rate regime again with the Kwacha being revalued upwards from about K12.00 to a dollar to K8.00 to a dollar.

The period afterwards marked government's efforts to completely liberalize the foreign exchange market. A change of government in 1991 proved fruitful as these efforts were rewarded when in October 1992 the government allowed the establishment of bureaux de change and hence the adoption of a flexible exchange rate policy. The immediate consequence of this was the concomitant liberalization of both the capital and current account (Musonda, 2001).

The IMF (2006) also noted that Zambia undertook extensive liberalization of the foreign exchange market during 1992-95. The introduction of bureaux de change, lifting of controls on current transactions, and permission to citizens and non-citizens to hold foreign currency accounts enabled market forces to play a larger role in the determination of the exchange rate. The Bank of Zambia was still able to exert influence over the exchange rate through the Bank's regular auctions. An interbank market in foreign exchange was established in 2003. Currently, the Bank of Zambia intervenes in the sometimes thin foreign exchange market to smooth excessive volatility and to meet its reserve targets.

In summary, a country study by Weeks et al. (2006) observes that monetary, financial and exchange rate policies in Zambia went through two phases after independence. The first phase, until the late 1980s, was characterized by extensive intervention in the economy in order to support the government's growth policies. On the other hand, the most important feature of the

second phase, since the late 1980s, was the implementation of an orthodox programme of economic reforms guided by the IMF and the World Bank. The exchange rate was liberalized. These policies were associated with successes, including a reduction of inflation from 160 percent per annum to twenty percent and also the stabilization of the nominal exchange rate by abolishing exchange controls in order to further improve resource allocation and attract foreign savings.

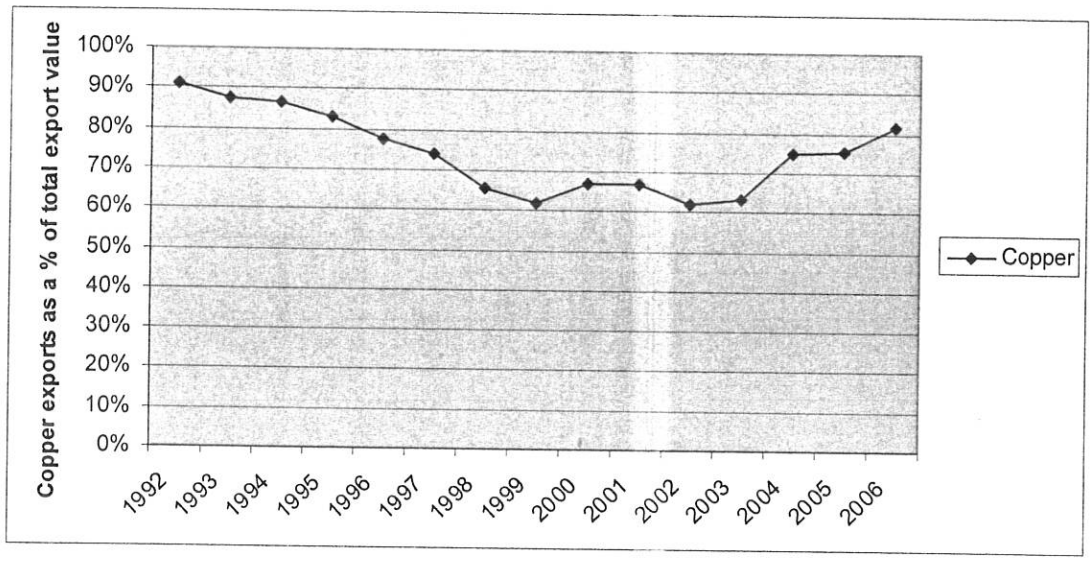
2.2 Structure and Composition of exports

As already noted, Zambia's economy, like most sub-Saharan African countries, thrives on the export of a primary commodity – i.e. copper. This in itself implies that the export sector is very much susceptible to changes/fluctuations in world prices (Winters and Sapsford, 1990). This section of the paper gives an account of the structure and composition of Zambia's exports.

Figure 1.0 below shows the share of copper as a percentage of total export value. The period being reviewed is the post-liberalization period when much emphasis was placed on the outward-oriented growth strategy. It is shown that close to a decade after liberalization, copper's share as a percentage of total exports declined. This may possibly be an attribute of an increase in the share of non-traditional exports as a percentage of total exports coupled with the slackened copper production experienced by the mining sector. However, around the year 2000, there was an increase in the share of copper as a percentage of exports which lasted approximately two years before it declined again in 2002. By 2003 an increase was recorded yet again and this time it lasted much longer up to end of 2006. Despite much anxiety in line with the pursuance of

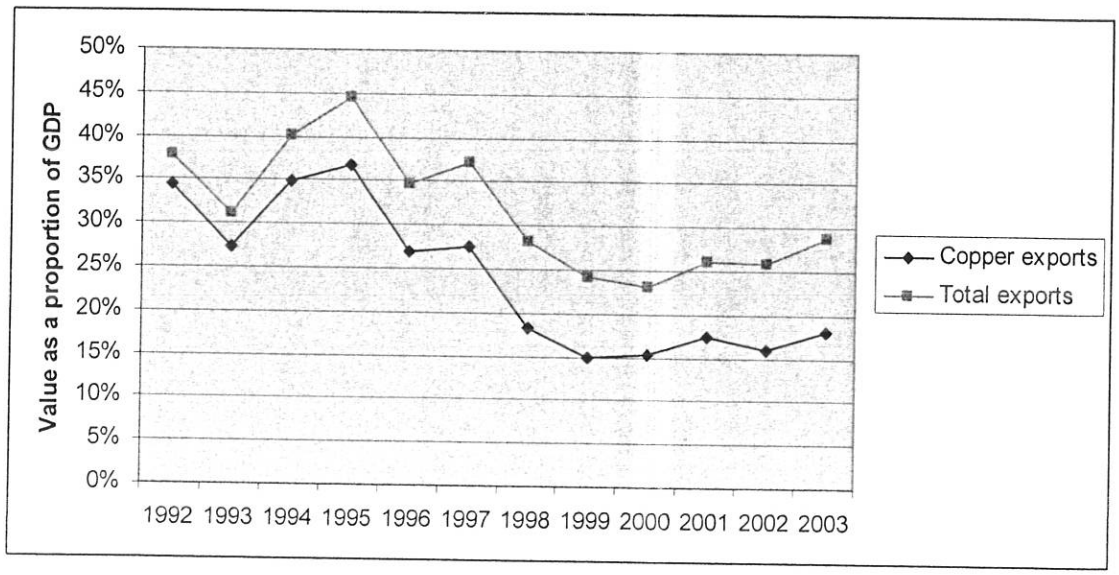
export led growth and the consequent need to effect diversification, copper's share alone as a percentage of total exports still remained high.

Figure 1.0 Zambia: Copper exports as a % of total export value (1992-2006)



Source: Author's own computation from statistical abstracts of the Bank of Zambia .

Figure 2.0 Zambia: Principal exports as a % of GDP (1992-2003)

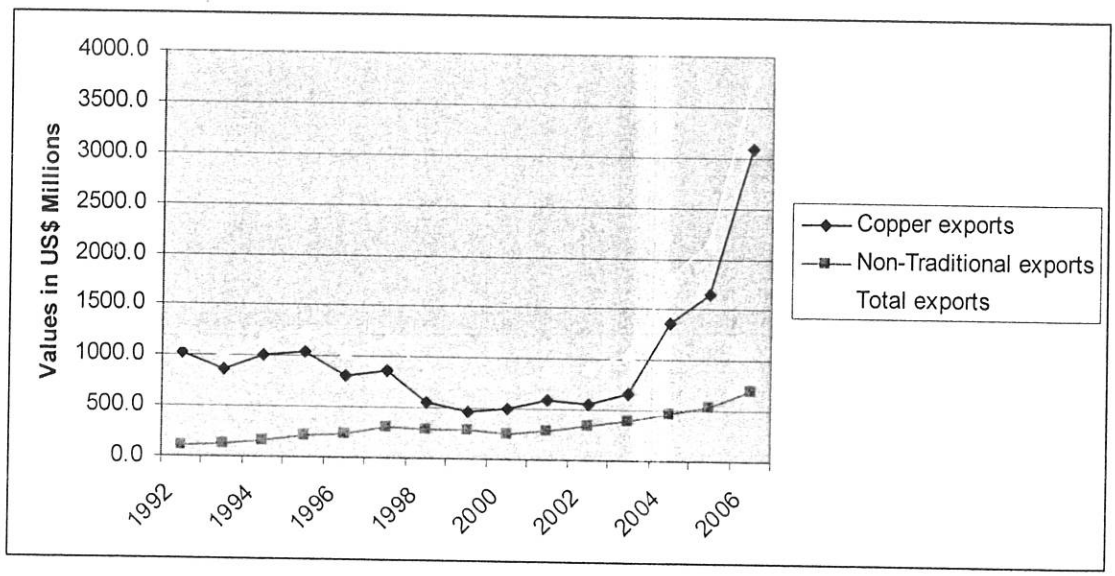


Source: Author's own computation from statistical abstracts of the Bank of Zambia.

Additionally, figure 2.0 above shows both the value of copper exports and total value of exports of goods and services as a proportion of GDP. The trend of total export value of goods and services mimics that of copper exports. This observation accentuates the importance of the latter in total export value.

As the IMF (2006) notes, prospects for sustained growth of the Zambian economy over the long-run are closely tied to the diversification of exports. The favorable performance of the Zambian economy in recent years has largely been driven by a rebound in copper sector output following the privatization of the main mining company in 2000, as well as the recent rise in the world prices of copper to historic highs (see figure 7.0 below).

Figure 3.0 Zambia: Goods exports (1992 – 2006)



Source: Author's own computation from statistical abstracts of the Bank of Zambia.

Non-traditional exports (NTEs) have also grown strongly but their contribution to export earnings is dwarfed by that of metals. Zambia's exports, led by copper, have grown sharply in recent years. Between 2001 and 2006, total exports more than quadrupled, from US$884.1 million to US$3,785.5 million (see figure 3.0 above). Between 2001 and 2005, the volume of copper exports is estimated to have grown by 40 percent while copper prices have doubled (IMF, 2006). Non-traditional exports have recorded a healthy growth, rising from US$295 million in 2001 to US$701.4 million in 2006 with an average annual increase of over 16 percent. However, after rising during the late 1990s, the share on non-traditional goods exports in total goods has declined in recent years.

Zambia's nontraditional exports consist of a variety of products and are destined for widely spread markets. In 2004, primary agricultural products accounted for more than a third of nontraditional exports, while engineering products (mainly copper wire) and floricultural and horticultural products (for example, cut flowers) each accounted for between 13-14 percent (Table 1.0).

Table 3.0 Zambia: Structure of Non-traditional exports, 2004 (in % of total)

Primary agriculture	34.9
Engineering	13.8
Floriculture and horticulture	13.4
Food processing	10.6
Textiles	5.3
Other manufacturing	6.2
Other	15.8
Total	**100**

Source: Export Board of Zambia[3] *(EBZ)*

[3] However, EBZ has been dissolved and has been assimilated into the Zambia Development Agency (ZDA)

Table 4.0 Zambia: NTEs share of total export value

Period	NTEs as a % of Total Exports[4]
1992 - 1994	12
1995 - 1997	22
1998 - 2000	35
2001 - 2003	36
2004 - 2006	23

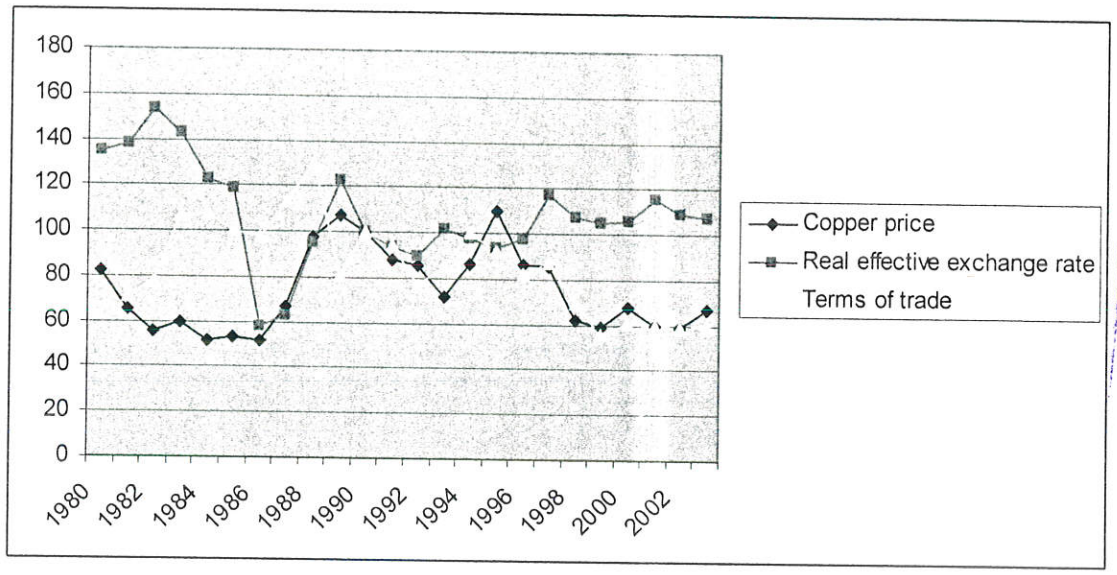
Source: Author's own computation from statistical abstracts of the Bank of Zambia.

Table 3.0 and table 4.0 are indicative in that it shows that export diversification strategies pursued by the Zambian government may have borne favorable results. NTEs share of export value had grown rapidly up until 2000 when they increased slightly between 2001 and 2003 before they fell in the 2004 – 2006 period. This fall in NTEs share as percent of exports coincides with buoyant copper prices[5].

Finally, the IMF (2006) also observes that long-term movements in the Kwacha's real effective exchange rate[6] reflect the vagaries of the Zambian economy, especially the swings in the world prices of copper and the terms of trade more broadly. Consider figure 4.0 below for a snapshot of trends in the copper prices, real effective exchange rate and terms of trade.

[4] Given value is the period average
[5] see table 7.0
[6] Note that in principle, the real effective exchange rate can be measured in a variety of ways, using different price and cost indices. For Zambia, it is reported that the only available measure is based on relative consumer price developments in Zambia and trading partners. While this measure is inferior to cost- based measures, it is not least because the CPI included imported goods, the price of which is a function of the exchange rate and thus provides and indication of trends in international competitiveness.

Figure 4.0 Zambia: Copper Prices, Real Effective Exchange Rate and Terms of Trade, 1980 – 2003 (1990=100)



Source: Author's own computation from the IMF World Development Indicators

All in all, the above analysis indicates that copper has been and still remains to be the back-bone for Zambia's economy. Consequently, the basic economic problem in Zambia is how to sustain the level of economic activity resulting from high copper prices when the world copper prices are low (Mupimpila et al., 1998).

2.3 The Tale of Zambian Copper

Mupimpila et al. (1998) have carried out a thorough survey on Zambia and the copper industry. Much of the analysis (particularly, the Zambian case) that follows below is an excerpt from their study. This tale starts by characterization of the global copper market. Later, specific mention is made of the Zambian copper sector and the evolution of its political economy.

2.3.1 Global Copper Market

Copper, as any other good or merchandise, is traded between producers and consumers. Producers sell their present or future production to clients, who transform the metal into shapes or alloys, so that downstream fabricators can transform these into different end-use products. One of the most important factors in trading a commodity such as copper is the settlement price for the present day (spot price) or for future days (International Copper Study Group[7] (ICSG), 2007).

The role of a commodity exchange is to facilitate and make transparent the process of settling such prices. Three commodity exchanges provide the facilities to trade copper: The London Metal Exchange (LME), the Commodity Exchange Division of the New York Mercantile Exchange (COMEX/NYMEX) and the Shanghai Metal Exchange (SHME). In these exchanges, prices are settled by bid and offer, reflecting the market's perception of supply and demand of a commodity on a particular day (ICSG, 2007). On the LME, copper is traded in 25 tonne lots and quoted in US dollars per tonne; on COMEX, copper is traded in lots of 25,000 pounds and quoted in US cents per pound; and on the SHME, copper is traded in lots of 5 tonnes and quoted in Renminbi per tonne. More recently, mini contracts of smaller lots sizes have been introduced at the exchanges (ICSG, 2007).

[7] The International Copper Study Group (ICSG), established in 1992, is an intergovernmental organization that serves to increase copper market transparency and promote international discussions and cooperation on issues related to copper. The ICSG is the only forum solely dedicated to copper where industry, its associations and governments can meet and discuss common problems and objectives. The current members and observers of ICSG are Argentina, Belgium, Chile, China, the European Union, Finland, France, Germany, Greece, India, Italy, Japan, Luxembourg, Mexico, the Netherlands, Peru, Poland, Portugal, the Russian Federation, Serbia, Spain, the United States and Zambia.

Exchanges also provide for the trading of futures and options contracts. These allow producers and consumers to fix a price in the future, thus providing a hedge against price variations. In this process the participation of speculators, who are ready to buy the risk of price variation in exchange for monetary reward, gives liquidity to the market. A futures or options contract defines the quality of the product, the size of the lot, delivery dates, delivery warehouses and other aspects related to the trading process. Contracts are unique for each exchange. The existence of futures contracts also allows producers and their clients to agree on different price settling schemes to accommodate different interests. Exchanges also provide for warehousing facilities that enable market participants to make or take physical delivery of copper in accordance with each exchange's criteria (ICSG, 2007).

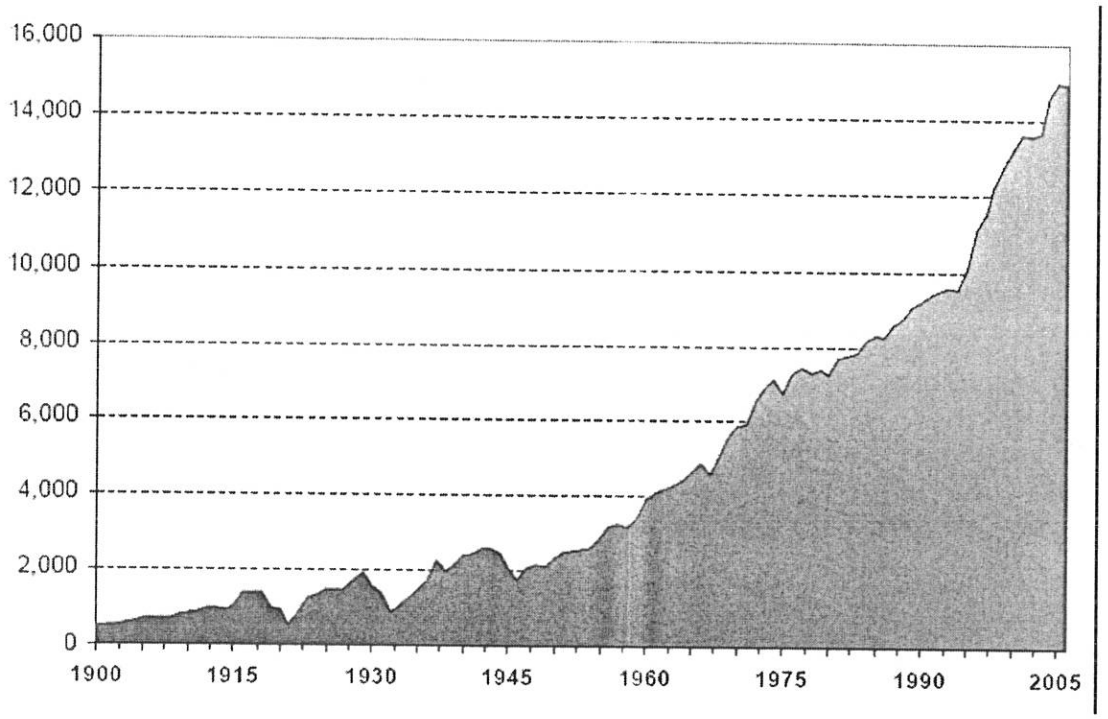
There are four major industries that consume most of the world's copper. These industries are the electrical engineering, the general engineering, the building and the transport industry. The remaining amount of copper is accounted for in the production of a wide range of domestic goods and other products such as coins, ammunition and copper compounds for agricultural purposes (Mupimpila et al., 1998).

The biggest customer of copper is the electrical engineering industry, which provides the equipment for electricity generation, including cables and wires. This industry consumes roughly 55% of the world's copper. Among the largest companies are Asea Brown Boveri (ABB) from Switzerland, Siemens from Germany, Mitsubishi and Mitsui from Japan, Enron and General Electric from the US, and GEC Alsthom, an Anglo-French joint venture. Phelps Dodge is an example of a mining company that also performs electrical engineering activities (ICSG, 2007).

Changes in these four industries clearly have a bearing on the world copper trade. In other words, industrial trends are an important component of the demand for copper. Henstock (1996) also believed that copper demand would increase, because of the fast-growing world demand for electrical power. Especially the developing countries would require more power stations, generators, distribution lines, cables, switchgear, and everything else that goes with an increased population and with its demand for domestic and other electrical appliances.

One of the salient features of the world copper market is that supply is fairly inelastic. By this we mean that it is very difficult to reduce copper production in the face of a glut in the world market (figure 4.0 confirms that copper production had been increasing from 1900 to 2006 with an annual growth rate of 4%). Prain (1975:53) explains the inelasticity of supply as follows: Theoretically, reductions in output can be achieved fairly speedily in the event of a surplus production developing. But in practice considerable problems arise in any consideration of cutting back production. Any significant decrease in mining production results in higher unit costs and in serious dislocation of the many sophisticated processes which are involved in producing the metal. Moreover, such a big proportion of the producing industry is located in developing countries, some of which are almost entirely dependent on copper for their economy, production curtailment is much more than a commercial exercise: national, political, and social implications are equally important factors and these have to be weighed against the behavior of the international market for there may well be period when it is better for some countries to go on producing copper, even at a loss, than not to produce any at all (Prain, 1975).

Figure 5.0 World: Copper Mine Production (Thousand Metric Tonnes), 1900-2006



Source: ICSG 2007 Statistical Yearbook

Therefore, the nature of world copper supply is that it is fairly inelastic. It does not adjust speedily to changing market conditions. What about demand then? Since most of the world's consumption of refined copper takes place in the industrialized and newly industrializing countries (see table 5.0 below), does this limitation make world copper demand subject to changes in market conditions? Well, there are other factors involved concerning the demand for copper (Mupimpila et al., 1998). First, it is important to note that copper is used both for industrial and speculative purposes. Secondly, a significant proportion of copper traded on the world market is quoted on the London Metal Exchange. And since the prices quoted by the London Metal Exchange are quoted in a specific currency (at present the US dollar), it follows

that a change in the exchange rate of the dollar affects copper prices. Because of these factors, changes in copper stocks on the world market play a significant part in determining the price of copper[8]. In particular, demand is subject to constant fluctuations, at least in the short-run. In fact, the entire history of the copper industry from the time of the Industrial Revolution has been one of booms and slumps. This is one basic feature of the copper trade: that of vacillating between booms and slumps, of feast and famine (Mupimpila et al., 1998).

Table 5.0 World: Leading exporters and importers of refined copper

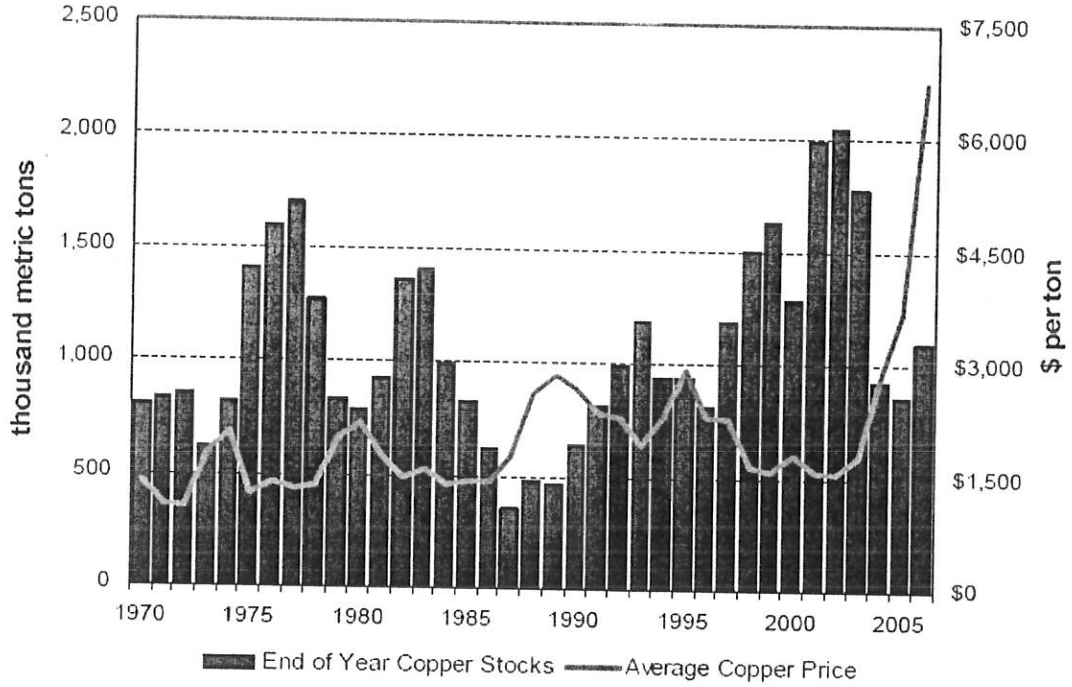
Exporters	Volume (Thousand metric tonnes)
Chile	2,606
Zambia	476
Peru	443
Kazakhstan	357
Japan	320
Poland	288
Australia	287
Canada	280
Russian Fed.	268
China	243
Others	1,938

Importers	Volume (Thousand metric tonnes)
United States	1,073
Germany	881
China	827
Italy	774
Taiwan	646
France	509
Korean Rep.	380
Thailand	267
Turkey	176
Brazil	175
Others	1,071

Source: ICSG 2007 Statistical Yearbook

[8] Figure 4.0 reveals that periods of huge end of year copper stocks are periods when average copper prices where low (for instance, 1975 to 1980).

Figure 6.0 World: Copper Stocks Vs Prices (Thousand Metric Tonnes and US$ per tonne, respectively)



Source: ICSG 2007 Statistical Yearbook

Thompson (1997) predicted that mine production of copper would steeply increase until 2000 in that new mines and extensions had been planned. The largest projects were scheduled for Chile, Argentina, Indonesia, and Australia. Because of the new production capacity, several market experts expect that there would be a large surplus in the near future (Ibid).

ICSG) (2007) statistical yearbook seemed to confirm Thompson's prediction. However, mine production had increased even further after 2000. According to ICSG data, world copper mine production rose by 30% during the 10-year period (annualized average growth rate of 3%), rising from 11.5 million metric tonnes (Mt) in 1997 to 15 Mt in 2006: copper in concentrates rose by

24% while solvent extraction-electrowinning (SX-EW) production rose by 63%. The SX-EW share of total mine production increased form 15% in 1997 to 19% in 2006. While the mine capacity utilization rate averaged 92% during the period, the rate fell sharply during the second half of the period and averaged only 89% in 2005-2006 as a result of the lower head grades, labour unrest, and operational failures. Notable changes in mine production over the 10-year period included a 2 Mt increase in annual Chilean production, a revival of the African copper belt where annual production by 260,000 metric tonnes (t), and a 38% decline (760,000 t) in U.S. production. Also notable was significant production growth from expansions and new projects in Australia, Brazil, China, Indonesia, Iran, Kazakhstan, Peru, and Russia and decreased mine production in Canada, Philippines , Serbia and South Africa. Over the 10-year period, world refined production rose by 29% from 13.5 Mt in 1997 to 16.3 Mt in 2006 (annualized growth rate of 2.9%). Primary and secondary refined production increased by 31% and 16%, respectively. The share of secondary production in total refined production, which averaged 13.5% over the period, trended downward from almost 16% in 1997 to below 12% in 2003, reversed course in 2004 and in 2006, owing to the compound effect of concentrates shortages and higher refined prices , rose back above 14%. During this 10-year period, China's annual refined production increased by 1.9 Mt to 3Mt, followed by Chile where production rose by 800,000 t to 2.9 Mt through 2003, before falling back to 2.8 Mt by 2006. Significant increases also occurred in Australia, India, Japan, South Korea, Russian Federation and Zambia, that together added more than 1.6 Mt to world refined production. In the United States, the leading world producer in 1997, production decreased by 1.2 Mt tons during the 10-year period, and it slipped to fourth position as a world producer of refined copper. Refined production also declined in Canada and in the European-15 (EU-15) countries, where production was down by

40%, mainly because France and the United Kingdom stopped producing refined copper, and Italian production decreased by 50%.

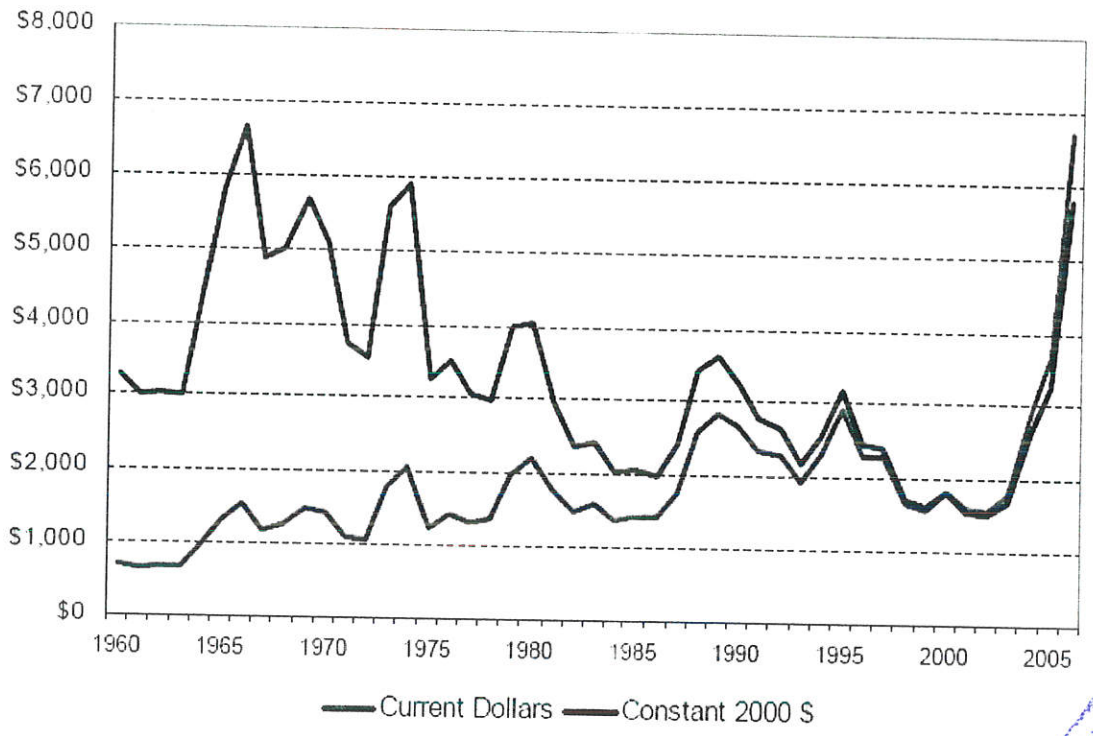
Annual refined copper usage increased by 30% during the 10-year period from 13.1 Mt to 17 Mt (annualized growth rate of 3%). In China, usage over the 10-year period increased by around 2.4 Mt (+190%), leading to a growth in total Asian refined usage of 70%. In Europe, usage grew by almost 1 Mt (22%) mainly due to an increase of more than 500Mt (324%) in Russia's usage and an increase of 230,000 t (6%) in the EU-15 countries. Refined copper usage in the United States and Japan fell by 660,000 t (-24%) and 160,000 t (-11%), respectively. Total world copper stocks trended upward from 1997 to a peak at 2.050 Mt in 2002. Stocks began to decline in 2003, and by year end 2006 had fallen by around 1 Mt (ICSG, 2007).

Table 6.0 World: World Copper Production and Usage (Thousand Metric Tonnes), 1960 – 2006

	Mine Production	Refined Production	Refined Usage
1960	3,924	4,475	4,738
1961	4,031	4,567	5,050
1962	4,216	4,689	5,048
1963	4,286	4,978	5,500
1964	4,443	5,210	5,995
1965	4,647	5,636	6,193
1966	4,626	5,778	6,445
1967	4,872	6,006	6,195
1968	5,010	6,360	6,523
1969	5,941	6,849	7,137
1970	5,562	6,871	7,291
1971	5,900	7,050	7,296
1972	6,541	7,548	7,942
1973	6,735	7,647	8,740
1974	6,915	7,656	8,310
1975	7,289	8,175	7,445
1976	7,097	8,211	8,539
1977	7,444	8,500	9,057
1978	7,306	8,632	9,527
1979	7,371	8,834	9,848
1980	7,230	8,869	9,396
1981	7,745	8,970	9,522
1982	7,721	9,246	9,090
1983	7,643	9,260	9,510
1984	8,136	9,313	9,930
1985	8,288	9,455	9,798
1986	8,266	9,920	10,112
1987	8,592	10,148	10,293
1988	8,775	10,512	10,668
1989	9,372	10,687	11,081
1990	9,226	10,804	10,886
1991	9,084	10,908	10,565
1992	9,497	11,045	10,761
1993	9,549	11,124	10,981
1994	9,553	11,239	11,420
1995	10,084	11,632	12,059
1996	11,097	12,677	12,636
1997	11,537	13,478	13,098
1998	12,248	14,075	13,511
1999	12,776	14,578	14,293
2000	13,209	14,796	15,138
2001	13,763	15,256	14,946
2002	13,576	15,334	15,231
2003	13,634	15,633	15,716
2004	14,601	15,915	16,846
2005	14,921	16,591	16,731
2006	15,008	17,331	17,042

Source: ICSG 2007 Statistical Yearbook

Figure 7.0 World: Copper Prices (London Metal Exchange)



Source: ICSG 2007 Statistical Yearbook

The average annual current (not adjusted for inflation) cash price of copper at the London Metal Exchange surged by over 330% between 2002 and 2006 (see figure 7.0). Karvey Special Reports (2006) also note that the surge in copper prices after 2003 can mainly be attributed to the fact that world consumption of copper began to outpace supply. This sudden increase in consumption has been due to the rapid developmental strides taken by emerging economies like China and India as well as the sustained investment in the growth of telecommunications by industrialized nations. Another reason that can be attributed to the price increase in copper is the continuing decline in warehouse stocks of copper held by various metal exchanges like the London Metal Exchange for instance (Karvey, 2006).

Also worth noting is that the nature of the world copper market has changed because of the increasing use of substitutes for copper. Aluminium is considered to be the main competitor for copper. The raw materials for the production of aluminium are more widely available and cheaper to obtain. For example, approximately 50% of total electric power flows through aluminium cables (Henstock, 1996).

2.3.2 The Zambian Scenario: The Political Economy of the Copper Sector

Since the discovery of copper deposits in the 1920s in northern Rhodesia, which would become Zambia at independence, copper has had an "extraordinary dominance" (Bostock & Harvey, 1972) in the country's economy. Colonial rule began with the British South African Company which acquired mining and commercial concessions. Minerals were the driving force behind the British South Africa Company's entering Zambia. At independence, Zambia inherited an economy with very limited supplies of physical capital, but an unlimited supply of monetary capital acquired from mineral royalties and revenue from copper mines. The price of copper rose steadily after 1964 to create a revenue surplus for the government (Bostock & Harvey, 1972). In 1969, Zambia was the largest producer of copper in the developing world and the third largest producer in the world after the United States and the former U.S.S.R., with production at 12.2% of total world production (Bostock & Harvey, 1972).

After independence, however, several attempts had been met by the government in order to gain full control of the mining sector. Finally, the nationalization of the copper mines was announced by the then President of Zambia, Dr. Kenneth Kaunda in what is now an often-quoted speech, the

Matero speech of August 1976 "Towards Complete Independence". This speech was actually the second phase of a nationalization process, which began in April 1968. Initially, the government secured 51 percent in a wide range of industrial enterprises, except the copper mines. However, in August 1969, President Kaunda announced that the government would acquire 51 percent shares in the two mining companies[9] in Zambia (Mupimpila et al., 1998).

In 1970, the government created the Zambia Industrial and Mining Corporation (ZIMCO); the organization which was to hold the government's interests in mining and industry. Thereafter, ZIMCO purchased 51 percent shares in both Zam Anglo and RST. The mines then began operating under two newly formed companies: Nchanga Consolidated Copper Mines Limited (NCCM) and Roan Consolidated Mines Limited (RCM), both of which were now majority owned by ZIMCO. In 1973, the government paid in full, the purchase of the 51 percent shares in mining companies. Thus, the government then had greater nominal control over the mining industry. Furthermore, in 1979, the government increased ZIMCO's shares in NCCM from 51 percent to 60 % and in RCM from 51 percent to 60.6 percent. Finally, in 1982, NCCM and RCM were merged into a new company, the Zambia Consolidated Copper Mines Limited (ZCCM), making it one of the larger copper mining companies in the world. Besides these changes, another significant aspect of Zambia's economic reforms concerning the mining industry was the passage of the Mines and Minerals Act in January 1970. This Act was significant in that it altered the system of taxation of the mining industry.

[9] These companies were: i) the Zambian Anglo-American Corporation (Zam Anglo), which was part of the mining empire of the Anglo-American Corporation of South Africa; and ii) the Roan Selection Trust (RST) which was affiliated with the American Metal Climax Corporation (AMAX) of the United States of America.

The increased government control over the mining industry in Zambia had concomitant changes in the country's system of government. During the period 1964 - 1971, Zambia was a multi-party democracy. In December 1972, however, the country became a one-party state under a variant of African socialism called Humanism. Thus, for 17 years, Zambia was ruled as a one-party state, by the United National Independence Party (UNIP), under the leadership of President Kenneth Kaunda. This was the status quo between 1973 and 1990.

In retrospect, it is argued that nationalization of the copper mines did not yield the expected results. There are several reasons for this. First, after the take-over, production costs rose rapidly, especially during the period 1970 - 1977. O'Faircheallaigh (1984: 112) in (Mupimpila et al., 1998) observed that during the period 1970 - 1977, RCM's production costs increased by 96 percent while those of NCCM rose by 84 percent. Secondly, from 1974 onward, there has been a deep and prolonged recession in the world copper market; due mainly to falling copper prices. Thus, the period after the copper mines were nationalized has been characterized by increased production costs and reduced world prices of copper. Both of these factors have contributed to reduced profitability of the mining industry. Thirdly, the quality of copper ore in Zambia had fallen over time. This also led to increased production costs; resulting from the need to mine copper at deeper levels. Finally, it is worth noting that the take-over failed to yield the expected results because of a host of institutional failures. Zambia did not have sufficient qualified administrative and managerial capacity to ensure the successful take-over and running of the copper mines. For the take-over itself, the country had to depend on advisers from Britain, Chile and Eastern Europe. In the initial take-over agreements entered into with the mining companies,

the companies retained management contracts that gave them considerable influence over the running of the copper mines (Mupimpila et al., 1998).

In the same vein, Mupimpila et al. (1998) also attempted to explain the factors that led to the decline in copper production from the 1970s period to 1990s. First, changes in the world copper market adversely affected copper production in Zambia. Since 1974, there had been a sharp and prolonged fall in the world prices of copper which, among other things, drastically reduced Zambia's foreign exchanges reserves. Secondly, there were production problems. With the continued depletion in foreign exchange reserves, precipitated by the drop in copper prices, the Government of Zambia, in the 1970s and 1980s, instituted controls on imports in an effort to curb the deteriorating foreign exchange position. As a result, the mines were subjected to shortages of equipment, spare parts and other inputs required for production.

Thus, the critical shortage of foreign exchange resulted in: *i)* a reduction in copper production because of reduced investment in inventory and spares, resulting in periodic shutdown at the mine sites as well as at the various plants; *ii)* exodus of skilled personnel as the declining economic conditions made it difficult to retain the personnel; and *iii)* internal transport problems due to inadequate supply of spare parts. Thirdly, copper production had failed in Zambia because of insufficient investment by the mining companies. Due to the low copper prices (in the 1970s to 1980s period, see also figure 7.0), the mining companies had been faced with financial constraints that made it difficult for the companies to invest in copper production. Finally, copper production had fallen because of the technical difficulties of operating at greater mining depth coupled with falling grades (Mupimpila et al., 1998).

However, in 1991, Zambia returned to a multi-party system of government. And the new government under the multi-party system of democracy has stressed its unwavering commitment to macroeconomic policy reforms, liberalization and privatization of the state companies, including the mining giant ZCCM.

Between 1992 and 1996, the Zambian government examined a number of options for transferring ZCCM to the private sector. The first option was for a single or group of foreign transnational mining corporations to acquire a controlling interest in ZCCM, and was the earliest to come under active consideration. The second option was to restructure ZCCM by dividing it into a number of different companies which could be offered for sale on an individual basis, and appeared on the government's agenda in 1994 following the submission of a World Bank funded study on privatization. The third option, which also emerged in 1994, was to transfer ZCCM intact into the private sector as an independent mining company under the control of the existing management. Each option had advocates and critics, and was subject to a number of constraints (Craig, 2001).

The strategy through which the privatization of ZCCM was to be implemented was announced in July 1996. This strategy was based on the unbundling option and envisaged a two-stage approach to privatization. In the first stage, the majority shares in the operating companies would be sold to new investors, with ZCCM maintaining a minority interest in each new company. With ZCCM transformed into an investment company with minority shares in a range of independently managed mining companies, stage two would commence. In this the government would sell all or most of its shareholding in ZCCM to domestic and international investors. The

government stated that the resulting companies would be registered in Zambia, that the government would retain a golden share in each, and that an inter-ministerial group would be established to monitor the private operators (Craig, 2001).

By 1998 several ZCCM units had been disposed of. For instance, Chibuluma – sold to Metorex of South Africa in October 1997 in a deal whose main terms were a cash payment of US$ 7.5 million, a free carried interest for ZCCM of 15% and a commitment to capital expenditure of US$ 34 million. The company formed from this agreement is Chibuluma Mines plc. Luanshya – sold to Binani Industries of India in October 1997 in a deal whose main terms were a cash payment of US$ 35 million, a free carried interest for ZCCM of 15% and a commitment to capital expenditure of US$ 69 million. The company formed from this agreement is Roan Antelope Mining of Zambia. Chambishi – sold to China Non-Ferrous Metal industries Foreign Engineering Construction. The transaction was signed in June 1998, and involved a cash payment of US$ 20 million, with a 15% free carried interest for ZCCM and a commitment to invest US$ 70 million. The company formed as a result is to be known as NFC Africa Mining plc (for a detail of the sale of ZCCM units see The Mining Journal, 1999).

The privatization of the Zambian copper industry was formally completed in March 2000 when the remaining productive units and assets of ZCCM had been transferred to private ownership to the newly formed Konkola Copper Mines plc (KCM) (The Mining Journal, 2000; Craig, 2001). The copper sectors' exports (in value terms, at least) seemingly increased in the subsequent years. This coupled with buoyant world prices put back the mining sector at the helm of economic activity in Zambia. By the beginning of 2006, prices on the London Metal Exchange shot nearly to US$10,000 per tonne – double the average of December 2005 – on the back of

strong demand from China and India in particular (http://ww.irinnews.org/report.aspx?reportid=59503). The good copper prices encouraged mining companies to double their production capacity. Additionally, new mines where opened and this proved positive vis-à-vis copper output. For instance, by September 2006, Equinox Ventures owner of newly found Lumwana mines[10] in the North-Western province of Zambia announced that construction of the project had commenced. (http://www.miningweekly.com/article.php?a_id=93891)

In a nutshell, the copper industry since independence has been characterized by slumps and booms. The wheels came off Zambia's economy in the 1980s, when copper prices slumped under the weight of a global recession. A new free-market government privatized the mines in the mid-90s. At its peak, Zambia produced about 750,000 tonnes of finished copper, before dropping to 200,000 tonnes in the 1990s. With concomitant buoyant world copper prices, mine production had increased to 440,000 tonnes in 2005 (http://www.miningweekly.com/article.php?a_id=93891).

[10] Lumwana mine is one of the world's largest undeveloped copper deposits – it will produce an average of 150 000 t/y of copper over its operating life

CHAPTER THREE

THE LITERATURE – ANALYTICAL FRAMEWORK

3.1 Introduction

Having established the dependence of the Zambian economy on copper exports (a primary commodity), the underlying question that needs to be addressed is one that seeks to explore the factors that determine supply of primary commodity exports. This section of the paper reviews literature that have attempted to pin-point factors that determine the supply of primary commodity exports both theoretically and empirically.

Essentially, this review starts by giving a general chronicle of modeling primary commodities (with specific reference made to the developing world). This narration in itself also attempts to draw a dividing line between theory and empirics. It should be noted though that such a distinction is not clear cut when dealing with modeling primary commodity exports. Secondly, specific account is given to general mineral modeling and then finally, the review ends by looking at copper export supply modeling. Needless to say, this schematic approach and/or characterization will be done in chronological order.

3.2 Primary Commodity Export Supply Modeling

In examining the factors that determine the supply of primary commodity exports, Alemayehu (2002) has carried out a deep review of literature which indicates a distinction between the long run (potential supply) and the short run (a proportion of potential supply). Binswanger (1992) in Alemayehu (2002) has identified a range of such factors which include; cost and accessibility of consumer goods, farm subsidies and taxes, research and extension, the existence and quality of road infrastructure as well as the availability of services such as marketing and credit. However, these factors may not operate in isolation as for instance, the quality of road infrastructure is likely to affect the availability of services.

Alemayehu (2002) observes that much of the analysis relating to the export problems faced by producers of primary commodities in developing countries would lead one to conclude that the problems faced by these producers are mainly price-related in nature. More specifically, overvaluation of the exchange rate and marketing board intervention are found to represent particular problems for these producers. His argument is that, although the literature on commodity export supply functions starts from structural equations, which accommodate a wide spectrum of these factors, the estimated reduced form equations are generally price-focused; they include either current or lagged (relative) prices. In general, he notes that these studies may be categorized under two themes – *price-focused models*, which use prices of different complexity as explanatory factors and; *mixed (heterodox) factor-based models*.

Alemayehu (2002) argues that the price-focused models stem from the 'cobweb' theorem of Ezekiel (1938) which states that output is determined by the level of price in the previous period. Nerlove's (1958) model is a modification of this. Nerlove describes the dynamics of agricultural supply by maintaining the assumption that producers are influenced by their perception of normal price, which is captured through adaptive price expectation mechanism. Consequently, production is a function of prices and other adjustment costs.

In his review of literature on studies which emphasize the distinction between the long run and short run, Alemayehu (2002) makes a remarkable observation that some studies define structural equations of supply as the sum of utilization of potential output (the utilization rate approach) and the potential output (potential supply approach). A specification of the reduced form model of these is a function of current and lagged prices, exchange rate and a supply shock indicator. Such classification is typically used for perennial crops and minerals.

Additionally, other studies follow the optimizations strategy of agents under a range of different assumptions. These strategies range from maximizations of average return per unit cost to examining a relationship between higher short-term rate of extraction under uncertainty with a higher interest rate (see Gray, 1914; Carlisle, 1954; Hotelling, 1931 Herfindahl, 1955 and Parish, 1938 in Alemayehu, 2002).

Supply response functions may also be categorized according to whether they relate to annual crops, marketed or perennial crops (Shu, 1975; Askari and Cummings, 1976). Their argument is that different models can be fitted for such estimations using simple OLS. For example, one

model found useful for annual crops is the Nerlovian adjustment model which employs a lagged dependent variable by assuming that farmers adjust by learning from their past expectation mistakes. In addition Bateman (1965) was the first to attempt to model supply response in perennial crops as he modeled Ghana's cocoa supply. The model uses expected producer prices for cocoa and a competing crop, such as coffee. Non-price factors are ignored but the dependent variable is the additional acreage under the planted crop each year in question (Alemayehu, 2002).

On the contrary, as indicated in Alemayehu (2002), models that include other factors other than price include Ady (1968). She developed an estimation for perennial crops for Ghana, Nigeria and Uganda. An additional explanatory variable is included – i.e. existing acreage (stock of crop) – and this represents an improvement to Bateman's model. In the liquidity model, farmers' incomes is incorporated as an additional variable indicating capacity to invest which is an attempt to relate investment to the difference between desired and actual level of capital (Ibid). Such models have been summarized under models based on capital and investment behavior theory presented in the Nerlovian adjustment model (Ibid). Alternative forms of this theory arise in specifying the factors that determine the desired level of capital stock. These include capacity utilization (capacity utilization theory), net output or return to capital (neo-classical), internal cash flow (liquidity theory) and expected profit-based approach (Alemayehu, 2002). Some studies consider supply as a function of expected price, expected opportunity cost, production costs, stock of output (trees in the case of perennial crops), potential of the industry and tax considerations while others incorporate the dynamic effects of the exchange rate, the general

price level, and an index of productivity (for example Kalaitzandonakes et al., 1992; Bond, 1987 in Alemayehu, 2002).

In general, the emphasis in commodity supply modeling is on relative prices. Most studies on the exports of African countries tend to follow a similar approach. For small African countries, Rwegasira (1984) as cited in Alemayehu (2002) shows that for the period 1960s–1970s, the short run elasticities are high for annual crops while long-run elasticities are high for tree crops and minerals.

Although there is a wide range of factors that have been identified as affecting supply of primary commodities, most studies empirically tend to narrow these factors to price variables, indicating the difficulty of quantifying non-price variables or obtaining reliable and complete set of data (Alemayehu, 2002; Mckay et al., 1998; Branchi et al, 1999). In addition, there is a tendency to ignore the influence of the nonagricultural sector, therefore implicitly assuming that the interactions between the two sectors are insignificant. Nonetheless, the bias of literature on supply-side reflects the dominance of the small country assumption, according to which countries have a negligible weight in the world market (Alemayehu, 2002).

Finally, the review above makes it clear that some factors other than price may be equally important determinants when specifications of export supply functions of primary commodities are made. Essentially, Alemayehu (2002) argues that the different factors emphasized by different authors are complementary and should thus be considered explicitly within any

estimation. But generally, time series studies have tended to produce rather low empirical estimates of elasticities (Mckay et al., 1998; Whitley, 1994; Ogbu, 1991).

In an effort to give an account of general primary commodity export supply modeling, this review uses Lyakurwa's (1998) study as a starting point. He uses a panel data of 22 sub-Saharan African countries for the period 1970-1995. He tried to determine the factors that influence export performance for the categories of resource exports of agricultural raw materials, fuels and mineral exports. The key variables are the real exchange and government expenditure, as measures of macroeconomic stability, gross domestic investment as a measure of infrastructure development, and an economy's potential to sustain high rates of export growth, corruption as a proxy for the cost of doing business and external tariff as a measure of market access (Lyakurwa, 1998).

The author notes that results show that while the combined effect of all the factors is about 74% in the case of agriculture raw materials and about 86% in the case of minerals, ores and metal exports, their effect on fuel exports is negligible. In all three cases, the real exchange rate is significant but negative while the lag of the real exchange rate is significant and positive. The variable government expenditure is negative and significant in the case of fuels and mineral exports but not in the case of agricultural raw materials although it has the right sign. The variable corruption is not significant in all three cases. The lag of gross domestic investment is positive and significant in the case of agricultural raw material export supply. External tariffs were not significant in the case of agricultural raw materials and mineral exports. Tariffs were, however, significant and positive in the case of fuel exports (Lyakurwa, 1998).

As already noted, emphasis on the supply-side imposes an underlying small country assumption. The major criticism of this approach is that, by basing itself on the small country assumption, it suffers from fallacy of composition or the adding-up effect (see Evans, 1993; Akiyama and Larson, 1994 in Alemayehu, 2002). As such, modeling exports without taking the global effects into consideration may not be an accurate depiction of reality (Alemayehu, 2002). Furthermore, demand side aspects are completely ignored in the model.

Another study of interest is one by Branchi and Spiezia (1999) who sought to analyze determinants of exports of coffee for a selected group of developing countries. The premise of their study was to evaluate the importance of price variables relative to more structural factors. Their paper focuses on two specific issues; the first one refers to the effects of changes in the international price of coffee on the level of exports from each country, with particular emphasis to the behavior of sub-Saharan countries. The importance of trade policy in determining export performances is the second issue investigated in their paper. The analysis is carried out on a sample of 26 countries, 12 of which are African, over a period of over 20 years, from the early 1970s to the mid-1990s. A broad small country assumption is maintained in the analysis, according to which the coffee exports of each of the countries selected had a negligible weight in the world market. Furthermore, by definition, the growth rate of production in each country is the sum of the growth of planted areas and of the increase in yields.

Branchi and Spiezia's (1999) study reveals that results of the regression analysis reported that taxation policy and the variations in the real exchange rate turned out to exert a positive effect on the cultivated areas. The regression explains about 35 % of the sample variance, meaning that

two thirds of the cross-countries differences in the growth rate of cultivated areas are due to other non-price factors. Some of these factors can be considered at least in part as policy-determined (such as the availability of infrastructure, inputs, marketing and extension services), while some others are purely exogenous, among them the availability of land or the vagaries of the weather. To account for the total effect on supply, they regressed the growth rate of coffee production on the variations of the exchange rate, the taxation coefficient and the yield. All the explanatory variables considered proved to be significant at a conventional level (95 % or more). However, the effects of price policies on the supply of coffee appear to be quite small. (Branchi and Spiezia, 1999).

Unfortunately, despite the authors' remark that policy-determined factors may have explained, at least in part, cross-country differences in the growth rate of cultivated areas, they are not considered explicitly in the models that were finally estimated. This may imply misspecification of the model.

In the same vein, Were *et al* (2002) after observing that Kenya's leading exports are primary agricultural products undertook a study premised on decomposition of Kenya's exports into three major categories: traditional agricultural (coffee and tea) and other exports of goods and services. Their study adopts a similar approach as most conventional commodity models that usually incorporate the real foreign income (of trading partners) and real exchange rate (proxy for relative prices) as explanatory variables in the estimation of the export supply functions in general.

For each of the three categories of exports, the authors focus on the following explanatory variables: real exchange rate, real foreign income (income of major trading partners) and total investment as a proportion of GDP. The inclusion of income and real exchange rate, as indicated above, is standard in trade models. The additional variable—investment to GDP ratio—is a proxy for capital formation to capture the supply constraints. Time series models were specified for three categories of exports: volumes of tea and coffee exports derived by deflating the values by the respective 1982 (constant) prices, and exports of other goods and services obtained as total value of exports of goods and services less the value of tea and coffee exports deflated by the export price index.

Their results, estimated through cointegration and error correction modeling, reveal that for coffee, the long-run coefficients for real exchange rate and investment as a ratio of GDP are significant and positive. However, income of trading partners is not significant. The results show that coffee export supply is responsive to prices in the long run. Given that coffee is a perennial crop, an attempt was made to capture lagged effects by incorporating lagged variables in the estimation. Except for real exchange rate and income of trading partners lagged two years, other lagged variables were only significant at more than 5% level. Estimations for tea produced troublesome results as there was no cointegrating relationship derived. For other exports of goods and services, the estimation results (both without and with lagged variables) show that income of trading partners and real exchange rate were significant determinants but private instead of total investment turned out to be insignificant (Were et al., 2002).

Additionally, Alemayehu (2002) specifies the export supply equation of a typical African economy in order to depict the behavior of commodity producers, mediated through the government. In his different models, he includes factors, other than price, foreign inflow, capital formation indicator and the expected profit indicator. He estimates export supply functions of primary commodities in different African regions and disaggregates the data according to the Standard International Trade Classification's (SITC) categories. However, what is important to the current study is that firstly, price-focused estimations are explored and then subsequent estimations are undertaken by adding other relevant explanatory variables. For instance, estimation using a real exchange rate and capital formation resulted in statistically significant results. However, estimation with foreign inflow produced mixed results (Alemayehu, 2002).

Desai's (1966) study is our starting point of mineral export modeling. He attempts to construct and estimate an econometric model of the world tin economy with the main emphasis being on the forces that determine the demand for tin. He presents estimates of the structural equations which are designed to explain forces behind tin consumption, output and prices over a sample of 14 annual observations spanning from 1948 to 1961. Total tin consumption was divided into three regions (see Desai (1966) for details). This will, however, be not pursued here. In estimating an equation relating to tin used for tinplate, the equation relates this to total tinplate output in the U.S. A trend variable in explaining tin consumption is added but no price variables were used in the final estimation. Desai (1966) justifies this by mentioning that:

> *"no price variable was used in this equation because the price of tin as well as the price of possible substitutes like aluminium were also tried in alternative*

formulations but were found to be statistically nonsignificant. Other estimated equations too did not include price variables."

For the case of tin output, the author tried several alternative estimations to relate output. He introduced current price, lagged price, current stock level or lagged stock which were all found to be statistically insignificant. Finally, a simple relationship for output was adopted but it related world tin output to output in the previous period and an export control dummy variable. Output coefficient lagged one period was positive but insignificant. The coefficient of the export control variable was negative and significant. For the price of tin, the author argues that since neither consumption nor output were found to be responsive to price, price was assumed to be determined by difference between output and consumption. The level of tin stock was introduced as a variable representing the history of output consumption imbalance. The coefficient of stocks over demand lagged one period was found to be statistically significant (Desai, 1966).

Banks' (1972) paper is a comment and a reaction to Desai's (1966) econometric model of the world tin economy. Banks (1972) counteracts to this model by mentioning that the Desai (1966) failed to produce a price effect anywhere in the model. However, Banks (1972) argues that employing some techniques discussed by Labys and Granger (1970) reveals that a preliminary analysis of the cross spectra for tin, copper, zinc and lead indicates that specification of consumption equations for tin should resemble that of other metals, and in these cases, price effects are definitely visible and highly significant estimates of price elasticities can be made. Banks (1972) specifies a Nerlovian adjustment equation where the total United States consumption of tin is a function of price in the previous period, a change in inventories of

durable goods in the United States. He employed annual data for 1953-68 and calculated the short run and long run price elasticties and thus yielded -0.55 and -1.262, respectively. Another critical point is that Desai's paper expressed the consumption equation in terms of primary tin consumption whereas Bank's specification of the consumption equation is that of total tin consumption. The premise of this discrepancy is that, as Banks argues:

> *"...given the well known fact that primary and secondary tin are, from the point of view of buyers, almost indistinguishable, I find it rather difficult to believe that a meaningful separation of consumption into its primary and secondary components could be made. On the other hand, I am prepared to agree that equations with a high degree of aggregation are only a starting point for our investigations, and those wishing to continue to finer breakdowns should be encouraged to do so. At the same time I am convinced that these breakdowns will have to be along industry lines, and essentially should have nothing to do with whether we are talking about primary or secondary metal..." (Banks, 1972).*

Desai (1972) replies to Banks' (1972) comment and mentions that Banks' comment and criticisms are unfounded considering that the two studies had different time periods and levels of aggregation. Desai (1972) argues that the definition of consumption is crucial to the significance of the price variable – for instance if the secondary tin consumption is excluded from total tin consumption, the coefficient of the lag of the price variable is still insignificant. Distinction between primary tin and secondary tin is also important because demand for primary tin is met almost entirely by imports in the United States and stocks are mainly held in primary tin.

Of critical importance, however, is the observation that none of the authors (i.e. Desai, 1966, 1972; Banks, 1972) makes mention of the time series properties of the variables on interest. Despite all the effort about inclusion of price variables for example, and use of different aggregation levels and estimations, no mention is made as to whether variables are stationary and our observation is that the non-stationarity of the variables may have affected estimation of the results hence reporting spurious regression results. Further, both sample periods for both authors are too short and this may have affected robustness of the estimations. Needless to say, both studies are much older than the advancement in econometric time series modeling properties. However, the findings as result may have reported spurious results.

A study by Fisher, Cootner and Baily (1972) develops an econometric model of the world copper economy, relatively disaggregated to incorporate different supply equations for each of the major producing countries and different demand equations for each of the consuming areas using data for the 1948-1968 period. We will use this study as a premise in examining copper export modeling. Separate supply curves of primary copper are estimated for the United States, Chile, Zambia and Canada. This review, however, concentrates on the Zambian case, where supply is represented by Zambian mine production as a function of price of copper (deflated by an index of the cost of living of Europeans in Zambia) and lag of mine production. At the point of means, the short run elasticity of Zambian supply is approximately 0.0684 while the long run elasticity is far greater. Indeed, as estimated, the effects of prices never die out, although the coefficient of lagged mine production is not significantly above unity; but the speed of adjustment is obviously

extremely slow, although ultimately the Zambian supply curve is nearly flat (Fisher, Cootner and Baily, 1972).

This study ignores the role played by other non-price factors which may be equally important. Also, the role of commodity inventories and/or stocks is ignored and this may be crucial in price determination and subsequently in commodity supply. Further, time series properties of the data employed such whether or not variables are stationary were not considered explicitly in the study. The main disadvantage of this is that the concomitant estimations may have reported spurious results. Additionally, the estimation period reveals that the time period being considered is too short to produce much more meaningful and/or robust results. Finally, the demand side aspect is ignored.

Richard (1978) develops a dynamic model of the world copper industry that is intended to show relationships existing between supply, demand, price and investment. The initial observation the author makes is that in the particular case of copper, it is the slow adjustment of supply relative to demand that creates situations of excess supply. The model is estimated using quarterly data spanning the period beginning with the fourth quarter of 1960 to the fourth quarter of 1975. On the supply side, production of refined copper is broken down between primary refined copper and secondary refined copper for both the United States and the rest of the world (referred to hereinafter as non-U. S.). In addition, for each primary production equation, an investment equation is specified to represent the behavior of mine capacity. Similarly, an equation representing the stock of copper available for reprocessing to the secondary industry is specified for both the United States and the non-U. S. The demand side is represented by two equations

corresponding to non-U. S. and U. S. consumption of refined copper. The elasticity of demand with respect to the price of copper relative to that of aluminium for both the U.S and non-U.S sectors is estimated to be not significantly different from zero while on the other hand, the supply equations for secondary copper yields price elasticities of supply that are similar in magnitude and are significantly different from zero for both the U.S and non-U.S - the U. S. price elasticity of secondary production is equal to 0.41 and the non-U. S. price elasticity is equal to 0.34. Estimates of the mixed stock/flow formulation of price formation are found to be significant. Both stocks and flows are relevant to price determination. The adjustment parameter of stocks to prices is relatively large, thus emphasizing the importance in determining price of the underlying level of copper stocks in the market. The relationship representing the desired demand for stocks yields a significant price elasticity, which implies that stocks are practically infinitely price elastic (Richard, 1978).

This study is commended as being a step further in an attempt to capture the dynamism of the copper industry with consideration of non-price factors in, for example, influencing supply. However, one major weakness of the resultant estimations is that time series properties are not addressed and this may have ultimately affected estimations despite use of quarterly observations to elicit more information by improving on estimation efficiency.

Spilimbergo (1999) carries out a study on copper and the Chilean economy. The purpose of this study was to examine the dynamic relationships between the copper price cycle, the Chilean business cycle, and the various GDP components in the country's economy. Descriptively, the author's analysis shows that GDP growth and the real price of copper have a strong correlation.

The author also sought to show that GDP growth is not merely a reflection of the evolution of the mining sector and thus examines this issue by using industrial production as an indicator of economic activity which does not include the copper sector directly. This examination also shows that there is a strong correlation between the copper cycle and the cycle of economic activity. Secondly, the author also showed how a short run shock in the copper sector is identified by using price changes via GDP components. Private consumption tends to be smoother and to lag so that the peak in consumption is on average two quarters after the peak in the copper price. Investment is more sensitive to the cycle and in all cases peaks one quarter after the copper price peaks. In the same vein, the effects of copper cycles on the exchange rates are quite strong – in particular, the correlation between changes in the nominal exchange rate correlates with the copper cycle where the nominal exchange rate appreciates during the copper boom and depreciates as the price of copper declines. In sum, the paper concludes that world copper prices play an important role in short term fluctuations and probably influence long term growth in the Chilean economy. While many mechanisms may be at work, investment seems to play a major role. In a copper price boom, the higher copper price and associated capital inflows create upward pressure on the real exchange rate (Spilimbergo, 1999).

While this study may be considered informative in guiding policy because of its descriptive analysis, it does not, however, develop an econometric framework which may have provided a gauge in assessing certain stimuli. Also, mere correlation between, for instance, nominal exchange rate and the copper cycle does not provide any substantial information. Consequently, quantifying short term shocks in the copper sector through price changes in GDP components proved to be problematic.

Vial (2004) examines structural copper market modeling strategies; taking a fresh look at the implications that globalization of industrial activities has had in primary commodity markets, such as copper. A structural econometric model is estimated using annual data for 30 years and aggregate elasticities are computed through simulations. The model is also used to estimate economic impacts of copper consumption promotion, and the simulation results show that promotion, when effective in raising copper use, have a significant impact in the market.

The supply side of the model was disaggregated between primary and secondary production for the main producing countries. Primary production was made a function of long lags of copper prices relative to aluminum, energy and wages, to capture the slow response of capacity to these variables. Secondary production was made a function of the relative price of copper to wages and to energy prices, as well as of the stock of recoverable material (a weighted average of copper consumption in the previous ten years). Of interest to the current study is that, for the case of Zambia, in the primary production model, long term elasticities were higher (in absolute terms) than short term elasticities. The effect of copper prices was positive and significant (for both the long run and short term). Additionally, in the long run there was a significant (negative) effect of energy prices on the supply of copper (Vial, 2004).

A good number of studies have been criticized in their construction of a good proxy for relative prices (see for example Edwards, 1989 in Musonda, 1998). This study, nevertheless, adopts aluminium price in the construction of a relative price variable for copper price. The proper

deflator would be weighted variable of prices of stainless steel, plastic and aluminium itself[11] (Richard, 1978).

Lofgren, Robinson and Thurlow (2006) assess the impact of changes in the world copper price and the possible closing down of mining production of the Zambian economy by defining two scenarios (to be made clear below). The authors use a computable general equilibrium (CGE) model[12] built around a 1995 social accounting matrix to simulate the short- and long-run effects of these two scenarios that reflect the current crisis[13] in Zambia.

In the first scenario, the simulation assesses the impact of a 20 percent fall in the price (in foreign currency) received by Zambia for its copper exports. The results show that, in the short run, the decrease in the world price of copper reduces export earnings in the mining sector, putting pressure on the trade balance. Depreciation of the real exchange rate, providing incentives to substitute for imports and increase exports, is needed to reduce the "non-mining" trade deficit. At the new equilibrium, the real exchange rate had depreciated by 10 percent, while total exports had risen by 4.1 percent and total imports fallen by 5.6 percent (Lofgren, Robinson and Thurlow, 2006).

The second scenario imposes a 75 percent reduction in the capital stock of metal mining. Given that the copper sector is highly capital-intensive (capital accounts for 86 percent of value added); this approximates a complete shutdown of the copper sector. It constitutes a severe shock for

[11] This is so because these are substitutes of copper in their use (see Mupimpila et al. (1998) for details of copper substitutes in use)
[12] However, this review will concentrate on the trade implications and modeling of copper
[13] This crisis is deemed as Zambia's strong dependence on copper exports which has suppressed other tradable sectors, indicative of a Dutch disease phenomenon.

Zambia's economy as it involves the withdrawal of a large part (19 percent) of the total capital stock and a severe contraction in the sector that dominates exports. In the short run, a real exchange rate depreciation of 42.1 percent is needed to induce the export increases and import substitution that is needed to make up for the loss of copper exports. At the new equilibrium, exports had declined by 34 percent and imports by 22 percent while real GDP at market prices had fallen by 16 percent (because of the fall in the economy-wide capital stock). In the long run, the higher degree of economic flexibility greatly reduces the required depreciation of the real exchange rate, to 25 percent, and enables export-oriented sectors to assume a larger share of the adjustment burden: the declines in total exports and imports are both smaller than in the short run (Lofgren, Robinson and Thurlow, 2006).

Perhaps presentation of the study by inclusion of an econometric framework would have yielded much more insight and given more information. However, the information given in the study may have communicated policy relevant tools in the Zambian copper sector.

CHAPTER FOUR

MODEL SPECIFICATION AND ESTIMATIONS

4.1 Introduction

This chapter examines the theoretical underpinnings of the export function and uses them to specify the export supply model for Zambia. In short, it links theory to the export function to be modeled and estimated in this study.

4.2.1 Theoretical underpinnings: Linking theory to estimation

As Labys (1973) notes, theory posits that export supply can also be derived from profit maximization problems of producers subject to the available production technology. However, our study focuses on the approach by Goldstein and Khan (1978) Chu and Morrison (1986), Hwa (1985) and Alemayehu (2002). This approach will be made clear below.

As a preliminary, Labys (1973:49) presents a study done by Burrows (1971) on a commodity of regular supply[14] – tungsten. He begins with a Koyck lag which specifies that output, q_t, must be a distributed lag of current and past prices, P_{t-i}.

[14] For a detail of commodities of regular supply (copper inclusive), see Labys (1973)

Thus;

$$q_t = a_o + a_1 \sum_{i=0}^{\infty} \lambda^i P_{t-i} \qquad \text{; Where} \qquad 0 \leq \lambda < 1 \qquad (1)$$

Successive values of the lag coefficient λ decline geometrically. This expression is simplified by first lagging it one period and by multiplying it by λ

$$\lambda q_{t-1} = \lambda a_o + \lambda a_1 \sum_{i=0}^{\infty} \lambda^i P_{(t-i)-1} \qquad (2)$$

Then, subtracting equation (2) from equation (1), we obtain;

$$q_t = [(1-\lambda)a_o] + a_1 P_t + \lambda q_{t-1}$$

The final equation that was estimated by Burrows (1971) is of the form:

$$q_t = b_0 + b_1 P_t + b_2 q_{t-1} + b_3 z_t + u_t \qquad (3)$$

where z_t is an exogenous factor which attempts to capture 'other' factors.

However, Labys (1973) adds that equation (3) can be modified to incorporate a lag structure on prices to obtain;

$$q_t = b_0 + b_1 \sum_{i=0}^{\infty} \lambda_i P_{t-i} + b_2 z_t + u_t \qquad (4)$$

The results of equation (3) and equation (4) can be used to explain the supply of commodities of regular supply.

4.2.2 Model transformations to fit the available data

However, most theoretical export functions are adjusted to fit the available data. Equation (4) above can be transformed to capture both short run and long run features that theory emphasizes. The premise of this theoretical representation stems from the distinction between the short run capacity utilization theory and the long run capital formation argument.

Following Alemayehu (2002), the response of price and other supply factors is likely to take two forms:

(i) In the short run, increased capacity utilization is important. As Labys and Pollack (1984:51) add: "where short run price increases stimulate output, the degree of response depends on the intensity of capacity utilization possible." Thus short run parts would be based on the commodity models of for example Goldstein and Khan (1978). Here, latent capacity utilization theory is the underlying hypothesis.

(ii) Normally, it is possible to recognize the long run response of intention to invest in a mining operation. Changes in current output reflect a response to invest because

of higher prices in some past period (Labys and Pollack 1984:51). Consequently, in the long run, producers (mines) are assumed to respond through change in potential output (i.e. capacity creation). For the case of Zambia, other supply-inducing factors, such as capital formation and inflow are believed to explain this.

The general theoretical representation is that:

Export supply = capacity utilization + capacity formation

Mathematically, following Alemayehu (2002), this may be given as:

$$X^{ss} = \alpha_0 + \alpha_1 \frac{ep_s}{p_d} + \alpha_2 \left(\frac{ep_s}{p_d} \right)_{t-1} + \left[\alpha_3 (\Delta K) + \alpha_4 Fi \right] \qquad (5)$$

Where;

X = export supply

E = nominal exchange rate (i.e. domestic currency per unit of foreign currency)

P_s = export price of the commodity

P_d = domestic price

Fi = foreign inflow

ΔK = capital formation indicator

The term in equation (5) in brackets [...] indicates capital creation and is composed of the foreign inflow as well as the capital formation indicator.

In addition the ΔK (i.e. capital stock) can be decomposed to capture capital inflow (Fi), domestic credit (DCR) and government investment (I_g). Incorporating this into equation (5) can be formally represented as:

$$\Delta K = \beta_0 + \beta_1 DCR + \beta_2 I_g + \beta_3 Fi \tag{6}$$

Incorporating (6) into (5) we obtain;

$$X^{ss} = \phi_0 + \alpha_1 \frac{ep_s}{p_d} + \alpha_2 \left(\frac{ep_s}{p_d} \right)_{t-1} + \phi_1 DCR + \phi_2 I_g + \phi_3 Fi \tag{7}$$

Where

$\phi_0 = \alpha_0 + \alpha_5 \beta_0$; $\phi_1 = \alpha_5 \beta_1$; $\phi_2 = \alpha_5 \beta_2$ and $\phi_3 = \alpha_3 \beta_3 + \alpha_4$

Transforming into logarithms for estimation[15] we have;

$$\ln X_t^{ss} = \phi_0 + \alpha_1 \ln \left(\frac{ep_s}{p_d} \right)_t + \alpha_2 \ln \left(\frac{ep_s}{p_d} \right)_{t-1} + \phi_1 \ln DCR_t + \phi_2 \ln I_{g,t} + \phi_3 \ln Fi_t + U_t \tag{8}$$

Where U_t represents the error term.

[15] Such a transformation implies that the estimated coefficients are elasticities. Also note that, to ease illustration, the same coefficients are maintained.

To render equation (8) useful to the Zambian case because of data problems, and noting that macroeconomic stability is an important determinant to domestic credit creation and inflows of foreign direct investment, we combine these two variables with *Ig* and represent them by gross domestic investment (*GDI*) as a proportion of GDP – *GROSSDIGDP* – as a measure of infrastructural development and an economy's potential to sustain high rates of export growth while at the same time it is intended to capture supply constraints as well (Lyakurwa, 1998; Were et al., 2002). Additionally, Musonda (1998; 2001) uses imports as a proxy for capacity utilization. We follow this argument and argue that since Zambia has been faced with foreign exchange constraint[16], which arguable may have led to compression of imports of raw materials and inputs which are very important in influencing copper export growth as well as for long term investment. According to Musonda (1998), the theoretical basis for this claim hinges on the understanding that when imported inputs decline due to inadequate foreign exchange, investment, which is the driving force for economic growth, slumps and as a result leads to a sluggish export performance (see Meijer, 1991; Mwanza 1992 in Musonda, 1998). We thus include imports (*IMPORTS*) as a measure of some aspects of capacity utilization as well as to capture residual investment constraints including acquisition of inputs for production.

Therefore, the modified supply equation with the above variables being augmented is;

$$\ln X_t^{ss} = \phi_0 + \alpha_1 \ln\left(\frac{ep_s}{p_d}\right)_t + \alpha_2 \ln\left(\frac{ep_s}{p_d}\right)_{t-1} + \delta_1 \ln IMPORTS_t + \delta_2 \ln GROSSDIGDP_t + U_t \qquad (9)$$

[16] Note also that Mupimpila et al. (1998) argue that import controls during the 1970s and1980s were imposed in order to curb the deterioration in foreign exchange reserves. Mines as a result were subjected to shortages of spare parts, equipment and other inputs required for production. Consequently, there was a reduction in copper production because of reduced investment in inventory and spares (Mupimpila et al., 1998).

Finally, following Zambia's fully fledged liberalization of the trade regime after 1991, we incorporate *LBD* a dummy variable[17] indicating the post liberalization period (1992-2003) to capture the trade regime aspect.

Ultimately, the final model and equation to be estimated is;

$$\ln X_t^{ss} = \phi_0 + \alpha_1 \ln\left(\frac{ep_s}{p_d}\right)_t + \alpha_2 \ln\left(\frac{ep_s}{p_d}\right)_{t-1} + \delta_1 \ln IMPORTS_t + \delta_2 \ln GROSSDIGDP_t + \delta_3 LBD + U_t \quad (10)$$

4.3 Methodological issues

The methodological issues address the need to identify the link between the supply theories and the estimation technique the study will employ. The starting point of such an identification stems from the fact that the traditional approach used in estimating supply functions of primary commodity exports has been criticized on methodological grounds in that there does not appear to be a clear distinction between short-run and long-run elasticities (Were *et al,* 2002).

Furthermore, it has been widely acknowledged that the application of simple OLS using time series data is likely to produce spurious results. Cointegration analysis can be used to avoid spurious regressions while at the same time providing a means of explicitly distinguishing between long-run and short-run elasticities through the error correction formulation. The error correction model is a formal representation of dependent and independent variables, with explicit

[17] Where 1 = 1992-2003; 0 = 1970-1991

distinction being made between short-run variations (i.e., the immediate impact effect) and long-run aspects (associated with long-run level or a steady state relationship). Thus, it represents an appropriate technique for estimating supply functions based, as it is, on a distinction between the theory of potential, and utilization of potential output (Alemayehu, 2002). These observations compel this study to use such an estimation technique.

Another important difficulty is that there lies an inherent difficulty in finding an exact empirical equivalent to the definition of the real exchange rate as a measure of competitiveness (see Edwards, 1989 in Musonda, 1998; Were et al., 2002). Consequently, as Dordunoo (1996:6) has argued, for empirical purposes the approach normally adopted is to proxy the indices of prices by either Consumer Price Index (CPI), Gross Domestic Product (GDP) deflator, Wholesale Price Index (WPI) or even unit labour costs or domestic real wages as others have suggested. However, this in itself poses as a hindrance to estimations as it provides no guide in choosing a given deflator. As noted, the real exchange rate by definition is complex both practically and theoretically.

Theoretically, Montiel (1991) has defined the real exchange rate (*RER*) as the relative price of tradable goods (P_t) to prices of non-tradables, (P_n), i.e.

$$RER = \frac{P_t}{P_n} \qquad (11)$$

The traditional approach defines the real exchange rate (RER) as the nominal exchange rate (e) multiplied by the ratio of foreign to domestic price level (P_t / P_n). In this case the general exchange rate is computed as:

$$RER = \frac{eP_t}{P_n} \tag{12}$$

Notwithstanding that in principle, the real exchange rate can be measured in a variety of ways, using different price and cost indices. For Zambia, it is reported that the only available measure is based on relative consumer price developments in Zambia and trading partners. While this measure is inferior to cost-based measures, it is not least because the consumer price index includes imported goods, the price of which is a function of the exchange rate and thus provides an indication of trends in international competitiveness (IMF, 2006). Therefore this study adopts this thought as it defines the real exchange rate as represented in equation (12) above by modifying it according to some studies that define the real exchange rate using commodity-specific prices instead of general world price in gauging primary commodity export supply (Alemayehu, 2002).

Combining the two arguments, the real exchange rate is;

$$RER = \frac{eP_{copper}}{P_n} \tag{13}$$

Where P_{copper} is the London Metal Exchange price of copper in US$.

4.4 The Data

This study uses annual data covering the period 1970 – 2004. The period after 1992 is of particular importance to the Zambian economy since it marks the period under which *fully-fledged* liberalization dawned. The importance of the period due to fully-fledged liberalization also marks the advent of the use of some policy tools[18] to affect exports in general.

The data used in this study were collected from different sources including; various international publications, the International Monetary Fund's IFS CD-ROM, Penn World Tables, Bank of Zambia statistical abstracts, UNCTAD handbook of Statistics, World Bank (World Development Indicators CD-ROM and Africa Development Indicators CD-ROM).

For the description of data and definition of the variables, see Appendix 1.

4.5 Time Series Properties

4.5.1 Unit Root Tests[19]

The essence of unit root testing is to determine the order of integration of a given variable of interest. Where *I (d)* implies that a variable is integrated of order d – d represents a natural

[18] For instance, the exchange rate as a policy tool since it is then when it was regarded as being fully flexible.
[19] Variables of interest: Copper exports (COPPER$), Gross Domestic Investment as a % of GDP (GROSSDIGDP), Real Exchange Rate (RERCOPP), Imports (IMPORTS) and the real exchange rate (RERCOPP) are all in logarithms – see Appendix 1 for a description of variables and data.

number. Therefore, essentially, as already noted, a variable is said to be *I (d)* if it differenced *d* times to make it stationary.

There are many ways of testing for unit roots, but this study concentrates on the Dickey-Fuller (DF) tests and the non-parametric test called the Phillips-Perron (PP) test.

4.5.1.1 Dickey-Fuller (DF) Test

To illustrate the DF test, consider a first order autoregressive process – AR(1) – of the form:

$$y_t = \theta y_{t-1} + \varepsilon_t \qquad ; \text{Where } \varepsilon_t \sim IID(0, \sigma^2) \tag{14.1}$$

Subtracting y_{t-1} from both sides of equation (14.1) we have;

$$\Delta y_t = (\theta - 1) y_{t-1} + \varepsilon_t$$

$$\Delta y_t = \theta^* y_{t-1} + \varepsilon_t \qquad \theta^* = \theta - 1 \tag{14.2}$$

A test of unit root is a test of $\theta = 1$ in equation (14.1) or $\theta^* = 0$ in equation (14.2)

However, Dickey and Fuller (1979) have shown that under the null that $\theta = 1$ or $\theta^* = 0$, the standard t-ratio does not have a t-distribution, not even asymptotically. The reason for this is the non-stationarity of the process (Verbeek, 2000). Therefore, the DF $\tau - statistic$ is the appropriate test statistic computed using Monte Carlo techniques.

A test of a single unit root in higher order AR processes can be obtained by extending the Dickey-Fuller test procedure. This leads to Augmented Dickey-Fuller (ADF) tests. Given an AR(p) process:

$$\begin{aligned} y_t &= \pi_1 y_{t-1} + \pi_2 y_{t-2} + \ldots + \pi_p y_{t-p} + \xi_t \\ \Delta y_t &= \pi_1^* y_{t-1} + \varphi_1 \Delta y_{t-1} + \ldots + \varphi_p \Delta y_{t-p} + \xi_t \end{aligned} \quad ; \xi_t \sim IID(o, \sigma^2) \qquad (14.3)$$

With $\pi_1^* = (\pi_1 + \pi_2 + \ldots + \pi_p) - 1$. The null hypothesis is $\pi_1^* = 0$ with the t-statistic as $t = \pi_1^* / s.e(\pi_1^*)$ compared against the DF $\tau - statistic$.

4.5.1.2 Phillips-Perron (PP) Test

Unlike the ADF test, the PP test makes correction of higher order autocorrelation. The correction is non-parametric since it uses an estimate of the spectrum at frequency zero and is robust to heteroscedasticity and autocorrelation of unknown form (Leybourne and Newbold, 1999).

For details of the PP test see Leybourne and Newbold (1999).

Table 7.0a: Unit Root Tests – ADF test

	Augmented Dickey-Fuller (ADF) Test				
	Level		First Difference		Comment on level of integration
Variable	WoT	WT	WoT	WT	
COPPER$	-2.270986	-2.908009	-3.1120**	-2.772543	I (1)
IMPORTS	-1.948576	-2.631129	-5.1191*	-5.02558*	I (1)
GROSSDIGDP	-1.189768	-1.581221	-3.2632**	-3.028349	I (1)
RERCOPPER	-1.982917	-2.200055	-3.3117**	-3.252***	I (1)

Table 7.0b: Unit Root Tests – PP test

	Phillips-Perron (PP) Test				
	Level		First Difference		Comment on level of integration
Variable	WoT	WT	WoT	WT	
COPPER$	-2.779***	-2.842641	-5.79590*	-5.68831*	I (1)
IMPORTS	-1.90213	-2.78499	-5.1568*	-5.0256*	I (1)
GROSSDIGDP	-1.925039	-2.650168	-8.24224*	-8.06351*	I (1)
RERCOPPER	-2.031784	-2.16976	-3.89751*	-3.8444**	I (1)

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

WoT=Without Trend; WT=With Trend

Note that both the Augmented Dickey-Fuller (ADF) Test and the Phillips-Perrron (PP) Test where employed. The results indicate that all variables of interest become stationary after the first difference[20] hence they are *Integrated of Order One I(1)*.

4.5.2 Cointegration Test

Once given variables of interest have been deemed stationary, it is customary to see if there exists a long-run relationship between them before determining the short run ECM relationship. Thus, cointegration tests are employed. There are two ways of testing the existence of cointegration between variables of interest and formulating an ECM model. The first approach (the Engel-Granger two-stage approach) begins by testing whether the variables of interest are stationary or not. If variables contemplated in the model follow an *I(1)* process, as we have established above, then, in the first stage, estimates of the long-run equilibrium equation (using OLS) is made. An ADF test on the residual of the long-run equation will then be conducted. This is to determine whether the variables in question are cointegrated (whether the error term follows a stationary process). If the error term is stationary (taken as proof of cointegration) in the second stage, we could combine the error term with the first difference of the variables (short-run indicators) to estimate the final model. However, this approach has a number of shortcomings, particularly when there are more than two variables in an equation (to be made clear below). This has led to the popularity of Johansen's approach which is better at handling multivariate systems (see Johansen 1988, 1991; Johansen & Juselius 1990). We follow this approach and the results are given below:

[20] Note: The variable copper exports (COPPER$), by using the PP test, seems to be stationary in levels (at 10%) but when a trend is added it has unit root in levels. This observation reinforces our claim that all variables are *I (1)*.

However, before we present the results, below is an illustration of the technicalities of cointegration.

The notion of cointegration, which was given a formal treatment in Engle and Granger (1987), makes regressions involving *I(1)*[21] variables potentially meaningful[22].

For simplicity, we define two variables, y_t and x_t and if $\{y_t; t=0,1,\ldots\}$ and $\{x_t; t=0,1,\ldots\}$ are two *I(1)* processes, then, in general, $y_t - \beta x_t$ is an *I(1)* process for any number β. Nevertheless, it is possible that for some $\beta \neq 0$, $y_t - \beta x_t$ is an *I(0)* process, which means it has constant mean, constant variance, autocorrelations that depend only on the time distance between any two variables in the series, and is asymptotically uncorrelated. If such a β exists, we say that y and x are *cointegrated*, and we call β the cointegrating parameter. This is the Engle-Granger two step procedure.

The Engle-Granger two-step procedure, however, has some weaknesses, specifically, when the number of variables is greater than two. Assuming that there is one cointegrating vector when in fact there is more than one, would lead to inefficiencies in the sense that we can only obtain the linear combination of these vectors, instead of the unique one (Harris and Sollis, 2003).

The Johansen multivariate coitegration analysis gives a more general method to counter these limitations. It starts from the unrestricted vector AR(VAR) process as;

---

[21] A variable is said to be *integrated of order d, I(d),* if it is differenced *d* times to make it stationary
[22] See Wooldridge (2003) for details

$$X_t = \prod_1 X_{t-1} + \prod_2 X_{t-2} + ... + \prod_k X_{t-k} + \Phi D_t + \varepsilon_t \; ; \; t=1,\ldots,T \qquad (15.1)$$

Where X_t is a vector of all possibly endogenous variables integrated of order one, D_t is the deterministic terms (constant, trend, dummies and other regressors that are considered fixed and non-stochastic). ε_t vector error terms assumed to be independent Gaussian with zero mean and variance Ω, the initial values $X_{t+k},...,X_0$ are fixed and the parameters to be estimated are $(\prod_1, \prod_2, \ldots, \prod_k, \Phi, \Omega)$ (see Johansen and Juselius, 1990).

This unrestricted VAR can be transformed into a vector error correction model (VECM) as:

$$\Delta X_t = \prod X_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Phi D_t + \varepsilon_t \; ; \; t=1,...,T \qquad (15.2)$$

Where, $\prod = \sum_{i=1}^{k-1} \prod_i - I$ and $\Gamma_i = -\sum_{j=i+1}^{k} \prod_j$; I is an identity matrix

Testing for cointegration in the Johansen procedure requires analyzing the rank of the matrix $\prod$ (for details see Johansen and Juselius, 1990)

A modification is made to equation (15.2) and rewriting we have;

$$\Delta X_t = \alpha \beta' X_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Phi D_t + \varepsilon_t \qquad (15.3)$$

The cointegration vectors β have the property that $\beta' X_t$ is stationary even though X_t itself is non-stationary.

Testing the null hypothesis that there are at most r cointegrating vectors amounts to testing whether the last (n-r) eigen values of the matrix $\prod$ are zero. That is,

H_0: $\lambda_i = 0$; $i = r+1,...,n$

The test statistic known as the lambda trace can be calculated as;

$$\lambda_{Trace} = -2\log(Q) = -T\sum_{i=r+1}^{n}\log(1-\lambda_i);$$

$r = 0,1,\ldots,n$-1 and

Q = (restricted maximum likelihood)/(unrestricted maximum likelihood)

Error Correction Models

If y_t and x_t are cointegrated with parameter β, then we have additional *I(0)* variables that can be estimated.

Given that;

$ecm_t = y_t - \beta x_t$, so that ecm_t is *I(0)*. We can include a lag of ecm_t is the following equation;

$$\Delta y_t = \alpha_0 + \alpha_1 \Delta y_{t-1} + \delta_0 \Delta x_t + \delta_1 \Delta x_{t-1} + \phi ecm_{t-1} + u_t$$
$$\Delta y_t = \alpha_0 + \alpha_1 \Delta y_{t-1} + \delta_0 \Delta x_t + \delta_1 \Delta x_{t-1} + \phi(y_{t-1} - \beta x_{t-1}) + u_t$$

The term $\phi(y_{t-1} - \beta x_{t-1})$ is called the error correction term. The error correction model allows us to study the short-run dynamics in the relationship between y and x.

To ease illustration,

given;

$\Delta y_t = \alpha_0 + +\delta_0 \Delta x_t + \phi(y_{t-1} - \beta x_{t-1}) + u_t$ and $\phi < 0$

- If $y_{t-1} > \beta x_{t-1}$, then y in the previous period has overshot the equilibrium; because $\phi < 0$, the error correction term works to push y back towards the equilibrium
- Similarly, if $y_{t-1} < \beta x_{t-1}$, the error correction term induces a positive change in y back towards the equilibrium

Below is the empirical test we carried out to ascertain cointegration in the variables of interest:

Table 8.0: Johansen Cointegration Test: 1970 to 2004

Hypothesized No. of CE(s)	Trace Statistic (λ_{trace})	5% Critical Value
None *	92.50583	88.80380
At most 1	57.33068	63.87610
At most 2	25.54462	42.91525
At most 3	13.71394	25.87211

Series: COPPER$ GROSSDIGDP IMPORTS RERCOPP LBD
*Denotes rejection of the null hypothesis of no cointegration at the 5% significance level
Trace test indicates 1 cointegrating equation at the 0.05 level
Test assumes linear deterministic trend

The above test results indicate that there is at most 1 cointegrating vector at 5% significance level as shown by the trace statistic (λ_{trace}). Hence we reject the null of no cointegration in the variables at the 5% level of significance. The results suggest the presence of cointegration, implying that there is a long-run relationship between the series.

For further verification, we also carried out an Engle-Granger two-step procedure and the results reported in Appendix 2 also confirm cointegration.

4.6 Estimation and Discussion of Results

4.6.1 Long-run Estimates/Results

The results for both the unit root and cointegration tests allow us to proceed with our long-run estimation.

Note that, during estimations, two different models where fitted for the dependent variable Copper Exports (COPPER$):

- *Model 1* independent variables – Real Exchange rate (*LRERCOPP*), Gross domestic investment as a share of GDP (*LGROSSDIGDP*), Imports (*LIMPORTS*) and the Liberalization Dummy (*LBD*).
- *Model 2* is *Model 1* plus lags of the explanatory variables of *Model 1*.

The results of these two different models are reported below:

Table 9.0: Long-run elasticities

Variables	Model 1	t-value	Model 2	t-value
LGROSSDIGDP	-0.120545	-0.71059	-0.0987	-0.5503
LGROSSDIGDP_1			-0.4081	-1.9092*
LIMPORTS	0.640463	3.28807*	0.7981	3.0144*
LIMPORTS_1			-0.3201	-1.2034
LRERCOPP	0.250142	2.056268**	-0.0926	-0.3703
LRERCOPP_1			0.3005	1.2152
LBD	-0.481800	-2.927599*	-0.1699	-0.7930
C	0.682045	0.361861	3.1771	1.3830
Adj. R-squared	*0.4374*		*0.4858*	
F-statistic	*7.60928(0.000)*		*5.4539(0.001)*	
Durbin-Watson Stat	*1.59*		*1.78*	
No. of Obsevations	*35*		*34*	
Ramsey RESET	*0.58(0.4524)*		*1.15(0.2935)*	
Jargue-Bera Normality test	*0.58(0.74)*		*0.91(0.63)*	

Notes: *(**) significant at 1% (5%) significance level. "L' before the variable of interest refers to logarithm.

* Significant at more than 5%

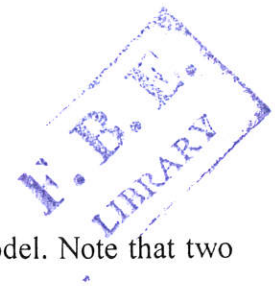
The analysis that follows below (particularly the one that incorporates lags) refers to the results of the parsimonious regression equation arrived at after obtaining the optimal lag length[23]. Also, a further check of model adequacy indicates that the diagnostic tests employed render credence to the model(s). For instance, the equation(s) is(are) well specified as given by the RESET test and the model(s) also pass the normality test. With this summary, we can now proceed to comment on the relevance of the estimates.

Model 1 is basically the long-run cointegrating equation for copper exports. The coefficients of the real exchange rate and imports are significant and positive. The finding on the coefficient of the real exchange rate is consistent with some studies which also find positive price effects (see for instance Vial, 2004). However, the coefficient of gross domestic investment as a ratio of GDP is negative and insignificant. The negative sign should be interpreted with care perhaps because we are dealing with gross domestic investment as opposed to specific investment in the copper industry[24]. Seen in a different way, the negative sign may actually conform to economic theory when a large component of gross domestic investment is public investment which actually crowds-out private investment and hence consequently adversely affecting copper export supply. The results, therefore, indicate that depreciation of the real exchange rate – as defined by equation (13) – and an increase in imports have a positive effect on copper exports with elasticities of 0.25 and 0.64, respectively. The coefficient of the Liberalization dummy – *LBD* – is negative and significant. The implication is that liberalization of the trade regime may have adversely affected exports of copper. This result as regards the liberalization dummy can best be appreciated if it is understood what liberalization was initially intended to. As noted earlier it has

[23] As given by the Akaike Information Criterion (AIC) for instance.
[24] Use of investment in the copper sector perhaps would have yielded different results but such data could not be obtained.

been argued that the reform of the exchange rate system and other policy measures beginning in 1992 was meant to boost, among others, the performance of the non-traditional exports due to the incentive structure associated with such reform efforts (Musonda, 1998).

Secondly, Model 2 was estimated to capture the lagged effects of the explanatory variables. Still, the coefficient of imports is positive and significant with an elasticity of about 0.79. However, the coefficient of its lag one period is negative and insignificant. The coefficient of gross domestic investment as a ratio of GDP is insignificant and still negative. The coefficient of its lag is negative and significant at more than 5%. Perhaps this attests our argument that if a significant proportion of public investment is captured by gross domestic investment, it may have crowded out private investment with a resultant negative impact on copper export supply. However, the coefficient of the real exchange rate is now insignificant and negative while the coefficient of its lag one period is positive even though insignificant..



4.6.2 Short-run Estimates/Results

The short-run estimates allow us to perform and form an error correction model. Note that two models (Model 4 and Model 5) where fitted for the dependent variable (the difference of copper exports):

- *Model 3* – Firstly, Model 1 as above is estimated and the error correction term (ECT) obtained. Secondly, to obtain the short run estimates of the ECM, the dependent variable being the difference of copper exports (*DCOPPERS*) was regressed on the difference of

the real exchange rate (*DRERCOPP*), difference of imports (*DIMPORTS*), difference of gross domestic investment as a ratio of GDP (*DGROSSDIGDP*), the error correction term lagged one period (ECT_1) and the liberalization dummy (*LBD*).

- *Model 4* is Model 3 plus lagged independent variables.

The results of these different models are reported below:

Table 10.0: ECM Models and/or Short-run elasticities

Variables	Model 3	t-value	Model 4	t-value
DLGROSSDIGDP	0.012225	0.0815	0.0239	0.1409
DLGROSSDIGDP_1			0.0825	0.3928
DLIMPORTS	0.732681	2.9727*	0.8068	2.9937*
DLIMPORTS_1			-0.2150	-0.7851
DLRERCOPP	0.189476	0.8722	0.1843	0.7112
DLRERCOPP_1			-0.2626	-0.9486
ECT_1	-0.793748	-3.9479*	-0.8378	-3.5810*
LBD	-0.015064	-0.1746	-0.0432	-0.4658
C	-0.014394	-0.2709	-0.0010	-0.0176
Adj. R-squared	*0.3702*		*0.293192*	
F-statistic	*4.879(0.002)*		*2.659243(0.03)*	
Durbin-Watson Stat	*1.86*		*1.8077*	
No. of Obsevations	*34*		*33*	
Ramsey RESET	*0.0019(0.965)*		*0.2033(0.65)*	
Jargue-Bera Normality test	*0.98(0.45)*		*0.97(0.61)*	

Notes: 'D' at the start of the acronym of the variable of interest indicates the first difference of the given variable. *Significant at 1%; **Significant at 5%

A summary of the diagnostic test even in this case renders credence to the models estimated. The RESET tests show that the model(s) is(are) correctly specified, the model(s) also pass(es) the normality test and the Durbin-Watson statistic shows that the problems of autocorrelation are unimportant.

The short-run ECM results as regards Model 3 show that the coefficient of Gross Domestic Investment as a share of GDP is now positive and but insignificant. The coefficient of imports is positive and significant. The coefficient of the real exchange rate is positive but insignificant. The liberalization dummy is negative and insignificant. The coefficient of the error correction term which is negative and significant indicates that about 79% of the deviation from the long-run equation is made up of in one time period.

Model 4 attempts to capture lagged effects in the short-run ECM. The coefficient of gross domestic investment as a share of GDP is now positive and insignificant. The coefficient of its lag is also positive and insignificant. The coefficient of the real exchange rate is positive but insignificant. However, even though the coefficient of its lag is insignificant it is now negative. The coefficient of the liberalization dummy is still negative and insignificant. The lag of the error correction term is negative and significant and indicates that about 84% of the deviation from the long-run equation is made up of in one time period.

All in all, results from the models of the long-run static estimations show that non-price factors may be more important determinants in explaining export supply. The results obtained from the long-run estimations may indicate the slow response of copper exports to prices while at the

same time advance the argument that while macroeconomic stability is a key ingredient to promoting exports supply of copper by providing channels of investment incentives for instance, care should be taken by the government and its agencies so that the problem of crowding-out private investment is done away with. The short-run ECM estimations also confirm these findings and the results so obtained also suggest that non-price factors may be more important determinants of copper export supply (this is supported by the result that the real exchange rate being the proxy for price was insignificant in all ECM estimations). Further, the consistent significant positive relationship of imports and copper export supply reinforces this claim and further strengthens our assertion that import compression resulting from prolonged shortage of foreign exchange is a major constraint to copper export growth. The non-significance of gross domestic investment as a share of GDP in all short-run models may be attributed to it being a conceivably poor proxy for supply constraints.

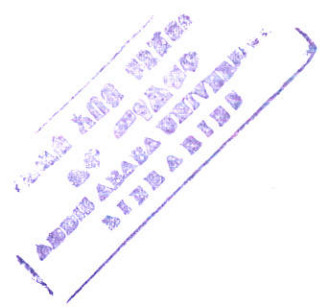
CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This study has provided evidence of the dependence of Zambia's export earnings on a single primary product – copper. The descriptive analysis of this study explored the structure and composition of Zambia's exports and it was revealed that while non-traditional exports as a share of total exports have been growing over time, their contribution to total export value is dwarfed by the strong dependence on Zambia's economy on copper exports alone.

Immediately after independence, Zambia enjoyed monetary benefits that accrued to government coffers because of its endowment of mineral wealth, particularly, from copper (exports). However, when copper prices on the world market fell around 1975, the country suffered a tremendous economic shock. The foreign exchange reserves dwindled and the government found it difficult to finance its investment and consumption needs. This situation forced the government to turn to external financing of its economic activities by means of borrowing. This scenario thereby exposed the country to huge amounts of international debt which it could not service, particularly due to low foreign exchange earnings on the back of falling world copper prices.



The low copper prices also served as a disincentive to invest in the mining sector and mining production was consequently adversely affected. The low mine production coupled with falling copper prices further perpetuated the economic malaise the country then experienced.

The government made several attempts to try and revive the economy but none proved successful in the long-term. Consequently, the government was compelled to follow the Structural Adjustment Programmes (SAPs) of the IMF and World Bank in an attempt to resuscitate the country from its economic ailment. The election of the new government in 1991 bore successful fruits in this regard because it is after that period that the country fully liberalized its economy.

Emphasis was placed to try and diversify export dependence away from copper alone and this called for introduction of non-traditional exports. Thus, the share of non-traditional exports has been growing over time. However, of major importance to this study is that the mining sector has not been spared by the winds of liberalization and several mining units have been privatized. With new investments in the mining sector and recent historical high copper prices, export earnings have increased exponentially. This in turn has shrunk the proportion of the contribution of non-traditional exports to total exports.

With that in place, the study has attempted to determine the factors that explain the supply of primary commodity exports both from a theoretical and empirical perspective. Both theory and empirics suggest that price and non-price factors are important determinants of primary commodity export supply.

This study has shown evidence of this result (i.e. importance of price as well as non-price factors in influencing the supply of primary commodity exports). Firstly, from the long-run estimations, it has been determined that imports play a critical positive role in affecting the supply of copper exports. Secondly, generally, the real exchange rate as a measure of relative prices was found to be a significant determinant of copper export supply. However, the literature for developing countries has produced some inconsistencies on the effect of the real exchange rate on export supply. For instance, some studies find insignificant and wrongly signed (negative) price elasticities (Branchi et al., 1999). On the other hand, our findings in this light are consistent with some studies that have found positive price elasticities (Were et al., 2002; Lyakurwa, 1998). Surprisingly, gross domestic investment as a share of GDP has a negative sign but we are comforted by economic theory of crowding-out private investment as aforementioned. Another explanation can be attributed to the fact that it may not be a good productivity indicator/measure. In the same vein, the coefficient of the liberalization dummy is significant (in Model 1) and therefore liberalization may have adversely affected copper exports (according to our findings).

Conversely, in the short-run, as given by the ECM representation, non-price factors are seen to have a significant influence of copper exports – particularly, imports. This result indicates that the effect of the real exchange rate is insignificant in affecting copper exports in the short-run. Also, the coefficient of the liberalization dummy is insignificant. As noted, the essence of liberalization was to diversify export dependence away from copper exports and thereby boost on non-traditional exports.

5.2 Recommendations

The recommendations of the study are in form of some policy prescriptions and/or implications derived from the findings.

While it can be appreciated that this study has provided some insights into the *'possible'* determinants of copper exports, it should be noted that caution should be taken in their interpretation thereof. Thus recommendations are based on the guide on possible focus areas vis-à-vis policy assertion. The argument that exchange rate policy is an important tool in positively affecting export supply must be viewed from a general macroeconomic context and therefore, devaluation per se may not be the relevant policy measure in enhancing copper exports because this depends on the extent to which this devaluation translates into real changes.

Clearly, the poor performance of the copper sector in Zambia cannot be entirely ascribed to negative price effects. Therefore, even more important in influencing copper exports are non-price factors that may particularly relate to the condition of the macroeconomic policies being pursued. It is not surprising to presuppose that a stable macro environment is key in positively affecting copper exports because it provides investment channels and/or incentives.

This paper acknowledges other non-price factors (costs and acquisition of inputs etc) play a pivotal role in production and export supply response. Sectoral analysis would be key in identifying such factors but this is however beyond the scope of this study. For a detailed analysis of other factors, sectoral analysis would have been more helpful in appreciating

transmission mechanisms between government macro level policies and an individual mining units behavior and reaction to such policies.

All in all, while appreciating that export-led growth is inevitable in achieving higher levels of development, it should also be noted that the major challenge for the Zambian economy is the ability of the economy to sustain its economic activities when copper prices are low. The main long-term goal of Zambian exports should lie in substantial diversification away from copper exports. Maintaining a stable macro environment is also key in attracting investment in strategic sectors of the economy that will help propel growth in the right direction.

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Appendix 1 **Definition of Data and Variables**

COPPER$: Copper exports value in millions of US$.

GROSSDIGDP: Gross Domestic Investment as a % of GDP as given by the International Monetary Fund (IMF).

RERCOPP: Real Exchange Rate of copper defined as the nominal exchange multiplied by the relative price of copper (as quoted at the London Metal Exchange) and Consumer price index.

$$RERCOPP = e\left(P_{copper} / P_d\right)$$

Where;

e = Nominal exchange rate defined as units of Kwacha per US$

P_{copper} = Price of copper (2000=100)

P_d = Consumer Price Index (2000=100)

IMPORTS: value imports (c.i.f) in millions of US$

In some cases, the letter 'L' will appear before the variable of interest and this shows that the variable has been log-transformed.

Appendix 2: Unit Root test for the residual to determine stationarity thereof.

ADF TEST

Null Hypothesis: ECT has a unit root
Exogenous: Constant

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.672381	0.0007
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

*MacKinnon (1996) one-sided p-values.

PP TEST

Null Hypothesis: ECT has a unit root
Exogenous: Constant

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.672381	0.0007
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

Where;

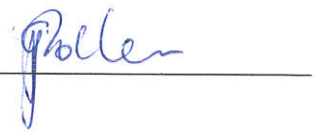
ECT = Residual

The t-statistics for both the ADF and PP tests show that we reject the null hypothesis of unit root and therefore conclude that ECT is stationary at 1% level of significance.

DECLARATION

I, the undersigned, declare that this thesis is my original work, has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly acknowledged.

Name : Gabriel Pollen

Signature : 

Date : 27th June, 2008

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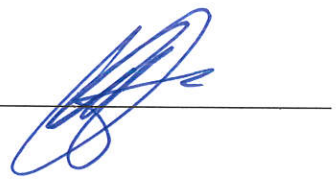
Signature : 

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