Doctoral Thesis

The Impact of Mining Sector on Economic development in Botswana

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ABSTRACT

Mining have the potential to be an important source of income and driving force behind broader economic development. Mineral production generates income and foreign exchange (if exported), can stimulate local economies through the local purchase of inputs, and can be the basis for downstream processing and manufacturing industries. Governments receive tax revenues from mineral production, which are available to fund education, health care, roads, electric-power supplies, and other forms of infrastructure. Yet, for many years resource endowed economies had been grappled with the notion that the possession of natural resources could be a curse. The latest commodity price super-cycle has inspired many including governments of resource endowed economies to think constructively about how to use their mineral wealth to benefit their citizens. The objective of this study is to examine the impact of mining sector on economic development of Botswana for the purpose of contributing to the discussion on developing a diversified economy.

Botswana's mineral-led growth is under threat as the government expects mineral revenues to start decreasing in the next decade when opencast mining will be replaced by underground mining due to depletion. Moreover, the base metal industry is struggling due to low commodity prices and high production costs. Apart from the expected decline in mineral revenues, the country's fiscal position has been adversely affected by the global economic crisis, a development that has led to a reduction in foreign exchange reserves, an increase in public debt and a cumulative budget deficit from 2009 to 2012. Therefore, there is a need to address fiscal policy and sectoral policies in recognition of mineral revenue decline.

The first aim of this study was to empirically investigate the dynamic relationships between mineral revenues, government expenditure and economic growth in Botswana. Mineral revenues are the main source of financing government expenditures and imports of goods and services. Increasing mineral revenues over the years have boosted public expenditures on social and economic infrastructure. In this study, we examine whether the government spending has enhanced the pace of economic growth or not. In meeting the first objective, vector autoregression and granger causality methodologies were used and data for 1994 – 2012. Overall results suggest that mineral revenues remain the principal source for growth and the main channel which finance the government spending. Furthermore, the results reveal lack of causality and little interaction between government expenditure and economic growth.

The second aim of this study was focused on examining the linkages between the mining and non-mining sectors. The results would show the level of economic dependency running from the mining sector to the non-mining (manufacturing and services) sectors and the extent to which different sectors benefitted from the mining export boom and vice-versa. Using vector autoregression and granger causality, the relationships between sectors were disentangled. The overall results showed that the mining sector has had a positive impact on other sectors in the economy. The empirical test results suggested that mining sector has been positively associated with growth in the manufacturing and service sectors. Services sector seems to have benefitted more from the mining sector than the manufacturing sector during 1976-2014. The direction of causality runs from mining to manufacturing and services, which implies that mining induces growth in both sectors and there is no causation from non-mining sectors to mining. The results indicate lack of backward linkages among the sectors, which is necessary for diversification to take place. Therefore the mining sector still is an enclave activity in the economy of Botswana.

The third aim of this study was to examine the determinants of copper prices. There is quite broad consensus that market fundamentals (physical and demand) explain commodity price fluctuations, particularly in the medium and long term. Yet, following the recent price boom, some dissent has arisen about the role played by the financialization of commodities and particularly, financial speculation. This study develops an empirical model for the copper market, consisting in an ordinary least squares with variables including both market fundamentals and financial speculations. Since the variables impact probably changes over time, the 23 years studied are divided into four periods (1993-1997, 1997-2005, 2005-2008, and 2008-2016) separated by three structural breaks related to the Asian Financial Crisis, Chinese boom and financialization of commodity markets and financial crisis. The results indicate that financial speculation impact was significant only in 2005-2008, explaining the price increase in this period. Overall, the results indicate that not only fundamentals can explain copper price changes. The results support the conclusion that, for the purposes of modeling and most importantly forecasting, current models based only on the fundamentals cannot fully explain price dynamics which are shown to be, in general more complex than has been assumed.

As the conclusion, our study indicates that beneficiation of minerals (diamonds) is necessary to ensure robust fiscal position of Botswana and also to sustain economic growth and development. Furthermore, rents from diamonds can be used to establish base metal beneficiation that could help diversify the economy beyond diamond dependency.

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Chapter 1 Introduction

1.1 Natural resource sector

Natural resource sectors have been key drivers of the unprecedented economic development of the 20th century, with the consumption of fossil fuel and forestry products powering the industrial revolution, the enlightenment, and global human progress that followed. Natural resources are assets (i.e., raw materials) occurring in nature that can be used for economic production or consumption; natural resource sectors are industries extracting and processing them. Today natural resource sectors remain important in the global economic landscape. The total value of natural resource sector exports from developing countries in 2010 was 9.8 and 9 times larger than foreign aid and remittances respectively (Jedwab, 2013; World Bank, 2014).

In this thesis we focus on one critical natural resource sector- mining, broadly defined to include coal and mineral mining and oil and gas extraction. Although the oil and gas industries have several different characteristics to coal and minerals, these sectors have many similarities and major resource sector companies tend to diversify across commodities for scale and scope efficiencies. Mining sectors can have several unique characteristics requiring special attention from policy-makers. Mineral resource endowments tend to be the property of the nation state, and resource rents are often legally intended to be distributed among countries current and future generations.

Mining sector is characterized by giant infrastructure investments, and long project life cycles requiring local and macro-level economic and political stability. Compared to other sectors, there is a greater role for policy-makers in weighing up the relative costs and benefits of large mining projects requiring government approval (e.g. through concessions, licensing, permits, special regulations) and often, for more political than economic reasons obtaining direct government support (e.g., through state-owned enterprises, favorable financing arrangements, tax exemptions, and direct subsidies).Understanding the role played by mining sector to fiscal policy and growth of other sectors in the economy and also understanding mineral markets is important for informing development strategies and policy settings.

1.2 Are natural resources a curse or blessing?

The positive relationship between mining and economic development rests on the concept of production function, which reflects the technical relationships that govern how much output a country can produce from a given amount of labor, capital, material, energy and other inputs. Therefore, where the extraction costs for a mineral commodity are less than its market price, mining generates economic rents. For this reason, most economists and policy makers presume that mining creates wealth and in the process contributes to economic development in rich and poor countries alike.

Yet, the past couple of decades, have witnessed a far less appealing view of mining's contribution to economic development of developing countries. Studies by Auty (1990, 1993, 1994a) and others found little or no economic growth in many mineral- intensive countries over extended periods. Growth was even negative for a number of countries. This research appeared to demonstrate that a favorable natural resource endowment may be less beneficial to at low- and mid-income levels of development.

As a result of these country case studies, more comprehensive empirical analyses attempted to identify and measure the effect of mining on economic development using cross-section samples of developing countries. Many of these analyses, including the influential works of Sachs and Warner (1995a, 1997b, 2000, and 2001), found that a greater dependence on mining was associated with slower economic growth after controlling for the usual determinants of growth. The accumulating empirical evidence suggesting that mining is negatively associated with economic development raises the possibility of a causal relationship and has stimulated the search for reasons as to why this might be the case. The possible explanations, it turns out, are many.

Foremost of these explanations is the Dutch disease theory. According to Corden (1984) natural resource boom squeeze profitability in other traded good sectors both directly (through resource reallocation) and indirectly (real exchange rate appreciation due to spending), commonly referred to as the resource movement effect and spending effect respectively. This results in the coexistence of the progressing and declining tradable good sectors. This phenomenon is emphasized as a cause for failure of resource-abundant economies to promote a competitive manufacturing sector, thus lowering economic growth in the long-run.

On same line, (Gylfason et al. 1999) empirically show that the recurrent boom and bust cycles are accountable for increase in exchange rate volatility, thus hurting investment in non-boom tradable sector. Dutch disease can result in the skewness of the export composition away from manufacturing and services exports that may contribute to economic growth (Gylfason, 1999). Moreover, according to Frankel and Roemer (1999) technological breakthroughs and innovation take place in manufacturing therefore Dutch disease may slow down economic growth by hindering manufacturing and services, which are probably good for growth.

Another explanation is that rents from mining may be misused and wasted. They may also promote rent seeking at the expense of rent creation (the efforts that increase the total profits or wealth available for distribution) therefore, may lead to a decline in institutional quality (Ross, 2001b; Sala-i-Martin and Subramanian, 2003). Even worse, rents may promote corruption, civil strife, and wars (Collier and Hoeffler, 1998; Gylfason, 2001; Sachs and Warner, 1997a).

Another strand of literature show that education as a form of investment especially suffers in resource-rich countries (Gylfason, 2001). When states start relying on natural resource wealth, they seem to forget the need for a diversified and skilled workforce that can support other economic sectors once resource wealth has dried up. Gylfason (2001) provide evidence that across countries public expenditures on education relative to national income, expected years of schooling and secondary-school enrolment are all inversely related to natural capital. While the costs of such declines might not be felt in the short term, as capital-intense activities take up a larger share of national production, their effects are likely to become more significant in the longer run as soon as economies start trying to diversify. This is explained more in terms of the sources of wealth. When a country's wealth depends in manufacturing sector, human capital investment is an essential part of wealth creation is an essential part of wealth creation. On the other hand, when a country's wealth arises from an endowment of natural resources, however, investment in a skilled workforce is not necessary for the realization of current income. Without a focus on wealth creation, or sustainability, insufficient attention will be paid to investments in human capital.

Another explanation is based on the instability of primary commodity markets. Price variations of 30% or more within a year or two are not uncommon (Davis and Tilton, 2005). In the case of mineral commodities, this volatility arises because demand fluctuates greatly over the business cycle. When the economy is booming, the end-use sectors that consume most mineral commodities- construction, capital equipment, transportation, and consumer durables are expanding even faster than the economy as a whole. Conversely, when the economy is in a recession, these sectors are usually even more depressed. Since metal market instability arises primarily because of shifts in demand, when output is depressed, so are prices. Similarly, when output is up, so are prices. This means that profits, and the taxes governments collect on profits, are particularly volatile. Therefore, the volatility of primary commodity markets causes considerable fluctuations in government revenues and foreign exchange earnings for mineral dependent developing countries.

These fluctuations make planning more difficult, and may as a result hinder economic development programs (Auty, 1998; Mikesell, 1997). Mikesell (1997) found that from 1972 to 1992, regions with high primary export shares experienced terms of trade volatility two to three times greater than industrial countries in the same period. Blattman et al. (2007) investigate the impact of terms of trade volatility, arising from excessive commodity price fluctuations, on growth performance of a panel of 35 commodity dependent countries between 1870 and 1939. They provide evidence of the adverse effects of volatility on foreign investment and through that on economic growth in what they call 'periphery' nations. Bleaney and Greenaway (2001) estimate a panel data model for a sample of 14 sub-Saharan African countries over 1980-1995 and show that growth is negatively affected by terms of trade volatility, and investment by real exchange rate instability. Fluctuating revenue profiles make it very difficult to pursue a prudent fiscal policy. The permanent income hypothesis would argue that windfall gains would be more likely to be saved and invested than consumed. Yet, Sachs and Warner (1997) found no strong evidence to suggest that resource-rich countries have higher savings rates.

It is also argued that mining is often an enclave activity. Needed supplies are imported, and little value added is carried out domestically, as ores and concentrates are exported for processing abroad. Additionally, mining requires few workers, and many of those it does employ (particularly the more skilled workers) come from abroad. As a result, the host country gets little from mining other than the share of the economic profits or rents they capture through taxation. Hirschman (1958), Seers, (1964) and Baldwin (1966) are of view that producers and exporters of primary commodity have limited linkages from primary-products as compared to manufacturing.

The first decade of the twenty-first century saw the biggest and most sustained commodity boom that transformed the mining industry. Emerging economy countries, which for years had grappled with the notion that the possession of natural resources could be a curse, began to think more constructively about how to use their mineral wealth to benefit their citizens. Governments of mineral-rich countries, began to look on the sector with fresh eyes as revenues resulting from higher commodity prices piled up. Moreover, the research focus changed to challenge the received wisdom that commodities production is an inherently enclave activity and that it undermines the viability of industry. Letsema (2011), Teka (2012), Oyejide and Adewuyi, (2012), and Adewuji et al., (2016) analyzed the determinants of backward and forward linkages, identifying policy responses which will broaden and deepen them. The research focuses on a diverse range of commodity sectors in a number of African economies, as well as on key infrastructural determinants of effective linkage development. A number of common factors are identified which increase linkages and which will lend themselves to policy intervention – the role of ownership, the nature and quality of infrastructure, spillover of skills to and from the commodities sector among others.

A focus on Botswana

Botswana is a typical of the countries that are endowed with abundant natural resources. The country’s economic growth and political stability are regularly celebrated in the academic literature. Books have been written explaining why the country prospered (Leith, 2005); it has been described as an African Miracle (Samatar, 1999); and a World Bank study argued that Botswana illustrates how a natural resource curse is not necessarily the fate of all resource abundant countries. Sarraf and Jiwanji (2001) carried a qualitative study on Botswana which focused, on management of the country’s diamond mineral boom. The research analyzed the management of Botswana government’s budget and accumulation of international reserves, placing special investigation on the government’s control over expenditures, investment decisions, domestic investments, international investment and management of the exchange rate and economic diversification. The study’s conclusion was that Botswana presented an illustrative case where natural resource curse was not necessarily the fate of all resource abundant countries, but rather prudent economic management helped the country to avoid the disastrous effects of the resource curse.

Auty (2001) qualitatively compares Botswana and Saudi Arabia's political state and the management of mineral rents in capital surplus economies. The author argues that Botswana was more successful than Saudi Arabia in sustaining the growth of its non-mining sector during its long mineral boom and its foreign reserves were higher relative to GDP. Yet, the Botswana rent stream has been inherently easier to manage than that of Saudi Arabia because it was less volatile and on a smaller scale relative to GDP. The study concluded that it was still too early to judge whether differences in the political state or in the rent stream explain Botswana's greater success in sustaining economic development.

Mogotsi (2002) quantitatively study the effects of diamond boom on non-mining sectors, a phenomena termed Dutch disease. The study argues that Botswana has suffered from a mild form of the Dutch disease. Two reasons for the mild form of the disease are that Botswana had high unemployment at the start of its mineral boom and it did not have a large pre-existing manufacturing sector. In Mogotsi's view skilled labor migrated to the mining sector and being replaced by less skilled, previously unemployed agricultural workers. There was no reduction in overall manufacturing employment but the lower skilled manpower is less productive, and causes a decline in the output of the sector. Additionally, Mogotsi argues that the core of the diamond boom from 1982 to 1987 saw both major spending increases and a significant appreciation of the real exchange rate. The real exchange rate depreciated after the initial boom but government recurrent spending did not. According to Mogotsi, should these revenues ever decline, the situation may be similar to that of other countries which enjoyed booms in the past, resulting in busts later, due to Dutch disease phenomena.

Iimi (2006) using cross-country data empirically readdressed the question of whether resource abundance can contribute to growth. As to the role of governance in transforming resource abundance into economic development, data from 89 countries reveal that an abundance of natural resources does not guarantee growth. What determines the degree to which natural resources can contribute to economic development is governance. Good governance - specifically a strong public voice with accountability, high government effectiveness, good regulation, and powerful anticorruption policies tends to link natural resources with high economic growth. Botswana has benefited from the coexistence of good governance and abundant diamonds to materialize growth.

Makochekanwa (2006), empirically examined the Dutch disease hypothesis on Botswana's main export products from manufacturing, mining and agriculture sectors. The study utilized the gravity trade model to test the hypothesis. The estimated results indicated that, diamond exports, instead of hurting the country's exports, rather boosted exports from manufacturing (textiles, vehicles and hides), mining (copper and soda ash) and agricultural sectors (meat and meat products).

Mbayi (2013) investigates Botswana's vision to become a downstream player in the global diamond industry by creating downstream capacities that can continue to benefit the country when diamond mining is no longer profitable. The research examines how efficiently human capital formation in Botswana's diamond cutting and polishing industry is taking place in order to create downstream capabilities that can foster the industry's competitiveness. The study examines the role of the education and vocational training system, industry training institutes and the firms themselves in creating the human capital required in the diamond cutting and polishing industry. The research argues that institutional industry training needs to be strengthened, particularly in light of technological changes that may result in more industry-specific human capital requirements in the Botswana's diamond cutting and polishing industry.

Our research follow a different line of inquiry. Motivated by the projected decline in mineral revenues due to diamond depletion and by the challenges facing base metal industry such as low prices and high production costs our study aims to examine the impact of mining sector on economic development of Botswana for the purpose of contributing to discussions on developing diversified sources of economic growth. Specifically, we focus on government expenditure, mineral revenue and economic growth relationship; mining and non-mining sectors relationship; and copper market analysis. This evidence could assist countries like Botswana to better align development strategies across different economic objectives thus broadening the economy further from mining dependence.

1.3 Overview of Botswana Economy

Botswana is a sparsely populated, arid, landlocked country in Southern Africa. The country has achieved independence from Britain in 1966 after becoming a British Protectorate in 1885. At independence the country was one of the poorest countries in the world, with per capita income of just $70 a year. In the first few years of independence, about 60 percent of current government expenditure consisted of international development assistance. There were only 12 kilometers of paved roads, and agriculture (mostly cattle farming for beef production) accounted for 40 percent of gross domestic product (GDP). By 2007 Botswana had 7,000 kilometers of paved roads, and per capita income had risen to about $6,100 ($12,000 at purchasing power parity), making Botswana an upper-middle –income country comparable to Chile or Argentina (Leith, 2005). The discovery of diamonds around independence and to a less extent other minerals and the prudent management of mineral revenues that followed enabled the development of the country.

Its success is also evident in other measures of human development. At independence, life expectancy at birth was 37 years. By 1990 it was 60 years. Under-five mortality had fallen to about 45 per 1,000 live births in 1990, and to 43.3 deaths per 1,000 live births in 2015 and this is remarkable compared to Africa as a whole (World Bank, 2001; 2015). Development assistance has shrunk to less than 3 percent of the government budget, and agriculture currently account for only about 2.5 percent of GDP. Major strides have also been made in infrastructure and education. Annual growth in per capita income averaged 7.0 percent between 1966 and 1999 (Sarraf and Jiwanji 2001). However, not all indicators are positive, income distribution in Botswana remains very unequal (the Gini coefficient was 0.55 in 1994 and 0.60 in 2015). Unemployment remains high, reflecting to a large extent rural to urban migration (Lewin, 2011).

As noted in the previous chapter, it is commonly accepted in economics and mineral economics that resource-abundant economies tend to grow less rapidly than resource-scarce economies. Botswana represents an exception to the resource curse rule by managing to transform mineral wealth into economic growth. For example Iimi (2006) argues the importance of good governance in facilitating economic development and Siphambe (2007) argues that policy coherence played a key role in channeling mineral revenues into economic growth. Botswana impressive natural resource management and growth record has seen the country dubbed as ‘Africa’s success story’ (Acemoglu et al. 2002).

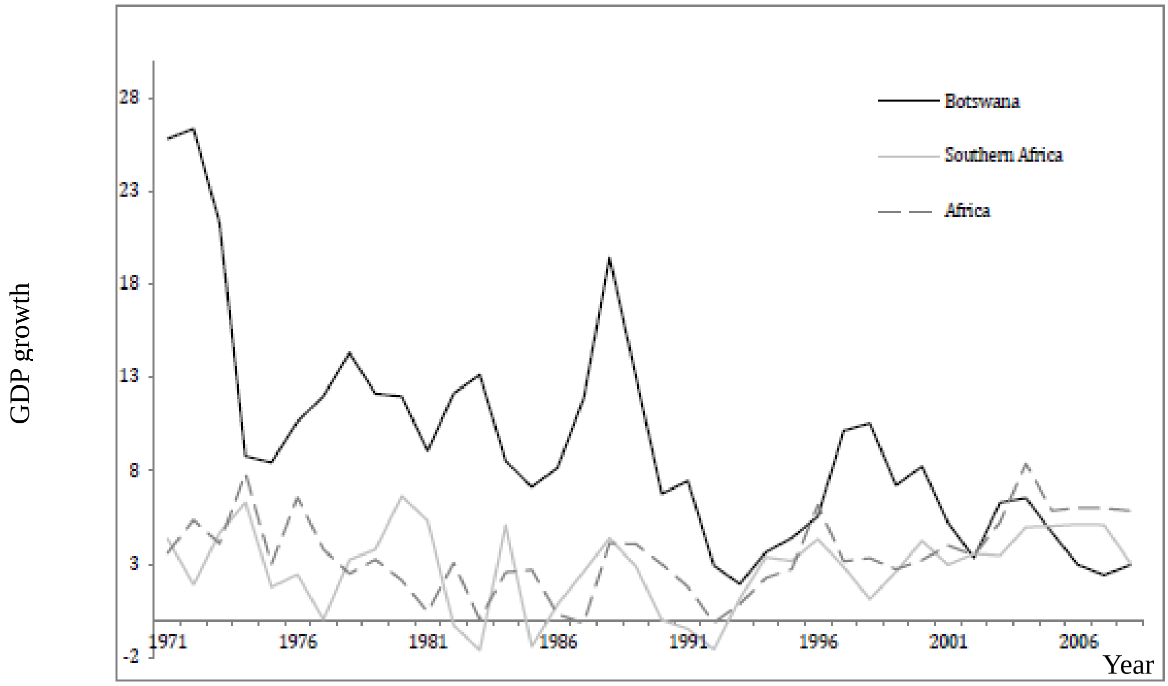

Figure 1.1 shows how Botswana gross domestic product (GDP) grew from 1971-2008 compared with the African and Southern Africa in the same period
Source: Mbayi (2013)

Botswana enjoyed positive GDP growth for the entire period and performed much better than Africa and Southern Africa. Botswana GDP growth was most impressive in the 1970s and 1980s but started slowing down in the early 1990s. In the early 2000s, for the first time in the period, Botswana started growing slower than Africa mainly as a result of the maturity of the diamond industry together with improved average GDP in Africa (see figure 1.1).

In terms of gross domestic product (GDP) by economic activities, the structure of Botswana's GDP has changed over the years, at independence in 1966 agriculture (mostly cattle rearing) contributed 42.7 percent of GDP, while mining was virtually non-existent, by 2006 agriculture contributed 1.7 percent of GDP, mining 41 percent. Noteworthy is that tourism (trade, hotels and restaurants) as well as the financial services (banking, insurance and business services) have been increasing in importance over time perhaps indicating positive signs of economic diversification (Table 1.1).

The exports trend in Table 1.2 and Figure 1.2 indicate that diamonds in particular constitute the largest share of Botswana exports. The fall in 1998, 2001 and 2009 was due to weak global demand for diamonds. The copper/nickel matte exports increased steadily from 2004 to 2007 due to improved copper prices and fell sharply thereafter as a result of drop in nickel and copper prices. Beef exports decreased from 1991 to 2002 due to drought conditions. Exports of soda ash overall experienced an increase due to demand in South Africa which is the major market for soda ash. The increase in textile reflected some response to increased world demand and to improved market access in the USA following the introduction of the Africa Growth and Opportunity Act (AGOA). Exports of motor vehicles fell from 1995 to 1996 and fell sharply from 1997 to 2001 due to the closure of the Motor Company of Botswana in 2000, which assembled Hyundai cars.

Table 1.1 sectoral distribution of GDP for selected years in Botswana economy

	1966	1975/76	1985/86	1990/91	1995/96	2000	2005	2006	2007	2008	2009	2010	2011	2012
Agriculture	42.7	20.7	5.6	4.8	4.1	2.6	1.8	1.7	1.8	1.7	2.3	2.9	2.5	2.7
Mining	-	17.5	48.9	39.5	33.9	40.9	40.7	41.7	39.2	36.5	28.3	24.5	24.7	19.6
Manufacturing	5.7	7.6	3.9	4.7	4.8	3.8	3.5	3.4	3.9	3.8	3.9	5.9	5.8	5.9
Water and Electricity	0.6	2.3	2.0	1.7	2.1	2.2	2.2	2.2	2.2	2.2	2.4	0.4	0.2	-0.4
Construction	7.8	12.8	4.6	7.6	6.2	5.2	4.5	4.4	4.8	4.7	5.7	5.4	6.0	6.8
Trade, Hotels and Restaurants	9.0	8.6	6.3	5.9	9.9	9.4	9.1	9.5	10.1	10.4	11.4	14.0	14.7	15.3
Transport, Post and Telecommunication	4.3	1.1	2.5	3.2	3.6	3.4	3.2	3.4	3.6	4.0	4.7	4.8	4.9	5.7
Banks, Insurance and Business	20.1	4.7	6.4	8.8	11.2	10.0	10.0	10.2	10.6	11.7	13.0	12.4	12.9	14.4
General government	9.8	14.6	12.8	13.5	15.4	14.8	16.6	15.6	15.6	16.2	17.9	12.5	12.0	13.2
Social and personal services	-	2.8	2.5	4.2	6.6	3.9	4.0	3.9	3.9	4.1	4.9	5.6	5.6	6.2

Sources: Siphambe et al., 2005; Bank of Botswana, Annual Report (2009, 2012)

Table 1.2 exports principal merchandise

	Diamonds	Copper/Nickel	Beef	Soda Ash	Textiles	Vehicles
1991	1,464.9	124.1	71.7	6.2	61.4	
1992	1,362.5	101.6	92.4	24.0	35.9	4.0
1993	1,379.2	81.8	78.8	20.7	37.4	10.5
1994	1,396.0	99.2	78.7	22.5	64.3	79.3
1995	1,445.0	114.7	84.1	25.2	51.6	284.2
1996	1,625.0	126.1	81.0	22.2	64.3	79.3
1997	2,099.1	95.1	67.8	42.5	67.9	299.9
1998	1,485.6	73.9	74.0	42.4	72.3	232.2
1999	2,079.0	88.3	58.3	42.5	53.6	144.3
2000	2,224.2	110.9	53.3	40.5	52.7	58.4
2001	1,506.8	57.5	55.3	29.5	12.7	17.2
2002	1,982.8	79.3	44.4	42.2	29.5	64.7
2003	2,387.7	143.9	53.7	46.5	45.9	88.5
2004	2,779.5	165.8	60.1	53.5	120.1	117.7
2005	3,269.6	460.7	59.9	64.7	214.3	115.1
2006	3,346.8	650.3	60.9	79.9	156.0	32.0
2007	3,267.1	904.8	96.3	77.2	452.8	35.6
2008	3,271.6	790.4	84.7	74.4	267.0	34.9
2009	1,959.0	513.7	68.9	73.4	196.4	69.5
2010	2,746.8	617.6	127.5	74.5	164.5	74.1
2011	3,762.0	510.3	68.3	76.6	264.2	110.2
2012	4,021.3	449.1	68.3	84.6	81.2	129.3

Source: Bank of Botswana, *Annual Report (2001, 2012)*

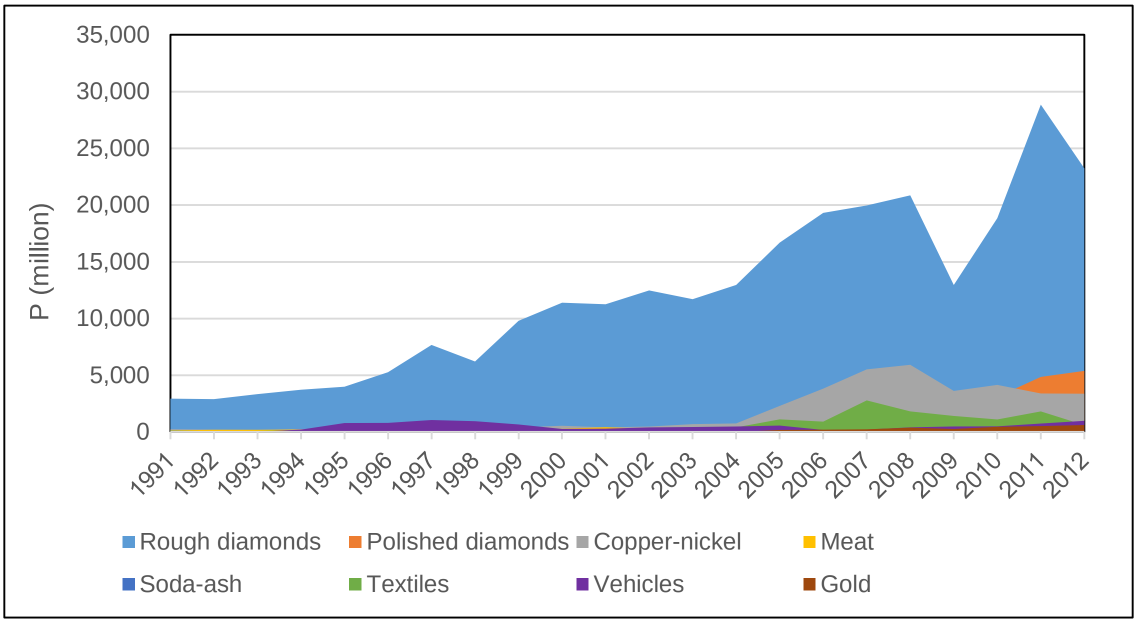

Figure 1. 2 shows merchandize export from 1991-2012

Mining is the key source of government finances with mineral revenue contributing significantly to government revenue in the last decades (see Figure 1.2). As a result, the government spending has been the main link between the mining sector and the rest of the economy indicating the critical role of fiscal policy in Botswana.

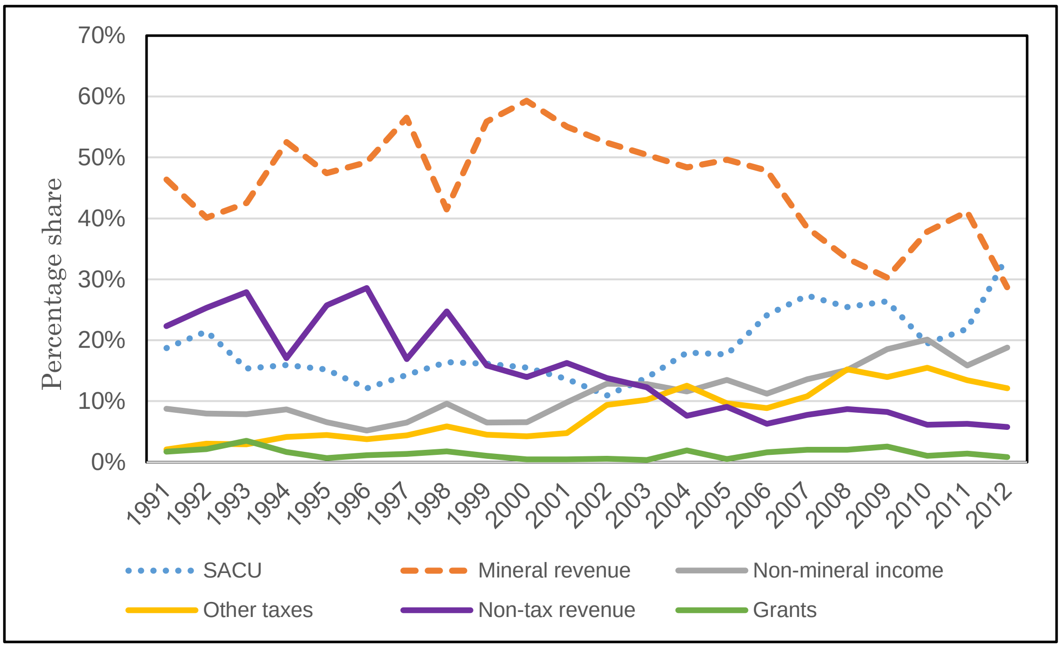

Figure 1. 3 shows composition of government revenue, 1991-2012

Source: Data from Bank of Botswana annual report 2001, 2008, 2012

Botswana's mineral-led growth is under threat as the government expects diamond revenues to start decreasing in the next decade when opencast mining will be replaced by underground mining due to diamond depletion. The cost of underground mining is higher than open cast and this will decrease the revenues accruing to government (Government of Botswana, 2009:6). Unless there are major new discoveries, diamond mining is expected to stop being profitable by 2029 as a result of resource depletion. Thus a result, government revenue from diamond mining will decline, at first slowly and then rapidly over the two decades (see figure1.4). However, the likelihood of new discoveries is high given current exploration activities and the extension of the lives of current mines.

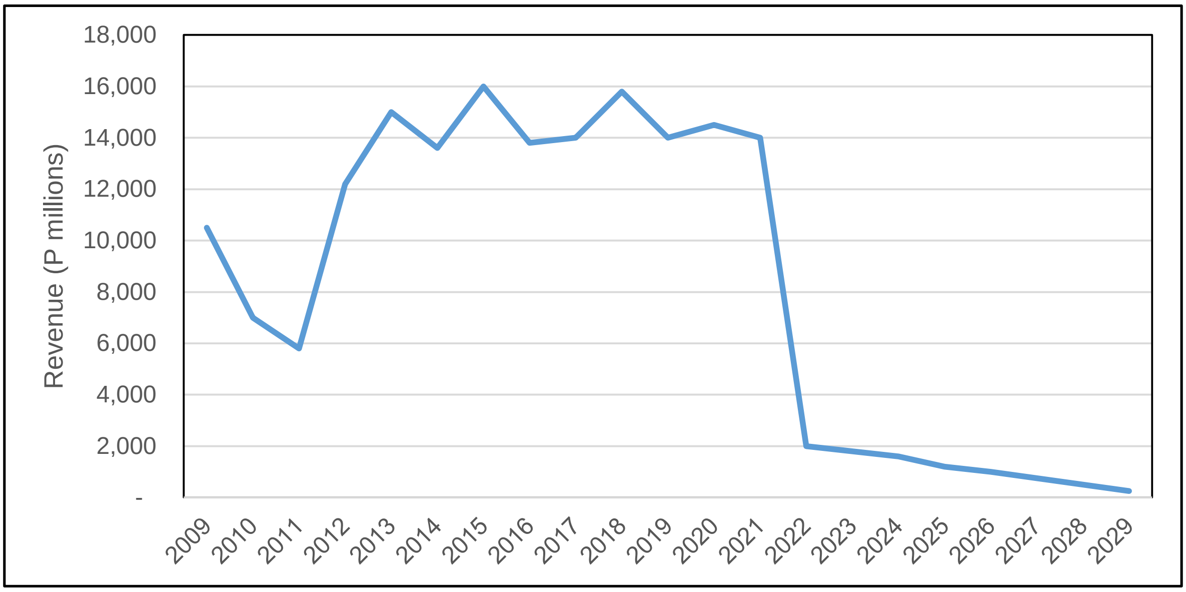

Figure 1. 4 shows projected revenue from diamonds 2009-2029

Source: Government of Botswana (2009)

In Pula current prices, the Pula is the local currency which roughly P9, 85 to the US$.

Mineral Policy and mining codes

The Government of Botswana main goal for the mineral sector is to continue getting the maximized economic benefits from the sector for the nation while providing a good climate for private investors to earn competitive returns. The government policy encourages prospecting and development of new mines. It also promotes opportunities for linkages to the rest of the economy to expand value-added activities, especially through downstream processing of minerals where commercially viable. The fiscal, legal and policy framework for mineral exploration, mining and mineral processing in Botswana is continuously being reviewed from time to time to make it more competitive.

All mineral rights in Botswana are vested in the state and Minister of Minerals, Energy and Water resources (MMEWR) ensure that mineral resources are investigated and exploited in the most efficient, beneficial and timely manner. This is done through development and implementation of the fiscal and legal policy framework for mineral development which aims at making Botswana's mineral sector to be competitive and attractive to investors.

Botswana's Mining Industry

Transnational companies have played a central role in Botswana's mining sector development. Although the Government has studiously avoided the worst aspects of 'resource nationalism', and has never nationalized mining companies, it has entered into long-term partnership with mining companies, with the Government enjoying an ownership stake in all major mining operations and carefully worked out revenue-and risk-sharing agreements. In doing so, it has taken a long-term view, promoting private-sector investment in the mining sector, and ensuring that it is itself well-resourced when entering into negotiations with international mining companies. As a result, it has been able to enter agreements that have given Botswana considerable benefits.

Botswana produces diamonds, coper-nickel matte, gold, coal and soda ash. Diamonds dominate the mining sector followed by copper and nickel. There is still significant mineral prospecting taking place in Botswana. In 2009, the Department of Geological survey had issued 1,124 prospecting licenses for al mineral prospecting and the biggest share of these licenses, over 35 percent were for diamond prospecting followed by energy with 22 percent and metals with 21.9 percent (Mbayi, 2013).

Copper-nickel

The first major investment in Botswana's mineral sector was by BCL, established in the 1960s to develop the copper-nickel ore bodies at Selebi-Phikwe (Jefferies 2009). BCL operated three linked copper-nickel mines in the Selebi-Phikwe area of north-east Botswana, and an associated smelter producing copper-nickel matte, which is sent abroad for refining. Other copper-nickel mining operations in Botswana include the Tati Nickel, which operated the Selkirk underground and Phoenix opencast mines near Francistown; Mowana African Copper mine and Discovery Metals.

Botswana's base metals sector faced some challenges such as the high input costs associated with mining processes, lower-grade deposits. Furthermore, the global minerals market is quite volatile, causing operations at the high end of the cost curve to decrease production at the slightest change in commodity prices. Year 2016 saw liquidation and shut down of some copper-nickel mining companies due to low commodity prices. BCL, Tati Nickel and Mowana mines are some of the victims. However, the base metals sector is considered to have a significant critical mass needed to anchor the beneficiation process in Botswana. The government's aim is to transform Botswana into a regional metallurgical hub.

Diamonds

Botswana produces over 30 million carats of diamonds per annum with a value of about US$3 billion (Table 1.1). There was a large drop in diamond production in 2009 as a result of the economic recession that impacted on diamond jewelry sales and fed through the value chain in the last quarter of 2008. All diamond mines in Botswana halted production at the beginning of 2009. Botswana's average value per carat is between US$80 to US$170, which includes both gem, and industrial diamonds. Industrial diamonds are worth considerably less than gemstones and if they were reported separately, the figure would give a more accurate value per carat for Botswana's gemstone production.

Table 1.3: Botswana diamond production

Year	***Production***		
	Volume (Cts)	**Value (US$)**	**US$/Cts**
2004	31,036,367	2,576,018,461	83
2005	31,889,771	2,870,079,390	90
2006	34,293,401	3,207,570,684	94
2007	33,638,000	2,960,144,000	88
2008	32,276,000	3,273,001,000	101
2009	17,734,000	1,436,454,000	81
2010	22,018,000	2,586,396,620	117
2011	22,904,554	3,902,115,905	170
2012	20,554,928	2,979,400,297	145
2013	23,187,580	3,625,538,396	156
2014	24,668,091	3,646,952,179	148
2015	20,778,642	2,986,469,130	144
2016	20,501,000	2,845,948,820	139

Source: Kimberley Process

Botswana's diamond value chain starts with exploration to find a viable diamond deposit for mining. Once a promising diamond deposit has been identified a number of specific methods to further assess and develop it follow. Once a viable diamond deposit has been found, the next stage of the value chain is mining. All diamonds in Botswana are extracted by open-pit mining, however, first underground mine is expected to open. DeBeers operates four mines in Botswana which include the Jwaneng mine which is the most profitable diamond mine. These mines are operated by a joint venture between the government and DeBeers, known as the Debswana Mining Company and account for almost all of Botswana's diamond production.

Debswana's Orapa and Jwaneng mines are the most important with Jwaneng contributing 70 percent to Debswana total earnings and Orapa having the biggest kimberlite pipe in the world. However, both these mines are old and nearing depletion, which the government expects to take place in the next decade. To prolong the life of its richest mine, Debswana has undertaken Jwaneng Cut 8 Project, which is expected to extend the life of the Jwaneng mine by seven years and ensure profitable and continuous production at the mine to at least 2025 (Miningmx, 21st March 2011). Moreover, DeBeers has a revenue optimization strategy, within which diamonds are only mined when the demand exists, that is why all Debswana mines stopped production during the recession.

Historically, Debswana mined all diamonds in Botswana but new producers have started independent diamond mines in the country such as Lerala mine and Ghaghoo Diamond Mine. Unlike the Debswana mines, the government has no direct ownership in the independent mines and these mines were licensed on condition that their rough diamond production is traded locally.

Botswana's Diamond Beneficiation Strategy

The government has decided it is crucial that Botswana uses its remaining diamond resources to foster long-term economic growth through the private sector, to create fiscal sustainability and to make the most of the remaining diamond deposits in light of approaching resource depletion (Government of Botswana, 2009). The beneficiation imperative in the diamond industry argues that the cutting and polishing of diamonds locally will further local economic development. The government's diamond beneficiation strategy is a four pronged strategy that aims to create downstream competencies in the cutting and polishing industry, jewellery manufacturing industry, diamond trading industry and ancillary businesses.

Botswana's Development Policy Framework

The country's economic development policy is discussed in order to understand how the mineral beneficiation policy fits into the nation's overall economic development plans. Botswana's economic development is guided by 6 year national development plans. The current National Development Plan 11 run from 2017 to 2023 and is the country's key development policy. With the theme of 'Inclusive growth for the realization of sustainable employment creation and poverty eradication'. Like the previous National Development Plan 10, the strategic thrust of NDP 11 is to strengthen economic diversification away from mining towards private sector growth. It is on the basis of the performance of NDP 10, and taking into consideration the development challenges facing the country that NDP 11 advocates for various policies and strategies to promote growth and create employment opportunities in the country.

Among the broad strategies to be pursued during NDP 11 are: (1) developing diversified sources of economic growth through initiatives such as beneficiation and local economic development; (2) the use of domestic expenditure as a source of growth and employment creation by ensuring that domestic aggregate demand, including government expenditure, is employed to support growth. Moreover, during NDP 11 the Botswana Government will continue to grow the economy through mineral beneficiation to maximize the value addition from minerals and to promote the development of the private sector to drive beneficiation. The strategies for mineral beneficiation include among others base metals beneficiation, which encompasses the identification of suitable beneficiation projects such as copper, iron, nickel and the creation of an enabling environment to drive the identified projects; the expansion of the diamond beneficiation beyond cutting and polishing and introducing alternative/additional diamond supply.

Summary

For the last four decades Botswana, one of the world's largest producer of diamonds by value, has enjoyed resource rents arising from its large endowment of diamonds resources that have underwritten the country's growth. The revenues that Botswana earns from diamonds are expected to decrease significantly in the next decade if no new discoveries are made. In line with Botswana's National Development Plan 11, this thesis aims to investigate the impact of mining sector in Botswana's economic development. It is crucial to empirically understand the relationship between government expenditure, mineral revenues and economic growth to ensure that expenditures facilitate growth. Furthermore, it is crucial to disentangle the relationship between sectors in order to make informed beneficiation policies. These two objectives together with copper market analysis makes contributions to the country's development plan strategy of developing diversified sources of economic growth.

1.4 Research Questions and Methodology

This thesis presents three self-contained empirical research papers under the aim of the impact of mining sector on the economic development of Botswana. We focus on government expenditure, economic growth, non-mining sectors and commodity price analysis in particular copper, and apply econometric techniques. Research methods vary by context and appropriateness for the research questions at hand. The three research papers use observational data. Key methods include (a) vector autoregressive and granger causality method, for linear interdependencies among concerned variables; and (b) ordinary least squares with breakpoints for structural change analysis of copper market.

The study on the dynamic relationship between mineral revenues, government spending and economic growth in *Chapter Two* examines the short and long-run relationship between the concerned variables. In particular it empirically examines whether the fiscal policy of

Botswana is counter-cyclical, whether mineral revenue has positive effects on the Botswana economic activities, whether the changes in government spending are caused by changes in mineral revenue and whether government spending positively impacts economic growth. To study these we used vector autoregression (VAR) and VAR Granger Causality.

Regarding the inter-sectoral linkages between mining and non-mining sectors, *Chapter Three*, also uses VAR and VAR Granger causality approach to investigate the dynamic relationship between sectors. Specifically in this study our aim is to understand the inter-sectoral linkages between mining and other sectors, by identifying the response of non-mining sectors to mining shock and how the latter affect the variation of non-mining sectors. Moreover, this study reveal the inter-sectoral linkage between non-mining sectors themselves.

The study of determinants of copper prices, *Chapter Four*, addresses the structural change in the copper market and the effects of various financial market factors on copper price changes. We used a general model of Bai and Perron (1998 and 2003) corresponding to a pure structural change to test for multiple structural breaks in copper prices. This method is based on the least squares principle. And to estimate the number of breaks Bayesian Information Criterion (BIC), Yao (1988) is employed. BIC provide a reliable information for structural breaks inference even in the presence of serial correlation.

Figure 1.5 presents how the impact of mining sector on the economic development in Botswana is investigated. The chart indicates the aim of each chapter and the key variables used.

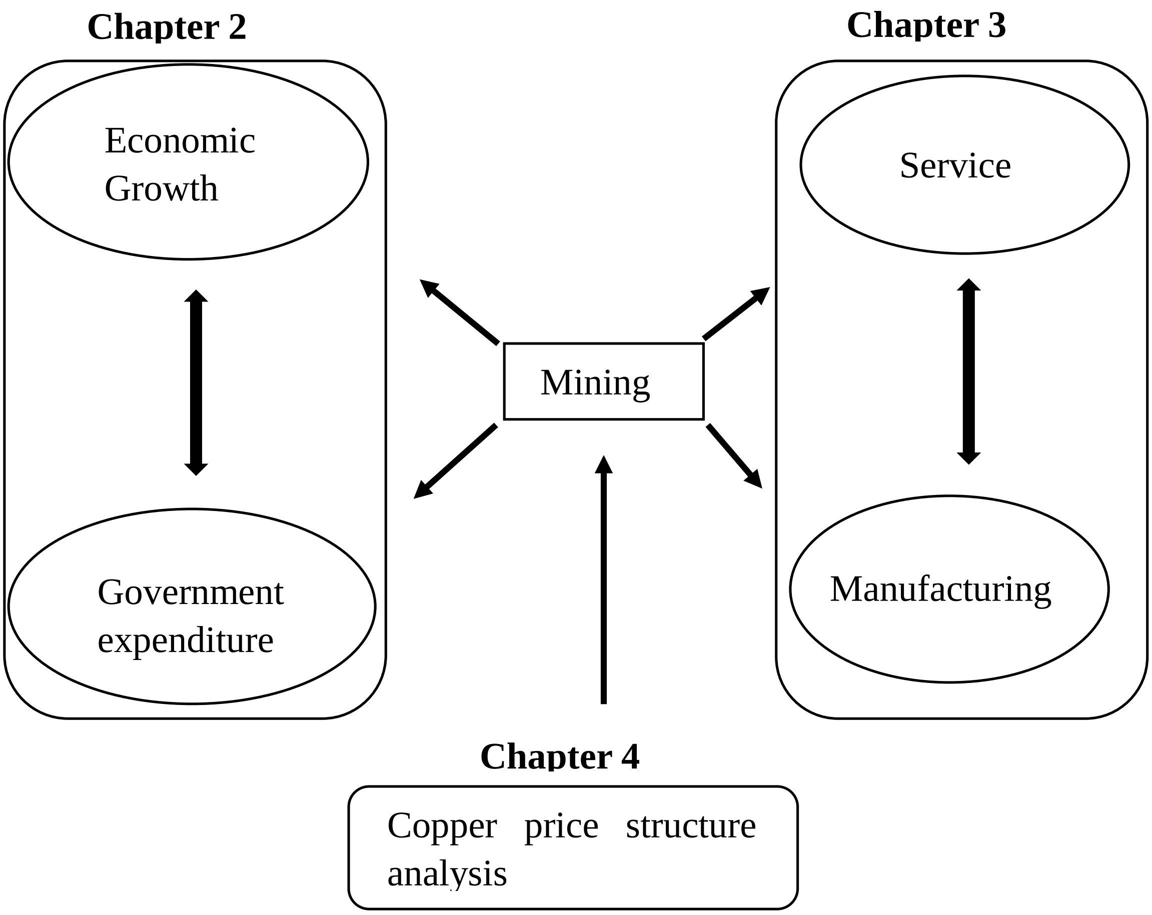

Figure 1.5 shows the structure of the research purpose

1.5 Structure of the thesis

The Introduction section provides an overview of the natural resource sector, the resource curse literature, overview of Botswana economy and the research questions and methodologies. The rest of this thesis is organized as follows: Chapter Two studies the Dynamic relationship between Mineral revenue, Government Expenditure and Economic growth in Botswana. Chapter Three explores the Linkages between mining and non-mining sectors in Botswana economy. Chapter Four analyzes the structural changes in copper market and the factors that causes price fluctuations. In the Conclusion section we wrap up the research outcomes of these three chapters.

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Chapter 2 Dynamic relationship between Mineral revenue, Government Expenditure and Economic growth in Botswana

2.1 Introduction

Sizable natural resource endowments and the potentially large economic proceeds from their extraction in a number of sub-Saharan African (SSA) countries provide an un-paralleled opportunity for economic growth and development in the region. The revenue from these resources can be used to address infrastructure and human capital and general services deficits that are obstacles to the development of sustained broad-based and inclusive growth not to mention to achieve improvements in social indicators (Lundgren et al. 2013).

In many SSA countries natural resources make a significant share of export and government revenue and several other countries in the region are poised to become significant resource exporters in the future. However, the revenues from exhaustible natural resources are distinctive in two key aspects; they are derived from depleting a finite stock of resources therefore intrinsically temporary, and since commodity prices are highly volatile they are unreliable. It is generally recognized that unsustainable increases in consumption are undesirable. Both exhaustibility and volatility potentially give rise to unsustainable increase in expenditure and therefore raise issues of intergenerational fairness- how the proceeds of mineral exploitation should be shared between the current and future generations.

According to (Zagler and Durmecker, 2003) fiscal policy is one of the macroeconomic policy instruments used to induce output, income and employment to move the economy to its optimal level. However, the fiscal dependence on the natural resource sectors and relatively weak non-natural resource tax base renders fiscal management highly challenging for natural resource exporting countries. The disappointing growth and weak economic performance of natural resource producers have been attributed to the procyclicality of government expenditures, evidenced in expansionary and contractionary fiscal impulses associated with fluctuations in resource revenues (Gelb 1988; Auty and Gelb 2001). Many resource exporters in Sub-Saharan Africa (SSA) experienced strong boom-bust episodes associated with fluctuations in resource prices. Whenever revenue surged it was immediately spent, resulting in large year-to-year changes in government expenditure. Moreover, Arezki and Ismail (2010) find asymmetric response of current and capital expenditure to changes in oil prices. With current expenditure increasing rapidly during booms and capital expenditure falling even more rapidly during busts. Thomas and Bayoumi, (2009) indicate in an empirical research that the deterioration of the non-oil fiscal balance in response to changes in oil revenue in SSA countries is considerably larger than in other countries.

Botswana's ability to avoid the resource curse by prudently managing its mineral wealth has been justly acclaimed. Mineral wealth management is based on a rule that allocates non-renewable-resource revenue to investment expenditure or savings: a Sustainable Budget Index (SBI) principle ensures that non-investment spending is financed only with nonresource revenue. The underlying principle behind the budget sustainability ratio is that, a country which is dependent on revenues from non-renewable resources such as diamonds in the case of Botswana, should fund its recurrent budget from non-mineral revenues. This is to ensure future fiscal sustainability, long after the exhaustible resources are depleted. Despite the positive performance of this measure of budget sustainability, there is a need to be cautious about the use of this ratio for policy making purposes. This is because, over time, a number of programmes, which are recurrent in nature such as maintenance of infrastructure, recurrent expenditure net of health and education sectors have been funded under the development budget (Ministry of Finance and Development Planning, 2016).

The government spending had been the main link between the mining sector and the rest of the economy indicating the critical role of fiscal policy in Botswana (Ezekwesili et al., 2010).

Yet fiscal policy is today facing a number of challenges. As indicated in the previous chapter, Botswana revenues from minerals are declining. Since 2009 Botswana faces persistent government budget deficits, a situation which is a reversal of past experience when a boom in mining led to nearly two decades of budget surpluses. The boom was driven by diamond production and exports and also favourable prices. As noticed the country's fiscal position has been adversely affected by the global economic and financial crisis: a development that has led to an increase in public debt and a cumulative budget deficit of P18.2 billion over the period from April 2009 to March 2012 (Bank of Botswana, 2012). Additionally, as indicated in the previous chapter, the peak of the contribution of minerals to the Botswana government's revenues appears to have passed, and the fiscal importance of minerals is likely to decline in the future.

The substantial mineral revenues have enabled the government to finance its expenditure programme. In 1995, Government expenditure amounted to US$543.5 million and in 2000, it reached US$1,227.5 million, and in 2010 it reached US$4,020.5 million, meaning that it more than doubled in every 5 years, an average annual increase in 17.7%. In 1995, recurrent expenditure amounted to US$367.2 million, accounting for 67.6% of the total Government expenditure. In 2000, it amounts to US$874.4 million and in 2010 it amounts to US$2,834.6 or 71.2% of the total, an average annual increase of 18.9%. Development expenditure increased from US$174.9 billion in 1995, accounting for 32.2% of the total government expenditure and in 2000, it amounted to US$359.3 million accounting for 29.2% of the government expenditure and in 2010 it amounted to US$1,189.9 million. This is an annual increase of 26.2% per annum. This indicates an inclination towards consumption. However, given that the development expenditure, which is financed by the mineral revenue have been increasing over the years the government fiscal situation is vulnerable to the exhaustible nature of diamonds.

This chapter is an attempt to empirically investigate the dynamic relationships between mineral revenue, government expenditures and economic growth in Botswana. The chapter examines whether government expenditure is a transmission channel through which the mineral revenue affect the economic growth. And most importantly our study empirically examine the nature of Botswana fiscal policy. We employ time series analysis to examine how mineral revenues affect economic growth both directly and indirectly through the fiscal channel.

This study according to our knowledge is the first study on a developing, net mineral exporting economy. Most studies in the literature use cross-country regressions with few case studies focusing on a single country. In contrast with existing cross-country studies, Granger no-causality test and vector autoregresion method are used to examine the link between mineral revenue and economic performance through the fiscal policy channel with data for Botswana.

2.2 Data and Methodology

2.2.1 Data

The data frequency is quarterly and the observation spans are from 1994 to 2012 of the following three variables: mineral revenues, government spending and economic growth. Mineral revenues are the rents from minerals including diamonds, copper-nickel and gold with diamonds contributing mostly to the revenue. These rents are the main source of income of the government of Botswana and they represent 13.5 % of GDP and 28% of government revenues in 2012 (Bank of Botswana annual report, 2012).

The second variable is government spending in real term. In Botswana, government spending consists of recurrent and development spending. The recurrent spending intend to maintain the present capacities of government administration. They include final consumption expenditure, property income paid, subsidies and other current transfers (e.g., social security, social assistance, pensions and other welfare benefits). By contrast, development spending is spending on assets. It is the purchase of items that will last and will be used time and time again in the provision of a good or service such as building of new schools, the purchase of new equipment, building new roads. In this study we focus on the development expenditures because they are financed by the mineral revenues.

Finally, the third variable is economic growth and is measured by the percentage change from one quarter of the gross domestic product (GDP) to the previous period. All the variables are in real local currency and are also in first-differenced logarithmic form. Data is collected from annual reports of Bank of Botswana.

2.2.2 The Research Methodology

To examine the relationship between mineral revenue, government spending and economic growth, we applied Vector Autoregressive (VAR) model and granger causality in VAR. Vector autoregression was introduced by Sims (1980) as a technique that provides a multivariate framework where changes in a particular variable (mineral revenue) are related to changes in its own lags and to changes in other variables and the lags of those variables. The VAR treats all variables as jointly endogenous without strong restrictions of the kind needed to identify underlying structural parameters. The model expresses the dependent variables in terms of predetermined lagged variable, and it is therefore a reduced-form model.

Although estimating the equations of a VAR does not require strong identification assumptions, some of the most useful applications of the estimates, such as calculating impulse response functions (IRFs) or variance decompositions do require identifying restrictions. A typical restriction takes the form of an assumption about the dynamic relationship between a pair of variables. In our VAR models, the vector of endogenous variables, according to Cholesky ordering consists of mineral revenue, government expenditure and real GDP. This assumes that the first variable in a pre-specified ordering has an immediate impact on all variables in the system. The pre-specified ordering of variables is important and can change the dynamics of a VAR system.

In the first ordering, the mineral revenue changes are ranked as a largely exogenous variable, especially in a case of Botswana economy. Although Botswana is one of the key producers hence suppliers of diamonds, its production are determined by global economic demand, therefore mineral prices hence revenues are an exogenous factor for the Botswana economy. We expect that significant shocks in diamond and other minerals (copper-nickel) markets affect contemporaneously the other key macroeconomic variable in the system.

The second variable in the ordering is government expenditures. Government expenditures can be broadly defined as recurrent and development expenditures. A pattern that has been observed in Botswana is the large growth of expenditures both recurrent and development expenditures. The dominant role of the government in the economy result in the government being the dominant sector. Human capital (education and health) bills plays an important role in the size and inflexibility of development expenditures in Botswana. The inflexible structure of government ranks it largely as an exogenous variable in our first ordering.

Real GDP as a measure of economic growth is affected by the level of government demand. The positive development of mineral prices hence revenue, results in high levels of government expenditures and economic growth.

In our unrestricted VAR models, the vector of endogenous variables, according to our first Cholesky ordering, consists of mineral revenues, government expenditure and real GDP:

$$y_t = (mineral\ revenue, government\ expenditure, real\ gdp) \qquad (1)$$

The VAR approach proceeded in four steps. In the first step, variables were selected for the data generating process (DGP). The time series of the individual variables were then investigated for deterministic and stochastic trends. A standard practice in the literature is to first test the order of integration for each individual variables using augmented Dickey Fuller (ADF) (Dickey and Fuller, 1981) procedure and Philip-Perron test (1988). According to (Lloyd and Rayner, 1993) augmented Dickey and Fuller test is designed to distinguish between stationary either with regards to mean or trend and non-stationary processes. A series is said to be integrated of order *d* denoted by $y_t \sim I(d)$ if it becomes stationary after differencing d times and thus y_t contains *d* unit roots (Lloyd and Rayner, 1993). The general form of Dickey and Fuller test ca be written as follows:

$$y_t = \beta' D_t + \emptyset y_{t-1} + \sum_{j=1}^{p} \varphi_j \Delta y_{t-j} + \varepsilon_t \qquad (2)$$

Where D_t is a vector of deterministic terms (constant, trend). The p lagged difference terms, Δy_{t-j}, are used to approximate autoregressive, moving average (ARMA) structure of the errors, and the value of *p* is set so that the error ε_t is serially uncorrelated. The error term is assumed to be homoscedastic.

If the stationarity test showed that all of the variables were stationary, that is *I* (0), then a VAR in levels could be estimated. If, however, the variables are non-stationary and integrated of the same order, a cointegration VAR model will be used. Moreover, proper lag selection is important for VAR specified type of analysis. Lag order selection criteria such as sequential modified LR test (LR), Akaike information criterion (AIC), Hannan-Quinn information criterion (HQC), Final Prediction Error (FPE) and Schwarz Information Criterion (SC) are used to select the optimal lag. The VAR regression can take the form:

$$y_t = b_{10} - b_{12} z_t + \gamma_{11} y_{t-1} + \gamma_{12} z_{t-1} + \epsilon_{yt}$$
$$z_t = b_{20} - b_{21} y_t + \gamma_{21} y_{t-1} + \gamma_{22} z_{t-1} + \epsilon_{zt} \qquad (3)$$

Once VAR model has been estimated the stability check test and autocorrelation test can be used to help determine whether the model is valid. In terms of model validation, one important property of our estimates is that the model should be stable, implying that variables in the system (x and y) are jointly ergodic: the effects of shocks die out.

A VAR system such as in Eq. 2 can be used to attempt to infer information about the direction or directions of causality between variables (x and y) using Granger no-causality test:

$$y_t = \alpha_0 + \sum_{i=1}^{m} \alpha_i x_{t-i} + \sum_{i=1}^{m} \beta_i y_{t-i} + \varepsilon_{y,t} \quad (4)$$

$$x_t = \gamma_0 + \sum_{i=1}^{m} \gamma_i x_{t-1} + \sum_{i=1}^{m} \emptyset_i y_{t-i} + \varepsilon_{x,t} \quad (5)$$

Where α_0 and γ_0 are constants, α_i, β_i ,γ_i and $\emptyset_i$ are coefficients, and $\varepsilon_{y,t}$ and $\varepsilon_{x,t}$ are uncorrelated disturbance terms with zero means and finite variances. The null hypothesis that mineral revenue does not Granger-cause government expenditure or real-GDP is rejected if the α_i coefficients in Eq. (4) are jointly significantly different from zero using a standard joint test (F-test). Similarly, government expenditure or real-GDP is said to Granger-cause mineral revenue if the $\emptyset_i$ coefficients in Eq. (4) are jointly different from zero. If both coefficients are jointly different from zero, a bi-directional causality will form. Our study employ three variables among which causal relation is examined. Following Granger no-causality test, impulse response functions and variance decomposition are estimated.

2.3 Empirical Results

2.3.1 Unit root tests results

As mentioned above augmented Dickey-Fuller unit root was used to test the non-stationarity in our data series. All the variables does not reject the presence of a unit root because the test statistic is greater that the critical value at 5% significance level. Phillip-Perron tests lead to similar conclusions. It is therefore evident from the results that all the variables are non-stationary I(1) in levels and stationary I(0) in first difference VAR analysis can be performed on first differenced time series. The results are in Table 2.1 below.

Table 2.1: Results of the unit root tests

	ADF		PP		Order of integration
	Level	1st diff	Level	1st diff	
Real-GDP	-2.22	-12.5***	-1.63	-17.2***	I (1)
Gov-Exp	-1.87	-9.68***	-3.16	-22.4***	I(1)
Min-Rev	-2.66	-11.3***	-2.41	-12.6***	I(1)

Note: The regressions both in levels and first difference include intercept.

***Indicates rejection of null hypothesis of non-stationary of the variables at 5% level of significance.

2.3.2 Optimal lag selection test results

To assess the optimal lag length we use EViews lag length criteria with a maximum lag length of four. The majority of the lag selection criteria identified the optimum lag of 4 therefore lag 4 is chosen for our VAR model and the results are in Table 2.2 below.

Table 2.2: Lag selection results

Lag	LR	FPE	AIC	SC	HQ
0	-	3.77E-05	-1.67	-1.57	-1.63
1	288.2	5.81E-07	-5.85	-5.46*	-5.69
2	22.8	5.23E-07	-5.95	-5.27	-5.68
3	31.2	4.02E-07	-6.22	-5.25	-5.83*
4	17.9*	3.82e-07*	-6.28*	-5.02	-5.78

*Indicates lag order selected by the criterion at 5% significance level.

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hanna-Quinn information criterion

2.3.3 VAR Granger causality test results

VAR regressions are run starting the sample at the earliest possible date with four lags, which is 1995q5. To assess the validity of our VAR, we test for stability and for autocorrelation of the residuals. None of the eigenvalues is over one, so our system is stable (Table A1). Moreover, we cannot reject the null hypothesis of no residual autocorrelation in the system (Table A2), therefore the model is valid. To determine whether real-GDP, government spending and mineral revenues can help predict one another we perform Granger causality test to the VAR model. The results are indicated in Table 2.3.

Table 2.3: VAR Granger-causality test results

Dependent variable: Real-GDP		
Regressors	Chi square	Probability
Gov-Exp	7.67	0.104
Min-Rev	14.02	0.0072
All	24.6	0.0018
Dependent variable: Gov-Exp		
Regressors	Chi square	Probability
Real-GDP	5.43	0.246
Min-Rev	11.4	0.0222
All	15.4	0.0517
Dependent variable: Min-Rev		
Regressors	Chi square	Probability
Real-GDP	2.35	0.672
Gov-Exp	0.655	0.957
All	4.03	0.854

The results reveal evidence that lagged mineral revenues help predict real-GDP (the p-value is 0.0072) and government spending (p-value is 0.022). The results indicate that real-GDP and government spending does not help predict mineral revenue neither do they help predict each other.

2.3.4 Impulse response functions results

In order to identify the effects of shocks to mineral revenue or real-GDP or government spending on the subsequent time paths of each of them, we must make the assumption about whether the correlation is due to current mineral revenue affecting current real-GDP and government spending or otherwise. Given the relative size of mining industry in Botswana economy, it is acceptable that mineral revenue would have a stronger effect on real-GDP and government spending, and this is supported somewhat by the evidence for lagged effects from the Granger Causality tests. Therefore, we choose as our preferred identification pattern interpreting the contemporaneous correlation as the effect of mineral revenue on government expenditure and real-GDP: mineral revenue is first in our ordering followed by government expenditure and real-GDP. The results are presented in Figure 2.6.1 (appendix).

The diagonal panels in Figure 2.6.1 show the effects of shocks to variable on future values of its own. In all cases, the shock fluctuate positively and negatively. A one-standard deviation shock to mineral revenue (Min-Rev) in the top-left panel is 0.2%; a corresponding shock to government expenditure (Gov-Exp) is close to 0.10%; and a corresponding shock to real-GDP in the bottom-right panel is close to 0.04% in the first quarter.

The off-diagonal panels (top, middle and bottom) show the effects of variables shocks on the path of each other. In the first row of the figure, we see that a one-standard deviation shock to government expenditure (Gov-Exp) and real-GDP have very little impact on mineral revenue (Min-Rev). The left and right side of second row indicate the response of government expenditure (Gov-Exp) to mineral revenue (Min-Rev) and real-GDP shocks. Government expenditure respond negatively in the first quarter, then increased a bit above zero in the second quarter as the lagged effects continue to kick in. From the second lag on, the effects continue a positive and negative pattern. The effect of real-GDP shock on government expenditure is zero in the first quarter, then raises the expenditure by above zero in the second quarter. From the second quarter on, the effect fluctuate and decays to zero from the seventh quarter.

In the third row, the first and second graph indicate the estimated effects of shocks to mineral-revenue and government spending on real-GDP. We notice that real-GDP respond positively a bit above 0.02% on the first quarter followed by a negative response in the second quarter. The pattern continues until the last quarter. The effect of government spending to real-GDP follows almost similar pattern although with smaller impact as compared to mineral revenue.

From the estimated results we notice that the effects of real-GDP and government expenditure on mineral revenue is zero in the first quarter. This is a direct result of our identification assumption: we imposed the condition that government expenditure and real-GDP have no immediate effect on mineral revenue in order to identify the shocks.

Recall that our identification assumption imposes the condition that any 'common shocks' that affect all the variables are assumed to be mineral revenue shocks, with government expenditure and real-GDP shocks being the part of the government expenditure and real-GDP VAR innovations respectively, that are not explained by the common shock. This might cause the government expenditure and real-GDP shocks to have smaller variance and might also overestimate the effect of the mineral revenue on government expenditure and real-GDP respectively.

To assess the sensitivity of our conclusions to the ordering assumption, we examine the IRFs making the opposite assumption: that the contemporaneous correlation in the innovations is due to government expenditure and real-GDP shocks affecting the mineral revenue. Figure 2.6.3 (appendix) shows the graphs of the reverse-ordering IRFs. The estimated results indicate that the effect of mineral revenue on government expenditure and real-GDP in column 3 now begins at zero and the effect of government expenditure and real-GDP on the mineral revenue third row does not. This interestingly indicate the change in the effects as a result of reverse in the order.

2.3.5 Variance decomposition results

Another tool that is available for the analysis of identified VARs is the forecast-error variance decomposition, which measures the extent to which each shock contributes to unexplained movements (forecast errors) in each variable. The first table of Table 2.6.3 show that the mineral revenue shock contributes 100% of the variance in the one-period-ahead forecast error for the mineral revenue changes, with government expenditure and real-GDP contributing zero. As our forecast horizon moves further into the future, the effect of government expenditure and real-GDP on the mineral revenue increases, however the effect is very little with mineral revenue shocks dominating by 92.8%, 10-period-ahead forecast error.

The second table indicates the estimated variance decomposition of government expenditure. The results show that government expenditure shock contributes about 92.5% of the variance in the one-period-ahead forecast error for its changes, with real-GDP and mineral revenue shocks contributing 7.5% and 0% respectively. Mineral revenue and real-GDP shocks contributed more five-period-ahead into the future by 13.4% and 3.5% respectively, while the contribution of government expenditure shocks were decreasing. As the forecast horizon moves further into ten-period-ahead forecast error mineral revenue and real-GDP shocks contributed 18.6% and 5.3% respectively to variances in government expenditure.

The third table shows the results for variance decomposition of real-GDP. The results show that real-GDP shock contributes about 61.9% of the variance in the one-period-ahead forecast error for real-GDP changes, with mineral revenue and government expenditure shocks contributing the other 35.9% and 2.2% respectively. As the forecast horizon moves further into the future, the effect of mineral revenue and government expenditure on real-GDP increase by 49.5% and 4.9% at the five-period ahead. The effects of mineral revenue and government expenditure further increase and the shares converge to 51.5% of the variation in real-GDP being due to mineral revenue and 6.4% being due to government expenditure shock and 42.1% explained by its own shocks. Like the IRFs, variance decompositions can be sensitive to the identification assumptions. The alternative ordering resulted in different results, therefore we choose the direction suggested by the VAR Granger causality as is reasonable.

2.4 Analysis and discussion

As expected considering the importance of mining sector in the economy of Botswana, mineral revenue determines real GDP. This is revealed by a uni-directional causality from mineral revenue to real-GDP. The impulse response function results indicate a positive relationship between mineral revenue and economic growth. Additionally, mineral revenues explain much of the changes in real-GDP.

The direction of causality between mineral revenue and government expenditure support the revenue-spend hypothesis as suggested by Buchanan and Wagner (1978) which holds that the direction of budget determination is from mineral revenue to spending. The impulse response results indicate that government spending respond negatively to shocks in mineral revenues in all periods. While the impulse response function indicate an almost negligible response of mineral revenues to government spending. Thus IRFs suggest a uni-directional causality from mineral revenue to spending. Additionally, the variance decomposition results are consistent with the IRFs, which indicate that government spending are more responsive to changes in mineral revenues than mineral revenues are to changes in government spending. Government spending explains 4.48% of the forecast error variance in mineral revenues while mineral revenue explains 18.6% of government expenditure. Thus the picture that emerges from Granger causality test, IRFs and VDC is that in Botswana there is a uni-directional causality from mineral revenue to government spending and the relationship is negative for the observed period. This implies that a reduction in mineral revenues leads to an increase in government spending and is in line with that of Moalusi (2004) and Mupimpila et al., (2010) who also found a significant negative relationship between government revenues and expenditures in Botswana.

The results does not reveal any causality between government spending and real-GDP. The impulse response function results indicate that government spending has a positive effect on economic growth in the short run, while the long-run dynamics indicate that government spending contribute little to the changes in economic growth. This could mean that government spending creates deficit as indicated by mineral revenue-government expenditure relationship and the government spend on non- productive projects. The results are supported by those of (Mupimpila et al 2012) and (Ezekwesili et al 2010) who reveal the negative relationship between government revenues and government spending.

Figure 2.1 presents a dynamic relationship between mineral revenue, government expenditure and economic growth in Botswana chart based on Granger no causality test and impulse response function. The figure shows that mineral revenue determines government expenditure and that the latter respond negatively to mineral revenue show. The negative response suggests that the fiscal policy of Botswana is countercyclical. Furthermore, the results indicate a positive effect of mineral revenue on economic growth and lack of causation between economic growth and government expenditure.

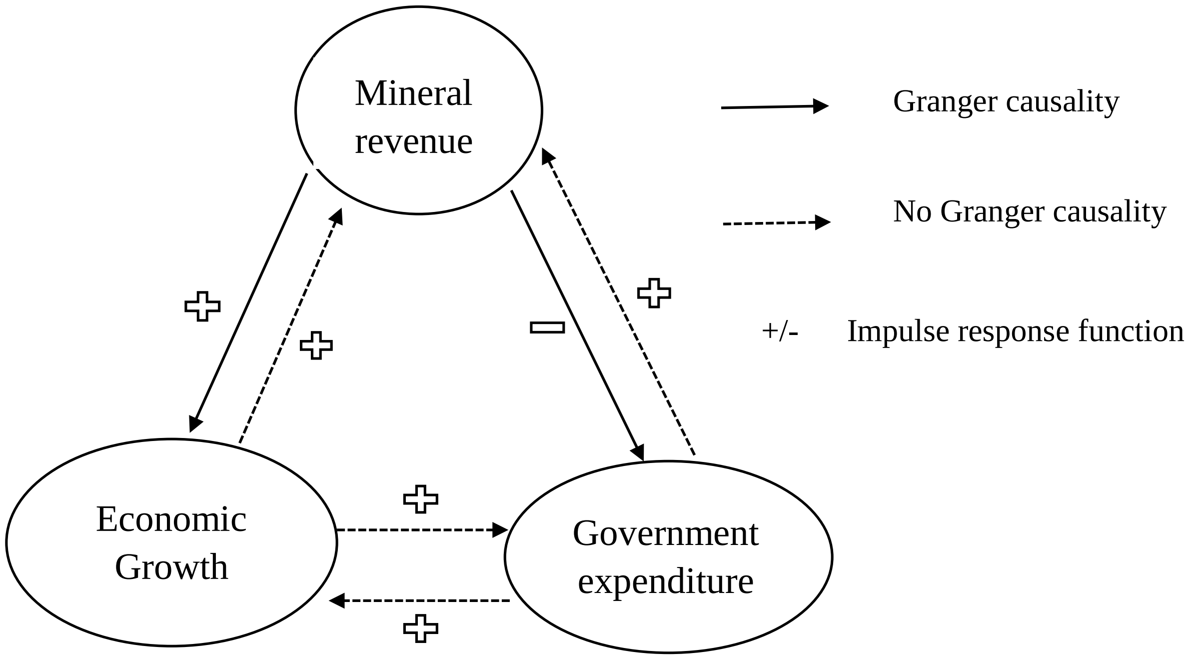

Figure 2.1 shows the impulse response functions and direction of causality results

2.5 Conclusion and policy implication

In this chapter, the causality, short-run and long-run dynamics between mineral revenues, government spending and economic growth in Botswana is analysed for the period 1994 to 2012, using quarterly data. The study employs a vector autoregression model (VAR), and Granger causality; and finds support that mineral revenues determines government spending and economic growth in both the short-run and long-run. The causal relation between government spending and economic growth was not established. In Botswana there is a positive relationship between mineral revenue and economic growth. While, the relationship between mineral revenue and government spending is negative. The lack of causation between government spending and the long-run economic growth could mean that the spending creates fiscal deficit or is being spent on non-productive resources.

According to (Ezekwesili et al 2010) the combination of a decline in mineral revenues and an edging upward of spending has resulted in more frequent deficit which explains lack of causation between spending and long-run economic growth. This is a symptom of resource curse that is defined by the challenge faced by resource rich countries to adjust their spending levels after the contribution of mineral revenues to government revenue rich a peak and the fiscal importance of mineral revenues declines. The empirical evidence in support of mineral revenue-and-spending relationship and lack of causation and long-run relationship between government spending and economic growth has implications on budget deficits in Botswana.

It is necessary for the government to increase taxes in order to reduce budget deficits. Tax revenues should be increased by broadening the tax base, improving tax compliance and tax administration procedures. These measures are necessary in the present era when Botswana faces persistent budget deficits, unlike in the past when a boom in mining led to almost two decades of budget surpluses.

2.6 Appendix

Table 2.6.1: VAR Stability condition check

Root	**Modulus**
-0.651613 - 0.552782i	0.854498
-0.651613 + 0.552782i	0.854498
-0.034714 - 0.834317i	0.835038
-0.034714 + 0.834317i	0.835038
-0.782420	0.782420
0.331832 - 0.694611i	0.769803
0.331832 + 0.694611i	0.769803
-0.396162 - 0.318744i	0.508470
-0.396162 + 0.318744i	0.508470
0.298727 - 0.270056i	0.402701
0.298727 + 0.270056i	0.402701
0.111319	0.111319

No root lies outside the unit circle.

VAR satisfies the stability condition.

Table 2.6.2: VAR Residual Serial Correlation LM Test

Lags	LM-Stat	Prob
1	7.45	0.59
2	12.6	0.179
3	7.35	0.601
4	7.16	0.62

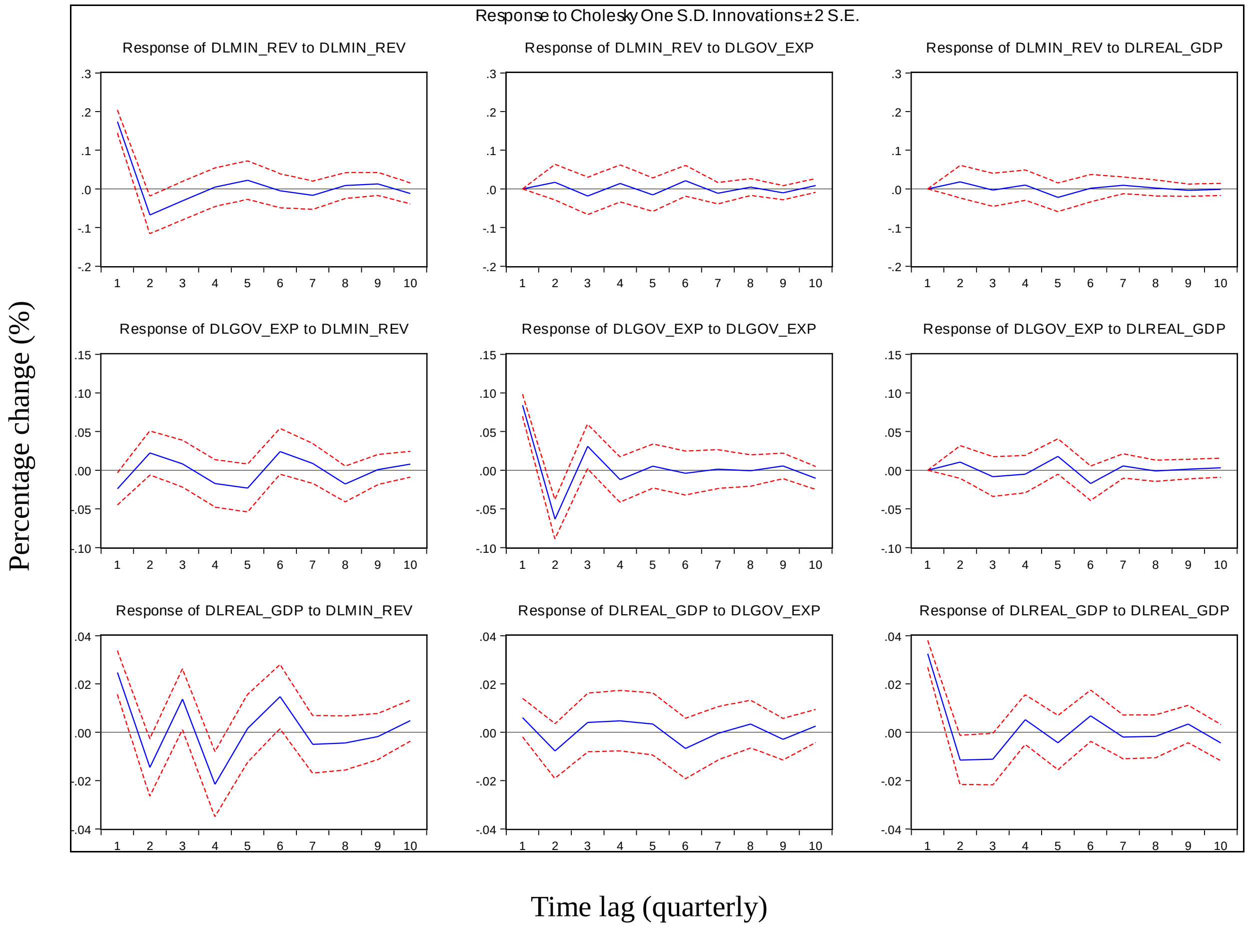

Figure 2.6.1: Indicate the impulse response function results.

Table 2.6.3: Variance decomposition results

	Variance decomposition of MIN-REV			Variance decomposition of Gov-Exp		
Period	MIN-REV	GOV-EXP	REAL-GDP	MIN-REV	GOV-EXP	REAL-GDP
1	100	0	0	7.54	92.5	0
2	98.2	0.83	0.95	8.74	90.4	0.91
3	97.3	1.73	0.94	8.54	90.1	1.35
4	96.6	2.23	1.18	10.4	88.1	1.49
5	94.8	2.77	2.41	13.4	83.03	3.56
6	93.8	3.85	2.38	16.4	78.4	5.22
7	93.3	4.13	2.57	16.7	77.8	5.38
8	93.3	4.17	2.57	18.4	76.3	5.27
9	93	4.41	2.58	18.4	76.3	5.27
10	92.8	4.48	2.58	18.6	76.1	5.27

Variance decomposition of Real-GDP

Period	MIN-REV	GOV-EXP	REAL-GDP
1	35.9	2.15	61.9
2	39.07	4.59	56.3
3	41.5	4.65	53.9
4	49.9	4.61	45.4
5	49.5	4.94	45.5
6	51.4	5.86	42.7
7	51.8	5.82	42.4
8	51.8	6.09	42.1
9	51.6	6.3	42.1
10	51.5	6.4	42.1

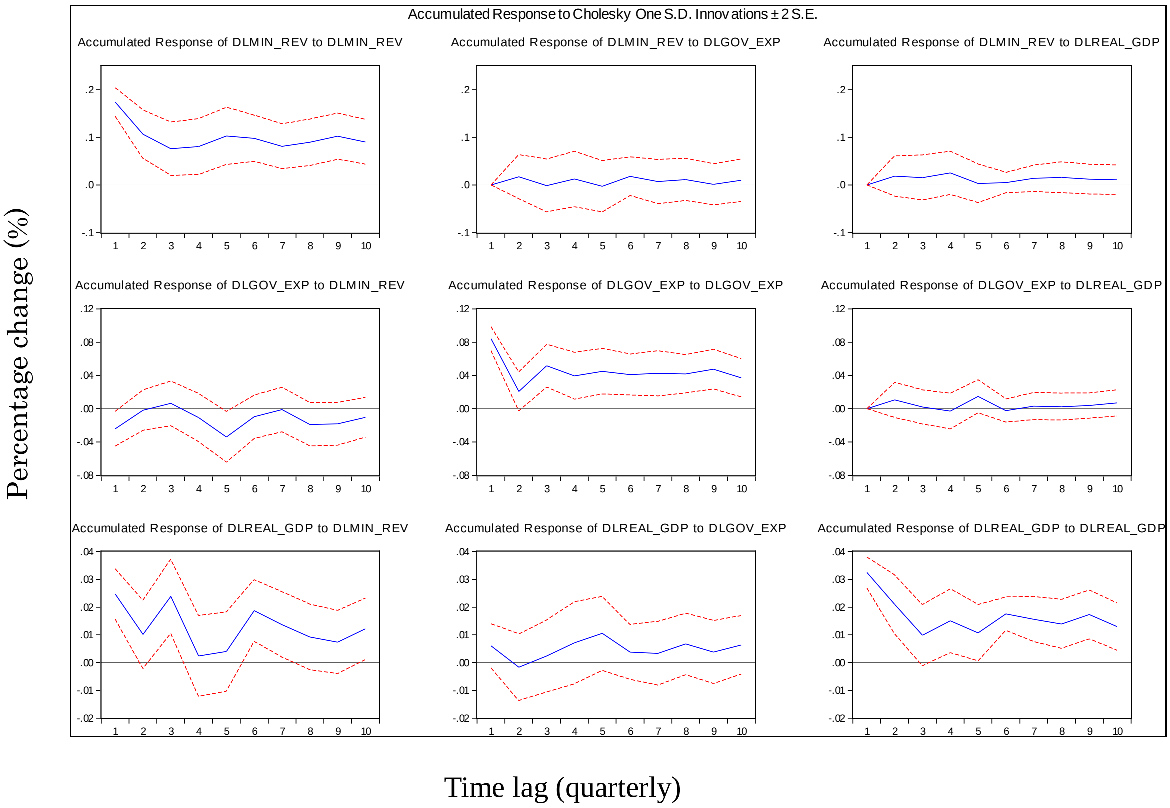

Figure 2.6.2: Indicate the accumulated impulse response function results.

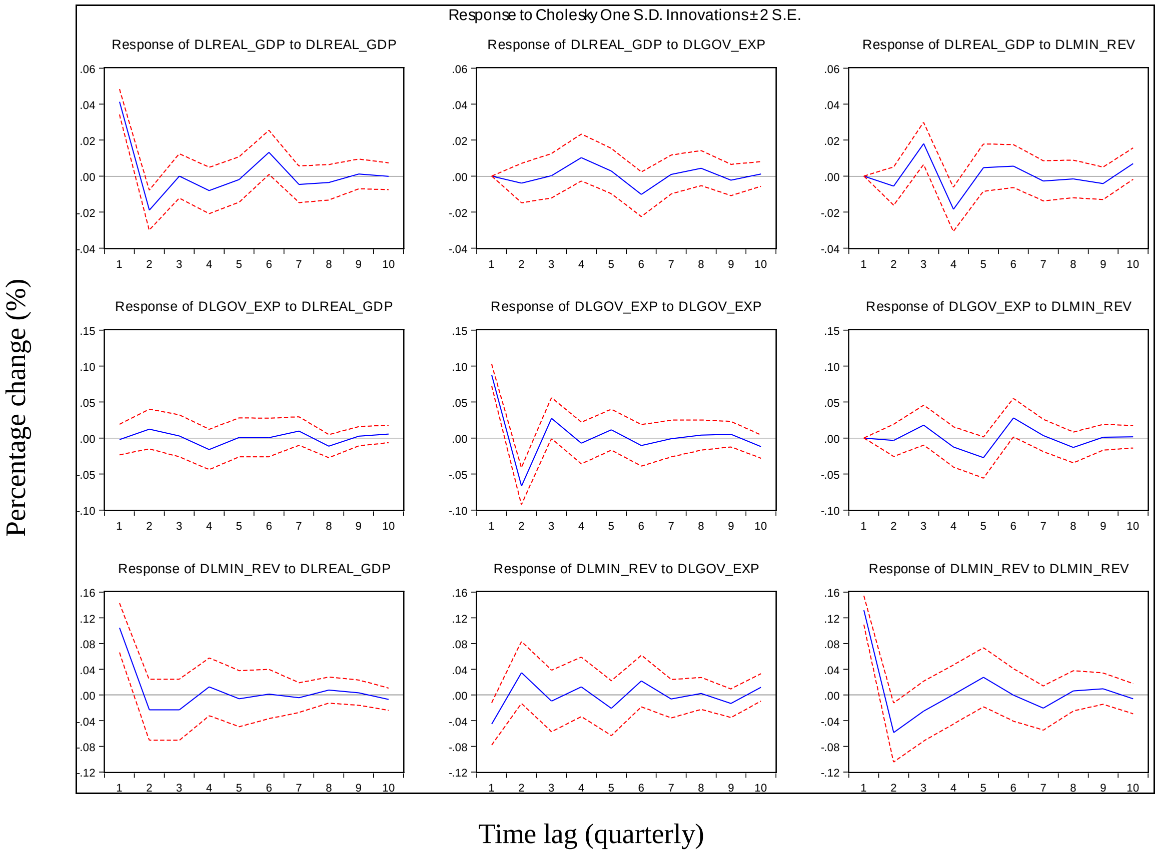

Figure 2.6.3: Indicate the impulse response function results for the reversed order of identification.

Table 2.6.4: Variance Decomposition results for reversed order of identification

	Variance decomposition of Real-GDP			Variance decomposition of Gov-Exp		
Period	Real-GDP	GOV-EXP	MIN-EXP	Real-GDP	GOV-EXP	MIN-EXP
1	100	0	0	0.054	99.9	0
2	97.8	0.72	1.49	1.27	98.6	0.09
3	84.7	0.62	14.7	1.23	96.2	2.52
4	72.2	4.11	23.7	3.06	93.3	3.55
5	71.5	4.33	24.2	2.88	88.7	8.43
6	70.1	7.09	22.8	2.72	84.3	13
7	70.1	7.05	22.8	3.3	83.7	13
8	69.8	7.55	22.7	4.05	82.2	13.8
9	69.3	7.65	23.02	4.08	82.2	13.8
10	68.3	7.58	24.09	4.22	82.1	13.6

Variance decomposition of MIN-REV

Period	Real-GDP	GOV-EXP	MIN-REV
1	35.9	6.79	57.3
2	32.2	9.16	58.6
3	32.5	9.1	58.3
4	32.7	9.44	57.9
5	31.7	10.3	58
6	31.4	11.4	57.3
7	31.04	11.3	57.6
8	31.1	11.3	57.6
9	30.9	11.7	57.4
10	30.9	11.9	57.2

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Chapter 3 Linkage between mining and non-mining sectors in Botswana

3.1 Introduction

The linkage among various sectors on the economy is one of the significant sources of economic development in the modest world. Strengthening of industrial sectors lies at the core of the development agenda as the overall economic growth depends on the sectoral growth rates which is influenced by the linkages between the sectors. Inter-sectoral linkages thus play a crucial role in the industrialization and socio-economic development of a country. This poses particular challenges for resource intensive economies since it is widely believed that the extraction of commodities is corrosive of industrial development.

Two primary reasons are offered to explain the negative association between resource extraction and industrialization. The first is the macroeconomic impact of resource extraction on relative prices and incentive systems, a phenomena called- Dutch disease. The second is the inherent enclave nature of commodity extraction, particularly in hard and energy commodities. Numerous aggravating factors explain the intensity of Dutch disease, depending on the nature of the booming sector. For instance, the more the booming sector is an enclave, with few linkages producing only small spillover effects on other sectors of the economy, the more likely the boom is to affect the latter's competitiveness. Likewise, the less developed and diversified the country's economy, the more spending effect will ripple through the entire economy due to the weak capital absorptive capacity of other existing sectors (Berger, 1982). In this study we therefore address Dutch disease argument from the nature of the booming sector.

The argument that Botswana has not suffered from the Dutch disease is polarized and limited to few studies. IMF study argued that Botswana has benefited from the coexistence of good governance and abundant diamonds to materialize growth. No clear evidence can be found that deterioration in the terms of trade would negatively affect economic development, as the Dutch disease model hypothesize (Iimi, 2006a). The resource movement effect is sharply limited by virtue of the capital-intensive nature of diamond mining industry, while the spending effect has been limited because a large percentage of goods consumed domestically are imported from South Africa, thus reducing the effects on the non-tradable sector (IMF, 2007). Yet, Mogotsi (2002), argues that Botswana has suffered from a mild form of the Dutch disease. Two reasons for the mild form of the disease are that Botswana had high unemployment at the start of its mineral boom and it did not have a large pre-existing manufacturing sector. In Mogotsi's view, the resource movement effect led to skilled labor migrating to the mining sector and being replaced by less skilled, previously unemployed agricultural workers. In terms of the spending effect, Mogotsi argues that the core of diamond boom from 1982 to 1987 saw both major spending increases and a significant appreciation of the real exchange rate. The real exchange rate depreciated after the initial boom but government recurrent spending did not (Mogotsi, 2002, pp. 144-146).

Recent studies challenge the enclave thesis by analyzing the determinants of backward and forward linkages, identifying policy responses which will broaden and deepen them. The focus is on local content policy and value addition as methods resource-rich countries are adopting to increase the benefits from resource extraction to their economies. These studies are not addressing whether there is Dutch disease or lack of linkages from mining sector but rather they promote linkages with other sectors of the economy through four main pillars: local employment opportunities, in-country spending and procurement of local goods and services, technology and skill transfer, and local participation through equity and management. Mbayi (2011) examined the extent to which Botswana is succeeding in creating a viable and sustainable cutting and polishing industry. The study reveal that Botswana has made progress in establishing a cutting and polishing industry and that there are linkages in the industry and a high degree of localization in the linkages. Wage bill estimates show that consumption linkages resulting from employment in the cutting and polishing industry are more valuable in the cutting and polishing firms than the supply chain. In their study (Morris etal.,2012) indicate that the depth and breadth of linkages is thin in Botswana and is limited to labor adding that there is potential for increasing linkages. Similar conclusion that there is progress in mining linkage was reached by (Fessehaie etal 2016).

The aim of this study is to investigate the dynamic interactions by applying time-series technique to structural change involving mining, manufacturing and services gross value addition in Botswana. The study contribute to the previous literature by investigating if there is evidence of positive or negative spillovers from mining to other sectors looking at the broad patterns of the sectors. The study empirically employ vector-autoregression model. The significance of this lies in the fact that processes of factor allocation and accumulation and technical progress (which underlie sectoral gross value addition interactions) can clearly be expected to differ between the short-run and long-run, yet no empirical evidence is available on this aspect. We are particularly addressing two questions: In the short- run, do shocks originating from mining have any effect the growth of manufacturing and services and how the latter sectors interrelate? In the longer run, to what extent fluctuations in the mining sector influence the growth perspectives of the other two sectors and how does non-mining sectors interact?

This study is relevant to Botswana given the decline in the role played by mining sector in the economy and the growth slump since 2009 and budget deficits that the country had experienced in the past few years. Most importantly, the peak of the contribution of mining sector to economic growth have passed and its economic impact are likely change as it becomes less important as a driver of growth. One more reason is important to understand these inter-sectoral linkages is that government policies in low-income countries and middle developing countries are often aimed explicitly at boosting the output of particular sectors or implicitly favor certain sectors. Indeed feeding the results of this type of modelling into the policy formulation process may help avoid or diminish unintended outcomes of such policy interventions. Considering the new strategy adopted by resource-rich economies to link commodities to the rest of the economy it is important for the countries with mature mining sector to consider the dynamic interactions or spillover effects between the sectors as they formulate policies to deepen and broaden linkages.

3.2 The natural resource curse-industrialization nexus

The relationship between natural resource endowment and industrialization has historically been viewed with some uncertainty. Prebisch (1964) put forward that primary-product exporters would find themselves disadvantaged in trade with industrialized countries because of the deteriorating terms of trade. Hirschman (1958), Seers, (1964) and Baldwin (1966) reinforced the negative consequence of producing and exporting commodities arguing that there are limited linkages from primary-products as compared with manufacturing. Needed supplies are imported, and little value added is carried out domestically as ores and concentrates are exported for processing abroad. As a result, the host country gets little from mining besides the monetary benefits from corporate taxation and royalties. However, this view has been challenged by both economic historians and econometric studies.

There is evidence of synergistic links between manufacturing and the resource sector in some industrialized countries. In his work (Innis, 1957) argued that Canada’s manufacturing is explained in large part by linkages to the export oriented fish, fur, timber and mineral commodities. Similarly, Wright and Czelusta (2004, 2007) argued that the development of manufacturing in the US and the recent development of industry in Australia and Norway can also be traced directly to the synergies arising between commodities production and industry. They conclude that technology, skills, knowledge and policies are instrumental in the success of resource-based industrialization.

On the related work, some studies of mining regions show that wages and other domestic expenditures do have multiplier effect on the local economy (Ahammad and Clements, 1999; Aroca, 2001; Clements and Johnson, 2000 and De Ferranti et al. (2002) suggests that mining sector in many cases promotes downstream and upstream linkages. These historical and recent experiences involved a positive and interactive relationship in which industrial growth was stimulated by linkages from the commodities sectors. Lederman and Maloney (2007) employed different estimation technique in time series data on the dynamic interrelationship between growth and the commodities sector and concluded that there is positive growth performance on resource intensive economies. Similar conclusion was reached by (Manzano and Rigobón 2007).

To ensure the extractive sector does not continue to be an enclave within the larger economy recently proactive approach to maximize the benefits from commodities through local content requirements and prudent policies to disseminate information among potential local businesses and joint ventures in developing countries have been undertaken. In their study, (Morris et al., 2011) using empirical enquiry into the nature and determinants of the breadth and depth of linkages in and out of the commodities sector concluded that policy in both public and private realm are necessary for the development of linkages. They further put forward that there has been a steady increase in the linkage development and that there are significant opportunities for deepening the process (Morris et al., 2012).

Teka (2012) found that the prospects of backward production linkages to the manufacturing sector in the Angolan oil and gas industry is limited to labor and to a lesser extend in basic services. Using descriptive and inferential statistical approaches and structural equation modeling approach (Adewuyi and Oyejide, 2012; Adedeji et al., 2016) prove that the linkages in the Nigerian oil value chain involve local firms and is mainly due to the result of local content policies. Bloch and Owusu (2012) indicate evidence of gold mining linkage into the Ghanaian economy. Based on input-output analysis (Klueh et al., 2007) quantify the relationship between oil sector and the growth of other sectors in the economy of São Tomé and Príncipe and also assess sectoral policies within the oil industry that would maximize the local benefits from oil exploration. In an attempt to contribute to this literature, this study empirically examine the causality linkages, short run and long run relationship between mining and non-mining sectors in the economy of Botswana using Granger causality test and vector autoregressive model to analyze data for 1976 to 2014. Unlike the previous literature our study focus on the broad pattern of the concerned sectors.

3.3 Methodology and model specification

3.3.1 Data

Time series data has been considered to explore the dynamic interactions among the three stylized sectors. Annual data on the growth rates of value added by type of economic activity sourced from central statistics Botswana reports for the period 1976-2014 have been used. The variables definitions are as follows:

- Mining sector (MIN): comprises of diamonds, copper-nickel, gold and soda ash and diamonds which have been the leading component of the sector.
- Manufacturing sector (MANUF): covers a wide array of sectors such as food and beverages, textiles and garments, jewelry making, metals and metal products among other things.
- Services sector (SERV): aggregate of financial services (banking, insurance, and business services), water and electricity, construction, and transport.

3.3.2 Model specification

3.3.2.1 Granger causality test

Causality tests between two stationarity series are based on Granger's (1969) definition for causality. The basic idea is that a time series X_t Granger-cause another time series Y_t if Y_t can be predicted significantly using the past values of X_t than by using only the historical values of Y_t. Suppose that Y_t and X_t are manufacturing and mining sectors respectively, then testing causal relations between the two sectors can be based on the following bivariate autoregression (Granger, 1969):

$$Y_t = \alpha_0 + \sum_{i=1}^{m} \alpha_i X_{t-i} + \sum_{i=1}^{m} \beta_i Y_{t-i} + \varepsilon_{y,t} \qquad (1)$$

$$X_t = \gamma_0 + \sum_{i=1}^{m} \gamma_i X_{t-i} + \sum_{i=1}^{m} \emptyset_i Y_{t-i} + \varepsilon_{x,t} \qquad (2)$$

where α_0 and γ_0 are constants, α_i, β_i, γ_i and $\emptyset_i$ are coefficients, and $\varepsilon_{y,t}$ and $\varepsilon_{x,t}$ are uncorrelated disturbance terms with zero means and finite variances. The null hypothesis that mining does not Granger-cause manufacturing is rejected if the α_i coefficients in equation (1) are jointly significantly different from zero using a standard joint test (F-test). Similarly, manufacturing is said to Granger-cause mining if the $\emptyset_i$ coefficients in equation (2) are jointly different from zero. If both coefficients are jointly different from zero, a bi-directional causality will form. However, our study employs four variables among which causal relation is examined.

3.3.2.2 Vector autoregressive (VAR) approach

We further explore the dynamic linkages between sectors using Sim (1980) approach. According to Sim (1980), tracing out a vector autoregressive system's moving average representation is a better way to provide insights on the dynamic interactions among the variables in the system. Vector autoregression consist of variance decomposition (VD) and impulse response function (IRF). Overall, VD and IRF examine the relative impact of each variable on other variables .The variance decompositions show the portion of the variance in the forecast error for each variable due to shocks to all variables in the system. Analysis based on VAR model enables someone to evaluate the strength of a causal relation. The moving average model of the shocks can be expressed as follows:

$$Z_t = \sum_{p=0}^{\infty} A_p \varepsilon_{t-p} \qquad (3)$$

where Z_t is a 2*1 column based on equation 1 and equation 2 and $\mathcal{E}_t$ is a 2*1 column vector that contains shocks of $\varepsilon_{y,t}$ and $\varepsilon_{x,t}$. Equation 3 indicates that Z_t is a linear combination of the current and past one-step ahead forecast error (shocks). Therefore, variance decomposition provides insightful information on unexpected variation in one variable with shocks from the other variable in the system. Impulse response function trace out the response of each concerned variable in the system to a shock from system variables. VAR provide insights into the dynamic linkages between mining, manufacturing, agriculture and services and the model specification is as follows:

$$\begin{bmatrix} w_t \\ x_t \\ y_t \\ z_t \end{bmatrix} = \begin{bmatrix} \beta_{10} \\ \beta_{20} \\ \beta_{30} \\ \beta_{40} \end{bmatrix} + \begin{bmatrix} \alpha_{11} & \cdots & \alpha_{1n} \\ \vdots & \ddots & \vdots \\ \alpha_{41} & \cdots & \alpha_{4n} \end{bmatrix} \begin{bmatrix} w_{t-1} \\ \vdots \\ w_{t-n} \end{bmatrix} + \begin{bmatrix} \delta_{11} & \cdots & \delta_{1n} \\ \vdots & \ddots & \vdots \\ \delta_{41} & \cdots & \delta_{4n} \end{bmatrix} \begin{bmatrix} x_{t-1} \\ \vdots \\ x_{t-n} \end{bmatrix} + \begin{bmatrix} \rho_{11} & \cdots & \rho_{1n} \\ \vdots & \ddots & \vdots \\ \rho_{41} & \cdots & \rho_{4n} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ \vdots \\ y_{t-n} \end{bmatrix}$$

$$+ \begin{bmatrix} \sigma_{11} & \cdots & \sigma_{1n} \\ \vdots & \ddots & \vdots \\ \sigma_{41} & \cdots & \sigma_{4n} \end{bmatrix} \begin{bmatrix} z_{t-1} \\ \vdots \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \vdots \\ \varepsilon_{4t} \end{bmatrix} \qquad (4)$$

Where w_t, x_t, a_t and z_t are endogenous that are mining, agriculture, manufacturing and services respectively. The lagged values of mining, manufacturing and services are captured in the vectors of x, y and z respectively and α, δ, ρ and σ are matrix of coefficient for the lagged endogenous variables and Ɛ is white noise.

3.4 Results and discussion

As a preliminary check, we verify that all the time series are stationary. This is done to avoid spurious regression caused by the presence of unit root. Accordingly, we first employed the Augmented Dickey Fuller (1981) and Phillip and Perron (1988) tests to check for stationarity for the mining, manufacturing, and services. In all cases, we comfortably reject the presence of a unit root in the growth rate series because the test statistic is more negative than critical value. Both tests lead to similar conclusions. Therefore, we conclude that VAR analysis can be performed on the time series data without differencing. The results are in Table 3.3 below.

Table 3.1: Unit root test results

Variable	Type	Level	
		Test statistics	Critical Value
MIN	ADF	-5.29*	-2.94
	PP	-5.29*	-2.94
MANUF	ADF	-8.97*	-2.94
	PP	-8.86*	-2.94
SERV	ADF	-5.22*	-2.94
	PP	-5.21*	-2.94

*denotes rejection of the null hypothesis of unit roots for Augmented Dickey Fuller test (ADF) and Phillip and Perron test (PP) test at 5% significance.

The next step is the selection of the appropriate lag length for VAR. Lags need to be specified in VAR model since they capture most of the effects that the variables have on each other. To assess the optimal lag length, we use lag selection criteria such as Sequential modified LR test statistic, Final Prediction Error (FPE), Akaike Information Criteria (AIC), and Schwarz Information criterion (SCI). The lag-length selection in the present VAR estimation is lag 3 based upon Akaike Information Criteria (AIC) and Final Prediction Error (FPE). According to Liew (2004) AIC and FPE are superior to the other criteria's in the case of small sample (60 observations and below), because they minimize the chance of under estimation while maximizing the chance of recovering the true lag length. The same lag length is used for Granger-causality estimation. The details on the lag selection have been provided in Table 3.4.

Table 3.2: Lag length selection

Lag selection criteria	Lag selection				
	0	1	2	3	4
LR	-	28.53[a]	22.44	24.68	11.17
FPE	2.74E-05	2.67E-05	2.92E-05	2.63E-05[a]	4.34E-05
AIC	0.85	0.81	0.86	0.66[a]	0.95
SC	1.03[a]	1.7	2.46	2.97	3.97
HQ	0.91[a]	1.12	1.41	1.45	1.99

[a] Indicate optimal lag order selected by the criteria.

LR: sequential modified LR test statistic

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

3.4.1 Granger causality test results

To determine if the growth rate of mining, manufacturing and services affect one another over time, we perform Granger causality test. The test results of Granger-causality between variables are given in Table 3.5. We see evidence that lagged services growth rate helps predict mining growth rate (the p-value 0.0584) and evidence that lagged mining growth rate helps predict services growth rate (the p-value 0.0396). Furthermore, we see evidence that mining growth rate helps predict manufacturing growth, while on the other hand, manufacturing help predict services growth. Overall, the results reveal the direction of linkage among concerned sectors, with a bi-directional causality between mining and services, and a uni-directional causality from mining to manufacturing.

Table 3.3: VAR Granger causality test results

Dependent variable: MIN		
Regressors	Chi square	Probability
Manuf	5.56	0.1353
Serv	7.47	0.0584**
All	10.6	0.102
Dependent variable: MANUF		
Regressors	Chi square	Probability
MIN	8.08	0.0444*
SERV	5.23	0.156
All	15.8	0.0151
Dependent variable: SERV		
Regressors	Chi square	Probability
MIN	8.34	0.0396*
MANUF	8.52	0.0365*
All	24.01	0.0005

* and ** denote rejection of the null hypothesis at 5% and 10% significance level.

3.4.2 Impulse response function results

In order to identify the effects of shocks to mining growth on the subsequent time paths of other sectors, we must make an assumption about whether correlation is due to current mining growth affecting current manufacturing and services growth or vice versa. Booming sector models Corden and Neary (1982) illustrate how an exogenous expansion in one sector may be mutually reinforcing or inhibiting for other sectors depending, inter alia, on sector factor usage and the non-tradability of different sectors output. Thus, we choose as our preferred identification pattern interpreting the contemporaneous correlation as the effect of mining growth rate on manufacturing and services growth rates: mining is the first in our ordering and manufacturing and services.

Figure 3.8.1 (appendix) present the impulse response functions results. The first column of this figure shows the response to one standard deviation shock to MIN. Manufacturing does not respond to the mining shock in the first and second year after the shock, then increased to 0.04% in the third year before declining to baseline in subsequent periods, while on the other hand SERV responded positively to mining shock after the second year, reaching the peak on the fourth year then decline thereafter.

The second column indicates the response of other variables to one-standard deviation shock on manufacturing. As a result of a shock in MANUF, MIN responds positively except in the fourth year and the response of mining lasted till the 8th year. The service sector respond positively and reached its maximum peak one year after the manufacturing initial shock, the response decrease to the third year and increase to the fourth year and got stabilized.

In the third column, the first and second graphs indicate the response of mining and manufacturing to a shock in the services sector. Mining does not respond in the first three years and respond positively in the fourth year, decrease to almost no response in the following years. On the other hand, manufacturing respond positively in the second year followed by a negative response in the third year and decays to zero after the 8th year.

Impulse response functions can also be estimated based on cumulative effect of permanent shock to one of the variables. For the preferred ordering this looks like Figure 3.8.2, a permanent positive shock of one standard deviation to mining growth would cause a positive growth to manufacturing sector and service sector.

3.4.3 Variance decomposition results

Variance decomposition results are presented in Table 3.8.3 (appendix). The variance decomposition of MIN indicates that it is entirely explained by its own shock in the 1-step ahead the of the time horizon. The explanatory power keeps on declining very slowly over time. In the 5-step ahead the horizon time, the percentage of MIN to the total variance declines due to the relative more explanation of variance by MANUF, and SERV with 11.3%, and 7.6% respectively. After 10-steps ahead the time horizon MANUF explains 11.6% of the variance followed by 8.1% of SERV.

The variance decomposition of MANUF shows that is explained mostly by its own shock, with MIN explaining 0.09% and SERV not explaining its variation. However, at 5-step ahead time horizon MIN, and SERV gained explanatory power. At 10-step ahead time horizon MIN, and SERV explained 10.3%, and 9.9% respectively to the total variation in MANUF.

Finally, variance decomposition of SERV suggests that at 1-step ahead time horizon, SERV explains most of its variation followed by MANUF with 21.6%. By the 5-step ahead time horizon MIN, and MANUF explain 19.5%, and 28.7% of the variation in SERV respectively. The result of 10-step ahead the horizon depict that MANUF explains 28.3% of the total variation followed by MIN with 20.5% of the total variance.

3.5 Discussion

The results indicate that there is dynamic interaction between mining, manufacturing and services in the economy of Botswana. Granger causality results reveal that changes in mining sector cause or precede changes in both manufacturing and services sectors. Additionally, the results reveal that changes in the services sector cause changes in the mining sector. The dynamic response results reveal that both manufacturing and services respond positively to the mining shock. A one percent point shock to mining value addition results in a positive response of manufacturing GVA on impact, reaching a peak at 0.4 percentage points above the baseline three to four years after the shock, and became negative for about two years at about 0.1 percentage and the effect dies out. Given manufacturing comparatively high share of imported investments goods and intermediate inputs, a positive mining shock, has positive effects on firms' profits and investment decisions. Furthermore, certain manufacturing industries may face increased demand following mining shock as the services sector increase output. On the other hand, a positive mining shock increases the cost of production in certain manufacturing sub-sectors, for which mineral and other commodities are intermediate inputs, and makes manufacturing exports less competitive abroad. In all, the positive effects dominate and manufacturing stands to gain from a booming mining cycle.

Gross value addition for services respond positively to mining GVA shock, peaking at 0.29 points relative to baseline after four years and remaining positive over a couple of years, with the response being more marked than for manufacturing activity. The service sector is subject to very little export demand or import competition. The positive response in activity likely reflect the involvement of services provided in the value addition process as well as second-round income effects from mining shocks, both on aggregate demand and through wage formation. Altogether, results point to positive linkages between mining, manufacturing and services activities. Yet, the estimated positive spillovers seem modest in size, especially for the manufacturing sector.

Caveats: The results presented here provide some indication of broad patterns of the Botswana economy to changes in mining GVA and guidance about the relative importance of some the main effects. Although the IRFs are accurately captured the response of the Botswana economy in the past, current relationships can be expected to evolve.

Figure 3.1 presents chart based results for the inter-sectoral linkage relationship. The figure indicates the direction of causality among sectors and the response of sectors to each other's shock. The results reveal a positive interaction between sectors, particularly a uni-directional (backward linkage) causality from mining to other sectors. The results indicate lack or little industrialization in the economy of Botswana as there is forward linkage that is the use of mining resources as an input in other sectors.

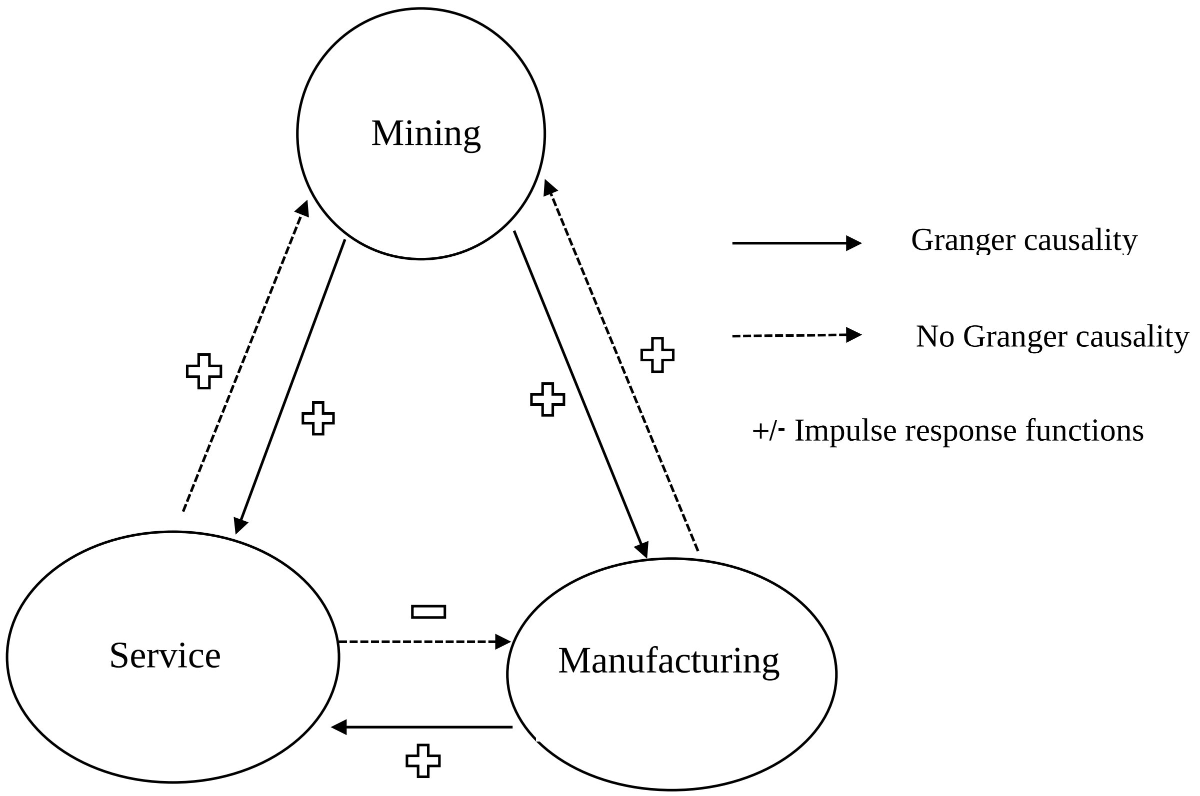


Figure 3.1 presents inter-sectoral linkage between mining and non-mining sectors in Botswana

3.6 Conclusion and policy implications

In this study, direction of causation, short-run and long-run dynamic linkages between three stylized sectors in the economy of Botswana is analyzed for the period 1976-2014, using annual data. The study employ VAR Granger causality and impulse response function and variance decomposition. Our analysis suggest that mining sector determine both manufacturing and services, generating positive spillovers and also help predict the growth of the two sectors. However, the estimated size of spillovers seems modest, which raises the question of the potential for mining to be better integrated with the rest of the economy or suggesting that there is room for mining to generate stronger linkages to rest of the economy, particularly to manufacturing and services. The results seems to be supporting (Mbayi, 2011; Morris etal 2012) that there is potential for increasing linkages. Moreover, the study indicate that there is much potential between manufacturing and services sectors to inter-link with each other.

3.7 Appendix

Table 3.7.1: VAR Stability condition check

Root	Modulus
-0.347859 - 0.690339i	0.773
-0.347859 + 0.690339i	0.773
0.755888	0.756
-0.614722 - 0.301509i	0.685
-0.614722 + 0.301509i	0.685
0.453683 - 0.461163i	0.647
0.453683 + 0.461163i	0.647
-0.071922 - 0.621098i	0.625
-0.071922 + 0.621098i	0.625

No root lies outside the unit circle.
VAR satisfies the stability condition.

Table 3.7.2: VAR Residual Serial Correlation LM Test

Lags	LM-Stat	Probability
1	11.10361	0.269
2	5.766675	0.763
3	18.17338	0.0332
4	6.037442	0.736

Probabilities from chi-square with 9 df.

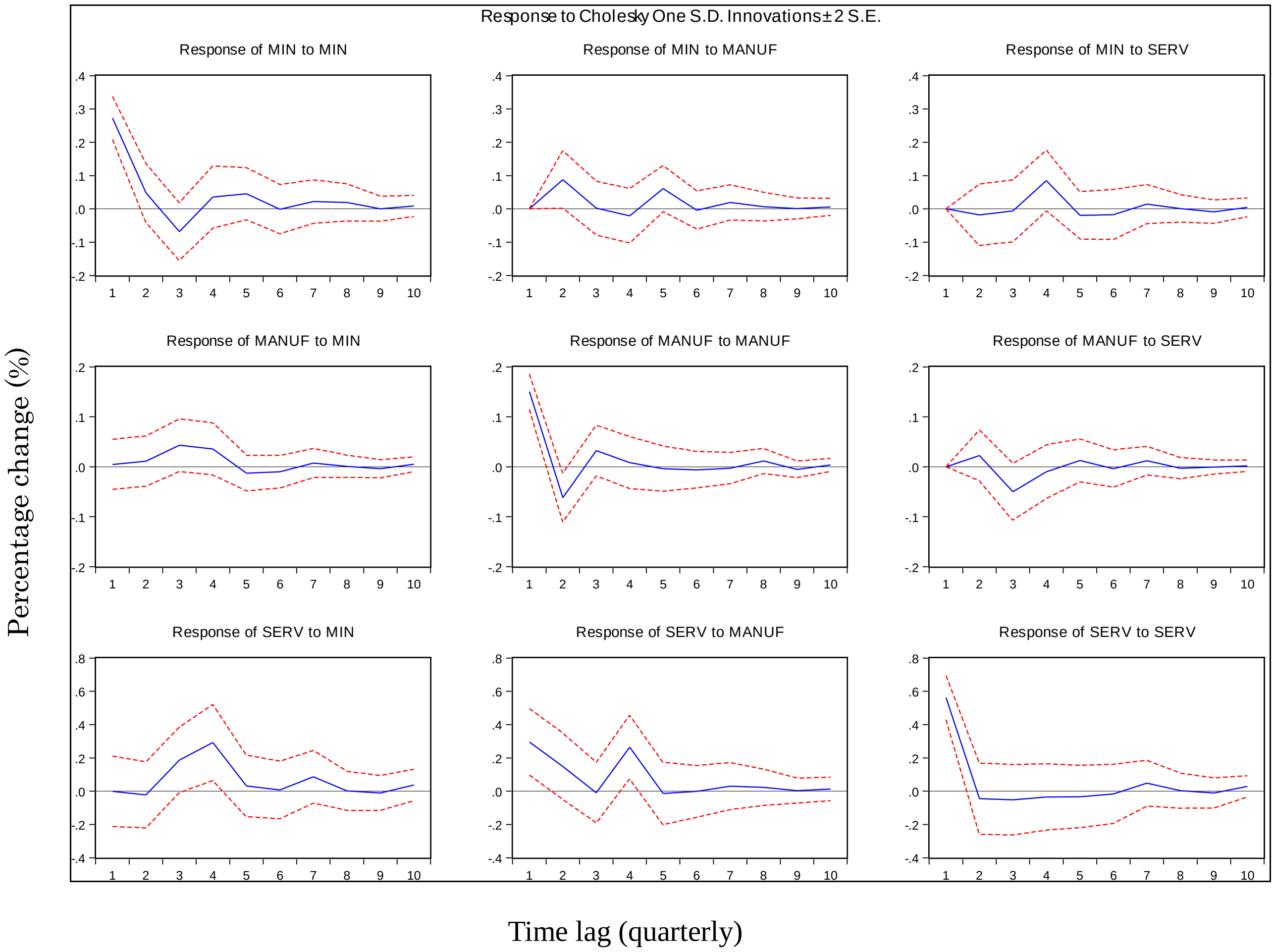
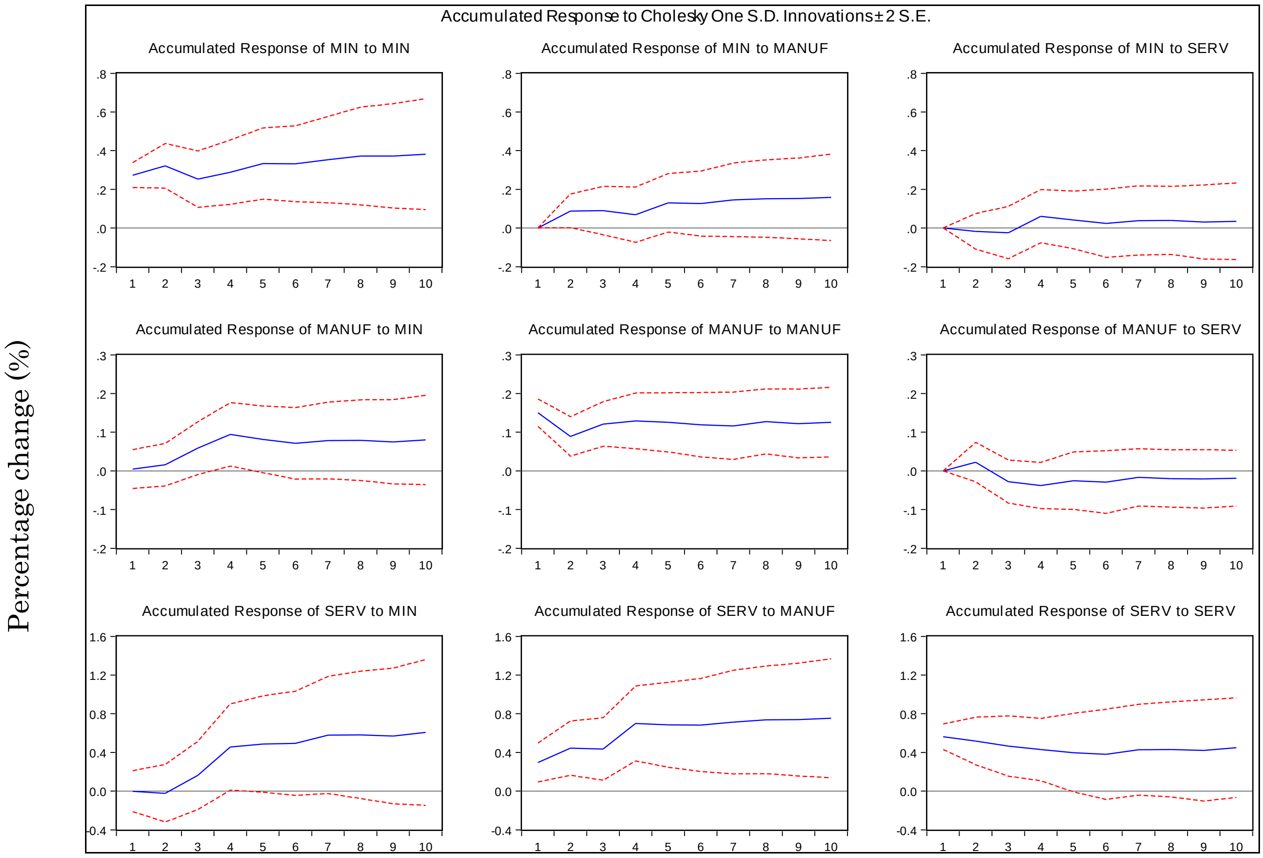


Figure 3.7.1: Indicate the impulse response function results.



Time lag (quarterly)

Figure 3.7.2: Indicate the accumulated impulse response function results

Table 3.7.3: Shows the variance decomposition of the mining, manufacturing and services sectors

Variance Decomposition of MIN:

Period	S.E.	MIN	MANUF	SERV
1	0.273	100.0	0.00	0.00
2	0.291	90.5	9.10	0.380
3	0.299	90.9	8.63	0.406
4	0.314	83.9	8.29	7.74
5	0.323	81.0	11.3	7.65
6	0.324	80.8	11.3	7.91
7	0.326	80.4	11.6	8.02
8	0.326	80.4	11.6	7.99
9	0.326	80.4	11.6	8.06
10	0.326	80.4	11.6	8.07

Variance Decomposition of MANUF:

Period	S.E.	MIN	MANUF	SERV
1	0.150	0.0947	99.9	0.00
2	0.165	0.543	97.6	1.86
3	0.18021	6.11	84.6	9.32
4	0.184	9.55	81.2	9.22
5	0.185	9.95	80.5	9.58
6	0.185	10.2	80.2	9.58
7	0.186	10.3	79.8	9.95
8	0.186	10.3	79.8	9.94
9	0.187	10.3	79.8	9.93
10	0.187	10.3	79.7	9.93

Variance Decomposition of SERV:

Period	S.E.	MIN	MANUF	SERV
1	0.636	0.000450	21.6	78.4
2	0.655	0.120	25.5	74.3
3	0.683	7.59	23.5	68.9
4	0.789	19.4	28.8	51.8
5	0.791	19.5	28.7	51.8
6	0.791	19.5	28.7	51.8
7	0.798	20.3	28.4	51.3
8	0.798	20.3	28.4	51.2
9	0.798	20.3	28.4	51.2
10	0.800	20.5	28.3	51.2

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Chapter 4 Determinants of copper prices from a structural change perspective

4.1 Introduction

The recent surge in commodity prices and even more so its abrupt end has triggered a debate over the extent to which developments in commodity markets are determined by the fundamental factors of supply and demand. The first explanation cites the dynamic demand by emerging economies, most notably China, which is further exacerbated by tight production capacity and relatively small inventories to meet the new demand conditions, as a driver behind commodity price movements (Humphreys, 2010; 2015; Radetzki, 2006; 2013b; 2017).

Another explanation rests on the observation that financial market participants are more actively engaging in commodity markets, thereby causing deviations from equilibrium price. The main evidence for this explanation is the rapid growth in commodity investments in the past decade by institution, hedge funds and individuals who buy and sell futures and options without an ensuing physical transactions. According to FCA (2014) commodity assets under management by financial investors increased in value from about $13 billion in 2003 to an astounding $450 billion in 2011. It is therefore, reasonable to assume that demand by financial investors was the main cause of the commodity price boom.

Empirical works focusing on the determinants of commodity prices beyond physical supply and demand tend to focus on the oil market. Through constructing the structural econometric model of the world oil market which includes OPEC capacity, OECD crude oil inventories, OPEC quotas and oil demand, Dees et al. (2007) found some evidence that oil demand and non-OPEC supply were rather inelastic to the changes in price, while OPEC decisions had a significant and immediate impact on oil prices. Furthermore, Dees et al (2008) investigated additional factors that might have contributed to the oil price increase between 2004 and 2006 besides supply-demand factor, found most of the increase in oil price during that period could be explained by concerns about future oil market conditions. Due to different methods employed and different sample periods selected, current findings on the relationship between the changes in oil prices and speculation in oil futures market are not in agreement.

Using multivariate financial approach, Cifarelli and Paladino (2009) found evidence that oil price shifts were negatively related to stock price and exchange rate changes during 1992 to 2008, and speculation indeed had played a significant role in the strong oil price fluctuations in recent years. By investigating information transmission over the global main benchmark crude oil spot markets and futures markets, Kaufmann and Ullman (2009) further found out that the surge in oil price before 2008 resulted from fundamentals and speculation together and conjectured that the mechanism of the oil market might have changed in 2004. Sanders et al. (2004) and Haigh et al. (2006) examined the relationship between non-commercial trader reports of the Commodities Futures Trading Commission (CFTC), found that increasing speculative funds were not the cause of the oil price surge in recent years.

On the other hand Stevens (2001) contended that micro managing oil markets is becoming more difficult as the information deteriorates and the drivers of oil prices become unpredictable and at times irrational (pg. 212). Lynch (2002) analyzed oil prices figures in different periods from 1859 to 2002 and pointed out that the path of oil prices is currently very different from what it was in the past, and this may imply the existence of some structural changes.

In the particular case of copper, there are numerous models for the market. Fisher et al (1972) is the seminal work in copper. Their model estimated for the period 1948-1968, divides the world into two separate but linked markets. The first market is the United States, where administered prices or producer prices dominated during the period of study. The second market is the rest of the world, based largely on the prices of the London Metal Exchange. Seven equations describe copper supply: five equations for primary production and two equations for scrap production. Four equations describe copper demand in the United States, Europe, Japan and the rest of the world. Although an important purpose of the model was to assess the impact of potential increases in Chilean output on copper prices and Chilean revenues, the model has perhaps been more influential as a standard against which to compare subsequent models of the copper industry. Charles River Associates (1978), in one subsequent model, incorporate exploration and discovery of new reserves into a copper model.

Wagenhals (1984) creates a complete and disaggregated study of the copper market. The analysis include copper market structure, supply, production capacity, and demand and price formation. Equations of primary supply, mine capacities, total consumption and refined copper consumption, and secondary supply are estimated. Tan (1987) constructed an econometric model for the purpose of long-term projections. The model focus in the market economies with the influence of excess supply and the study covered 1964-1983 period. The study has shown that the copper market has undergone considerable structural changes and give support to the notion that copper demand and supply are price-inelastic, and that copper demand has been influenced primarily by the industrial production of the consuming countries.

Vial (1989) also creates a model of the world copper industry characterized by the disaggregation of the production in mineral ore, blister and refined copper. For these three products, the author estimates short run supply functions including the main producers, and investment functions, and the price equations. Valencia (2005) estimated econometric model of the world copper industry incorporating geographically disaggregated equations of production capacity, primary supply and demand for the largest producers and most important consumers of fine copper. The study demonstrated that stockpiling has a less significant influence over price than production cutbacks. As well, a decrease in the Chinese growth rate of industrial production strongly affects the level of total demand and copper price and the copper price is also sensitive to changes in the dollar strength against other currencies.

Analyzing these studies, we find out that copper market have been econometrically modelled based on supply, demand as well as physical balancing. In the case of the role of financialization and financial speculation in the price of copper in levels the academic literature is confined to Guzmán and Silva (2017). The authors empirically unified the three main determinants of commodity prices including fundamentals, financial speculation and liquidity to explain copper price moves.

The purpose of this paper is to examine the role of financial speculation in the acceleration of copper price moves by providing empirical evidence of financial speculation by quantifying the role of the speculative component in explaining copper price increase. Development of this model led to questions about the market structure and its evolution, resulting in the period analyzed divided into different periods based on various developments that precipitated such structural shifts. Understanding the determinants of copper prices is of first-order importance for global economy given that copper is important for the export earnings of several developing countries. Furthermore, there are a large number of industrialized and developing countries that need huge amounts of copper to continue with their process of development.

4.2 Determinants of commodity prices

Fundamentals

Market fundamentals are considered by many as the only determinants of commodity prices (Radetzki 2008, 2017; Tilton and Guzman 2016). The widely accepted theory is that, in the short term, the critical factor in determining prices is physical demand because supply is inelastic close to equilibrium and not very sensitive to price changes, while, in the long run, it is physical supply that determines price because the supply cost structure generates a practically constant incentive price close to equilibrium.

Even those who most keenly defend market fundamentals as the determinants of commodity prices also recognize that in the short run (for example daily, monthly), mineral prices can be affected by other exogenous variables that can modify the expectations of different agents who operate in the market, altering price behavior with respect to what would be deduced from fundamentals alone. Yet, this effect is assumed to be weak over longer periods of time such as medium and long term (from several months to several years).

There is a relatively broad consensus that, in the long term, price behavior tends to reflect the fundamentals. For example, in industries such as lithium Tilton (2009) and iron ore (Pustov et al. 2013), it has been shown that the long-run supply curve generates a region in which the incentive price remains practically horizontal over a wide range of demand and, in general, the long-term price can, therefore, be calculated exclusively by taking this regardless of the level of demand. In the case of copper, although no academic studies have estimated the physical supply curve, we have found that producers, market analysts, and other agents commonly base all their long-term forecasts precisely on estimation of the long-term supply curve, typically using incentive prices per operation and project.

According Radetzki (2006; 2008) argue on the basis of simple empirical evidence that it is precisely the surprising and sustained increase in demand that explains the last three price booms (the first commodity boom was strongly related to Korean War, the second boom was related to unrest in the Middle East in 1973) in mineral commodity markets. In the case of the latest boom which began in 2003, he argues that the main determinant is a demand shock, prompted by a combination of unprecedented macroeconomic expansion and high intensities of commodity use in a number of emerging nations, notably China. In part, the boom owes its longevity to continued strong economic growth: real world GDP expanded by more than 4%each year over the 2004-2007 period (International Monetary Fund, 2008).

Non-fundamentals

Financial speculation

In the absence as yet of a satisfactory explanation based on fundamentals, theoretically and empirically, attention has increasingly turned to non-fundamentals (that is, factors other than physical demand and supply). Particular interest has been shown in the potential role of financialization of commodity markets and, especially, financial speculation in the latest commodity price boom. The quest for explanations that go beyond the fundamentals also reflects a perception that the price levels and spikes seen during the latest boom cannot be explained only from the standpoint of costs. One of the main reasons historically put forward for thinking that fundamentals cannot fully explain commodity price movements is due to Pindyck and Rotemberg (1990) and has to do with the remarkable empirical co-movement of the prices of different commodities.

It has been argued that at least part of the co-movement of prices could be explained by financial market factors since investors in the market tend not to differentiate between commodities and, therefore, acquire them in aggregate manner. Exponents of the commodities financialization hypothesis argue that this has increased the use made of this asset class for financial speculation by investors who do not seek to hedge the risk of physical sales and purchases but hope to obtain a return by taking a position contrary to their expectations of future price movements.

The literature on the impact of financial speculation on commodity markets is quite extensive, Andreasson et al. (2016), Chan et al., (2015), Cifarelli and Paladino (2009; 2015) and Mellios et al., (2016). Yet, much of the empirical work has focused on energy commodities and, particularly, oil (Kaufmann and Ullman 2009; Dees et al. 2008; and Zhang and Yao 2016). In general the literature considers three effects of financial speculation on commodity markets that can potentially affect prices: herd behavior (Pindycky and Rotemberg 1990), rational speculative bubbles (Emekter et al. 2012), and arbitrage between spot and futures prices in strong contango conditions (Tilton et al. 2011). They all suggest that the effect of financial speculation on commodity prices may exist only in specific periods of time and not be permanent over time.

The empirical arguments that have been put forward to support the hypothesis that financial speculation has affected commodity prices include the financialization of commodities (Liu et al. 2011; and Tang and Xiong 2012) and the testimonies of relevant market agents. In the case of the role of financialization and financial speculation in the price of copper, the academic literature is, to the best of our knowledge confined to Shao et al. 2013. In this paper, the author examine the role of speculation in the formation of possible price bubbles and, using econometric models of the GARCH and EGARCH type, suggest that the investment of funds in commodities is not a significant cause of copper price fluctuations and, in fact, that speculation in this market generally tends to reduce price fluctuations. Importantly, yet, they focus on the effect on price volatility rather than the price level. However, it is more important to explain the role of that financial speculation may play in the level of commodity prices rather than its possible role in price volatility since it is generally in the latter that is recognized to play a significant role and it is in the price level that its importance has been ruled out by exponents of the fundamentals.

4.3 Selection of variables

In an attempt to determine the impact of financial speculation, a regression analysis was developed. Its aim was to relate copper spot price to copper market factor- stocks and financial variables including (financial speculation, and dollar index).

Stock: The increase and decrease of stocks can have substantial effect on short-term supply in mineral commodity markets. Changes in the quantity of mineral commodities stored is of importance for pricing, as these can have a stabilizing as well as destabilizing effect on prices. Stockpiling can stabilize prices if stocks are reduced when prices rise, because the additional supply will limit the price increase. The opposite can also be the case, however, if further price rises are anticipated and stocks are built up (Gocht et al. 1988). Therefore, an inverse relationship between stocks and the price of copper is expected.

Figure 4.1 shows the correlation between copper prices and stock

US dollar exchange rate index: Like most commodities traded internationally copper prices are settled in US dollar, therefore fluctuations in the US dollar exchange rate index play a critical role in driving copper prices (Valencia, 2005 and Guzman and Silva, 2017). When the dollar strengthens against other major currencies, the prices of commodities tend to drop. Similarly, when the value of the dollar weakens against other major currencies, the prices of commodities generally move higher. The latter case was evident from 2002 to 2007 when the US dollar plunged against the currencies of its major trading partners, while on the other hand copper prices were soaring up.

Financial speculation and oil prices: Recent years have seen a rapid growth in the involvement of investors in the commodity markets, inspiring what is called the 'financialization' of commodity markets. There is debate on whether this increased interest is resulting in commodity prices becoming disconnected from fundamentals. The literature on the impact of financial speculation on commodity markets is quite extensive, and much of the empirical work has focused on oil (Kaufmann 2011; Kaufmann and Ullman 2009; and Zhang and Yao 2016). Furthermore, it has been argued that part of the price co-movement could be explained by financial market factors since investors in this market tend not to differentiate between commodities and, therefore, acquire them in an aggregate manner, Arezki et al. (2014).

4.4 Empirical Model and data

4.4.1 Data

The monthly data set to evaluate the structural change and the effects of financial market variables on copper prices include observations of LME copper spot prices, LME stockpile, US dollar exchange rate index, oil price, and speculation open interest data from January 1993 to December 2016. We use LME copper spot prices as the dependent variable because it represents the price paid for physical tonnes obtained from a variety of sources. To evaluate the effect of stockpile on copper prices, we collect data on LME copper stockpile available from LME. WTI spot price is used in this study to evaluate the effects of oil market. The data is sourced from the US Energy Information Administration (EIA). The nominal prices have been deflated using the Producer Price Index (PPI) of the USA, taking all the values to constant 2016 dollars.

To measure the effect of speculation on copper price change, copper futures open interest is used. The data is sourced from the Committee of Traders (COT) reports of the CFTC. The US dollar exchange rate (USDX) factor is measured by the US dollar index representing the value of the US dollar against a basket of foreign currencies. The USDX data is from the website of American Federal Reserve Committee. The data used is transformed from weekly to monthly and unit root test results for all variables using Augmented Dickey-Fuller (ADF) test and Phillip-Perron (PP) test are given in Table 1. All the variables have unit root therefore are converted to be stationary by taking the first difference.

Table 4.1: Unit root tests results

	ADF		PP		Order of integration
	Level	1st diff	Level	1st diff	
PRICE	-1.33	-11.1**	-1.20	-11.1**	I (1)
STOCK	-2.34	-10.8**	-2.12	-19.4**	I (1)
USDX	-1.54	-11.9**	-1.42	-11.9**	I (1)
OIL PRICE	-1.95	-13.1**	-1.87	-12.8**	I (1)
OPEN INTER	-0.818	-15.0**	-1.26	-22.7**	I (1)

Note: Table 1 reports the unit root tests for all the variables (null hypothesis: there is a unit root). All the variables have a unit root in levels, but rejected the null hypothesis at 5% significance level denoted by **.

4.4.2. Structural characteristics of the copper market

Since the variables impact probably change over time, structural breakpoints were taken into account. In our study we consider the data generating process in the copper price with m breaks (m+1 regimes);

$$y_t = z_t' \delta_j + u_t \quad t = T_{j-1} + 1, \dots, T_J \qquad (1)$$

For $j = 1, .., m + 1$. This is a general model of Bai and Perron (1998, 2003) corresponding to a pure structural change model. Here y_t is the observed dependent variable at time t; $z_t\ (q \times 1)$ is a vector of covariates and $\delta_j (j = 1, .., m + 1)$ is the corresponding vector of coefficients; u_t is the disturbance at time t. The indices $(T_1, .., T_m)$, or breakpoints are explicitly treated as unknown. The method of estimation is based on the least squares principle. For each m-partition $(T_1, .., T_m)$ the associated least-squares estimates of δ_j are obtained by minimizing the sum of squared residuals.

$$S_T(T_1,..,T_m) = \sum_{i=1}^{m+1} \sum_{t=T_{i-1}+1}^{T_i} (y_t - z_t'\delta_i)^2 \qquad (2)$$

Let $(\{T_j\})$ denote the resulting estimates based on the given m-partition $(T_1,..,T_m)$ denoted $\{T_j\}$.

Our equation specification consists of the dependent variable (LME copper spot price) and a single (constant), and allows for serial correlation that differs across regimes through the use of HAC covariance estimation. We allow up to three breaks in the model, and employ a trimming percentage of 20%.

Bai-Perron tests of L globally optimized breaks against the null hypothesis of no structural breaks along with the corresponding UD_{max} and WD_{max} that is Double maximization tests are used to test for the existence of breaks. Bayesian Information Criterion (BIC), Yao (1988) is used to find the number of breaks. According to Hall et al. (2013), BIC criterion provides reliable information for structural breaks inference even in the presence of serial correlation.

Figure 1 shows the three shifts or breaks in November 1997, January 2005 and October 2009 respectively. Through investigating the historical events and market situation around the breakpoints, we could find some relevant evidence economically. The breakpoint in November 1997 correspond with the period of Asian financial crisis caused by assets bubbles. The impact of Asian regions reduced business activity thus demand was felt in many commodity markets. Among the metals, copper prices declined by 36% between June 1997 and February 1998 (UNCTAD, 1998). Around this breakpoint commodity markets, copper included suffered from the slowing of global growth. The first reason was the deep economic recession that followed the oil crisis of the late 1970s. The second reason was the economic slowdown and eventual collapse of the Soviet Union. Between 1990 and 2000, the economies of the former Soviet Union shrank in size. Both these developments had a severe negative impact on demand for minerals (Humphreys 2015). There was too much mine capacity and mineral prices were persistently weak and investors had largely lost interest in mining.

The breakpoint in June 2004 coincided with the rapid increase in commodity prices, copper included. The rapid growth in China's demand for minerals prompted a corresponding need for rapidly increased supply. After years of underinvestment the market was unable to respond to the upsurge in Chinese demand. The scale and persistence of the resulting price increases had by 2005 given rise to the notion that commodity markets were embarked on super-cycle driven by expanding demand from China and other emerging market countries. There were also suggestions that a rise in investor interest in commodities was serving to exaggerate price movements. According (Kaufman, 2010; UNCTAD, 2009; Gilbert, 2010) financial speculation was the driver of commodity price boom.

The breakpoint in October 2009 corresponds with the world financial crisis caused by credit crunch. Two peaks occurred in commodity prices in 2008 and 2011, and this is explained by the occurrence of the recession of 2008-2009 triggered by the financial crisis. According to Radetzki and Warell (2017) this crisis made only a short-run impression on the major commodity indices. This is explained by the fact that the recession mainly afflicted the advanced economies, while economic growth among the recently dominant commodity consumers of emerging and developing Asia experienced only a short-dip followed by an impressive recovery.

According to the analysis above, it could be considered that the copper market had undergone 3 structural changes since 1993 to 2016. We therefore divide copper price characteristics into four periods based on the breakpoints: Period 1 (January 1993 to October 1997); Period 2 (November 1997 to December 2004); Period 3 (January 2005 to September 2009) and Period 4 (October 2009 to December 2016). The results are supported by Guzmán and Silva (2017), who identified two breakpoints related to Chinese boom and financial speculation, and financial crisis in a different period of time studied. Our study further identified a breakpoint related to a prolonged deep economic recession, economic slowdown and Asian financial crisis that resulted in too much mine capacity and weak mineral prices.

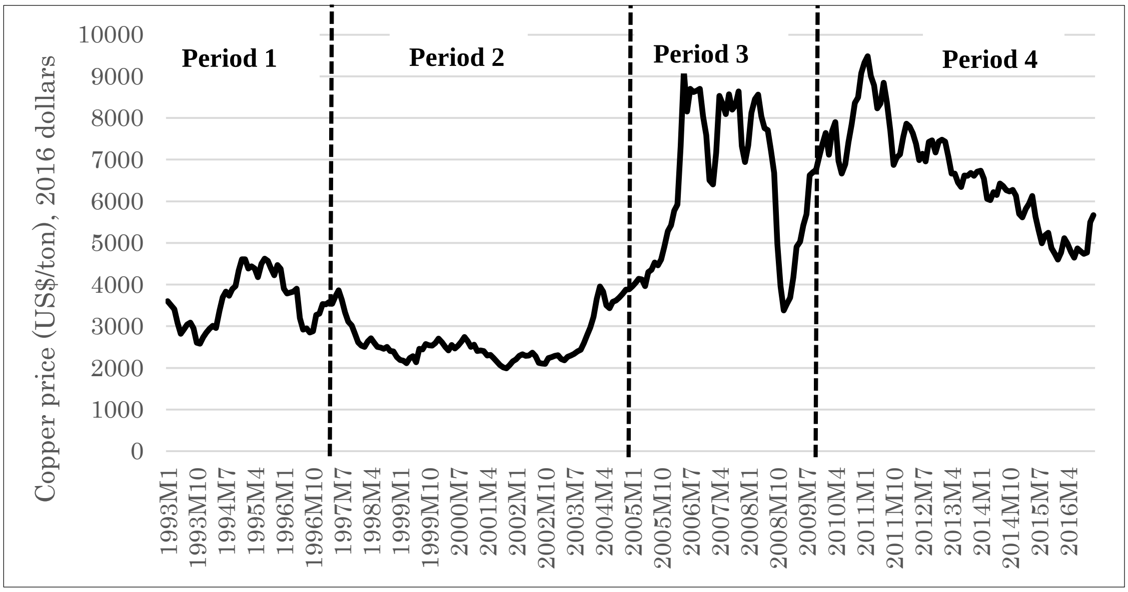

Figure 4.2 shows different structural change periods in copper prices

4.4.3. Econometric analysis of copper price determinants

To determine the effects of different factors on copper price changes, least squares regression analysis for copper price changes to various drivers is constructed. The model considers the relationship between real spot copper price and copper lagged price (one month lag), copper stockpile, USDX, real oil price and speculation open-interest, and the model is established as follows:

$$p_t = \alpha_i + \beta_{oi}(L)p_t + \beta_{gi}S_t + \beta_{ui}USDX_t + \beta_{pi}O_t + \beta_{xi}F_t + \varepsilon_t \quad (3)$$

Where $i = 1,2,3,4,$ corresponds to the four sample periods ("March 1993 to October 1997"; "November 1997 to December 2004"; "January 2005 to September 2009" and "October 2009 to December 2016," respectively; P_t is the real LME copper spot price at time t; S is the

LME stockpile at time t; USDX is the US dollar exchange rate index at time t; O is real WTI crude oil price at time t. F denote open-interest at time t and ε_t is the error term. All the variables are expressed in first log-differences and L is the lag operator.

4.5 Results

4.5.1. Period 1 (March 1993 - October 1997)

In period 1 the results indicate that the copper price changes are affected by its lagged price and stockpile only. USDX, oil price and open interest are not significant, which may mean they are not the main driving forces in this period to explain changes in copper price. Specifically, 10% rise in P_t (-1) is associated with 3.12% increase in copper price, while an increase in stockpile reduce copper price changes by 1.29%. The diagnostic tests of all the regression models are valid.

4.5.2. Period 2 (November 1997 – December 2004)

In period 2 the results indicate that all variables are not significant to explain copper price changes except its lagged value, P_t (-1). Specifically, a 10% increase in P_t (-1) is associated with 3.27% increase of changes in copper spot price. According to (Plunkert and Jones, 1999) this period has experienced large global surplus partly explained by Asian financial crisis in 1997 and early 2000's economic recession therefore is quite reasonable to have copper price changes explained by its previous historic price.

4.5.3. Period 3 (January 2005 - September 2009)

In this period the adjusted R^2 value is 51.3%, and is the highest as compared to other sub-periods. The diagnostic tests are validated for the regression. The P_t (-1), USDX, oil price and open interest significantly affect the copper price changes. Open interest is significant in this period and also the oil price. Specifically, when open interest increase by 10%, copper price change rise by 2.73% and 2.78% for 10% increase in oil price. All things equal, the results would imply that an increase in open interest would have a positive effect assuming a direct causality. The results indicate that financial speculation played a role in the acceleration of copper prices. Our results further indicate that oil price has a positive effect together with financial speculation, which could support the view that financial speculation explain part of co-movement of commodity prices.

4.5.4. Period 4 (October 2009 - December 2016)

Copper price change are significantly affected by price (-1), and USDX. Diagnostic tests are valid. Price (-1) positively affect copper price changes, whereas USD had a negative effect. Specifically, 10% rise in price (-1) resulted in 1.80% increase in copper price changes. While a 10% increase in USDX is associated with 13.54% decrease in copper price changes. As compared to Period 3, speculation and oil price are not significant in this period. This could be explained by financial crisis, which according to Radetzki and Warell (2017) had a short-run impression on the major commodity indices.

Table 4.2: OLS estimation based on structural breakpoints

	Period 1	Period 2	Period 3	Period 4
Constant	-0.000814 (0.913)	0.00405 (0.385)	0.00278 (0.7903)	0.00331 (0.5085)
P_t (-1)	0.312** (0.0125)	0.327*** (0.0019)	0.261** (0.0196)	0.1802* (0.0712)
Stock	-0.129*** (0.0054)	-	-	-
USDX	-	-	-1.517** (0.0175)	-1.354*** (0.0001)
Oil price	-	-	0.273** (0.0234)	-
Futures	-	-	0.277** (0.0191)	-
Adj. R-sq.	0.230	0.110	0.513	0.218
D-W	2.00	2.09	1.97	1.88
LM test	0.229	0.236	0.991	0.605
Heteroscedasticity test	0.882	0.655	0.226	0.339

Note: "-" indicates that the variable is not significant even at the 10% level and is removed from the equation. The numbers in parentheses represent probability. ***, **, * represents that a statistic is significant at the 1%, 5% and 10% significance levels, respectively. The Breusch-Godfrey serial correlation LM tests residual autocorrelation. Null hypothesis: there is no residual autocorrelation. The Breusch-Pagan-Godfrey tests for heteroscedasticity. Null hypothesis: there is no heteroscedasticity.

4.6 Analysis and discussion

According to the results, we find evidence that financial speculation accelerated copper price moves during the last price boom. In period 1, price (-1) and stockpile produced significant effects on copper prices changes. USDX, open interest and oil price didn't seem to play a significant role in explaining changes in copper prices. While in period 2 all variables are insignificant to explain changes in copper prices except historical copper prices. According to (Plunkert and Jones, 1999) during this periods copper market experienced stagnant world demand and rising inventories; LME intervention in the market that caused sharp price drop; strong global demand growth and sharp inventory decline. Furthermore commodity markets experienced Asian financial crisis and suffered from the early recession of 2000's. Humphreys (2015) refer to the period from 1975-2000 as the barren years for the mining industry because of economic slowdown and declining intensity of use of commodities by Western economies. These events could explain why some of the variables are insignificant.

In period 3, stockpile is not significant, whereas lagged price, speculation, US dollar exchange rate index and oil price are significant to explain changes in copper prices. In this period, strong economic growth in the world led to excess speculation and market fundamentals such as US dollar exchange rate market and oil market were very active in trading. All of these added to the upward pressure on price. Compared to other periods, the copper prices in this period fluctuated more violently and were more sensitive to different kinds of market information. The results are supported by Guzmán and Silva (2017) that financial speculation have accelerated and amplified prices of copper movements between 2005 and 2008. In period 4, price lag and US dollar exchange rate index have a positive and negative effect respectively and are statistically significant whereas speculation, oil price and stockpile are not.

4.7 Conclusion

From the late 1990s to 2003, the LME copper prices sat below US$2000 per tonne. It climbed sharply in 2004, peaking mid-2006 at almost US$9000/tonne and it has since been characterized by high fluctuations. This paper has examined the determinants of copper price changes over the time period from 1993 to 2016, with particular interest on the role played by financial speculation. Using least squares with breakpoints our study first test and estimate the number of breakpoints in real copper prices and then examines the effects of drivers of copper price changes under different breakpoints using least squares regression analysis. The results indicate that from January 1993 to December 2016, LME real copper spot prices have been characterized by structural changes and its determinants varies. Most importantly our study indicates that financial speculation amplified the fluctuation of prices during the price boom period contributing to the conclusion that fundamental forces alone cannot explain the price moves.

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Chapter 5 Conclusion

Currently the mixed structured open economy of Botswana is largely dependent on mineral revenue mainly from diamond sector and to a lesser extent copper-nickel. The current setup in which the mineral sector is responsible for a significant portion of economic growth (GDP), export earnings and government revenues hence expenditure, is constantly viewed as an economic danger looming given that the diamond sector is mature thus nearing depletion, while on the other hand the base metal industry is faced with challenges of high operation costs, low grade deposits and low commodity prices. It is critical to recognize that policy changes may be required in response to changing circumstances in the mining sector as mineral resources deplete. Moreover, the economic impact of mining is likely to change as it becomes less important as a driver of growth. This study is concentrated on the impact of mining sector on economic development of Botswana for the purpose of contributing to the national development plan of developing diversified sources of economic growth through beneficiation and use of domestic expenditure as a source of growth. Below presents a summary of our research results.

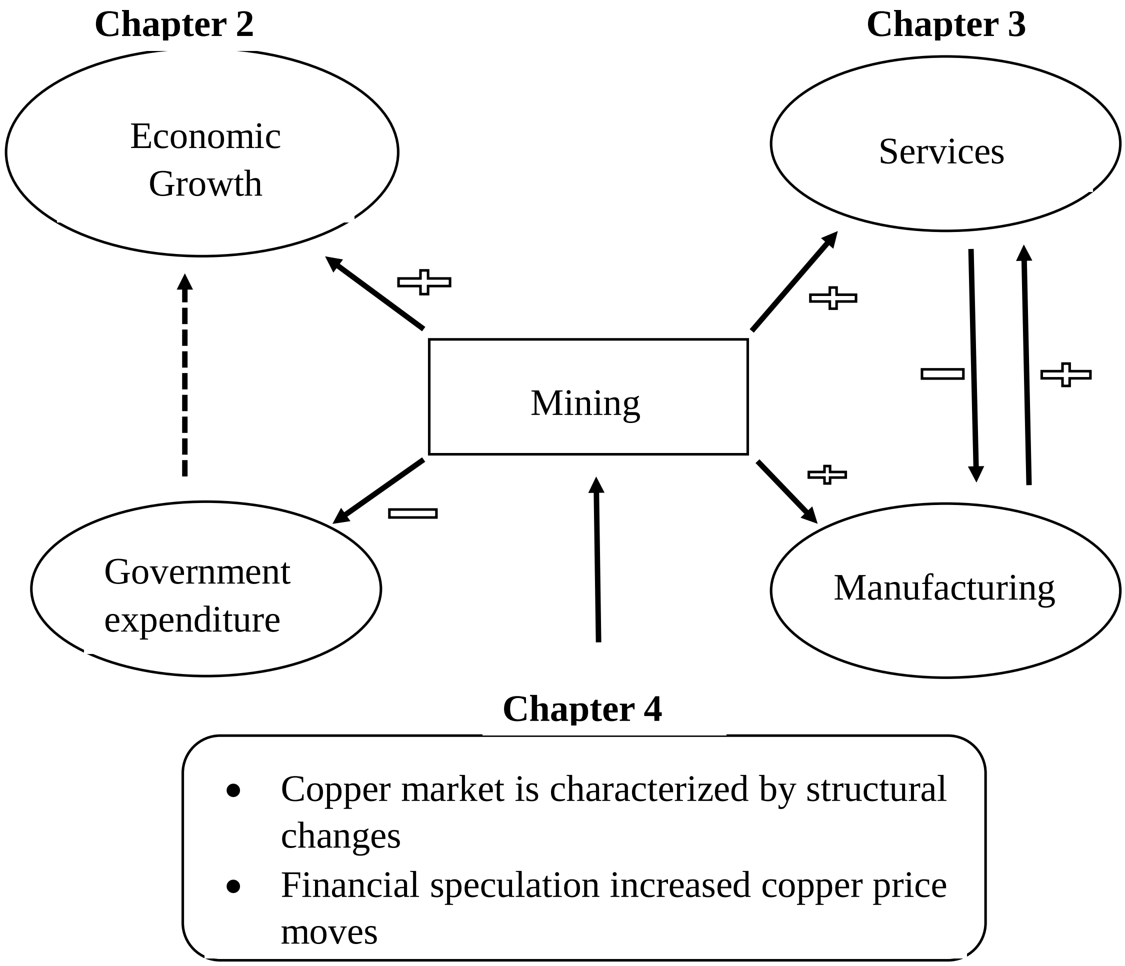

Figure 5.1 summarizes the results of the whole study

This thesis is structured around three studies. The second chapter analyzes the dynamic relationship between mineral revenue, government expenditure and economic growth in Botswana. Given the high degree of dependence in mineral revenue, a comprehensive analysis that considers the main transmission channel of mineral revenue shocks on the Botswana economy is vital. It is important to examine the relationship between mineral revenue and government expenditure to empirically reveal the nature of fiscal policy in Botswana. Furthermore, given that mineral revenue finance government expenditures, it is crucial to empirically find out if the latter contribute to economic growth. Our results reveal that mineral revenue determine both government expenditure and economic growth. Granger-causality results reveal no linkage between government expenditure and economic growth. Furthermore, the results reveal that there is negative relationship between mineral revenue and government expenditure. This negative relationship, suggests that fiscal policy is counter-cyclical in nature and this is recommended for other mineral resource dependent economies. However, lack of causality between economic growth and government expenditure indicates that Botswana's countercyclical fiscal policy is ineffective. Our study present policy implication that Government of Botswana should continue with a counter-cyclical fiscal policy, yet they should come up with a fiscal rule that earmark the percentage of mineral revenue to be invested on capital formation and in particular mineral beneficiation and downstream projects that can diversify the sources of government revenue. Furthermore is important that the government reorient public expenditure focusing on improving the quality of spending through enhanced public expenditure management.

Chapter 3 examines the linkages between mining and non-mining sectors in the economy of Botswana. Our analysis suggest that mining sector determines both manufacturing and services, generating positive spillovers and also help predict the growth of the two sectors. The results suggest a backward linkage from mining to other sectors. The study reports that mineral revenue shocks predominantly affects the services sector as compared to the manufacturing sector in Botswana. However, the estimated size of spillovers seems modest, which raises the question of the potential for mining to be better integrated with the rest of the economy or suggesting that there is a room for mining to generate stronger linkages to rest of the economy, particularly to manufacturing and services. For a more complex and integrated economy to be realized, a forward linkage is necessary, where mineral outputs will be used as inputs in other sectors rather exporting raw materials.

The fourth chapter is focused on the structural change on copper market and determinants of copper prices. The study applies the structural change testing methods of Bai and Perron (1998, 2003) and Yao (1988) to the problem of locating and identifying significant changes in the LME copper market. We use these methods to investigate monthly LME spot prices from January 1993 to December, 2016. Our results reveal that significant structural breaks took place on November, 1997, January 2005 and October 2009 and these dates are validated by international economic events such as Asian financial crisis, world rapid increased demand for commodities and world financial crisis. The results show the existence of structural breaks refutes the utility of investigation of the full sample as a whole. And in different structural periods the main drivers of copper price changes and their way of influence and degree are significantly distinct. Most importantly the results indicate the influence of speculators and investors in copper price changes. Overall, the results indicate that it is necessary to unify market fundamentals and financial variables in order to explain copper price moves. It is very probable that the future evolution of copper prices will be determined not only by physical demand but also to a significant extent by the level of financial speculation in mineral commodities.

As the overall conclusion, our study indicates that mining sector has a positive impact on the economic growth and development of other sectors in Botswana. The results also indicate a negative relationship between mineral revenue and government expenditure which imply a countercyclical fiscal policy, the policy appears to be ineffective as our results indicate no causation between economic growth and government expenditure. Our study find no evidence of linkage from other sectors to the mining sector, which entail lack of forward linkage in the economy. Furthermore, the results reveal that financial speculation exaggerated copper price moves.

It is necessary for the government of Botswana to address the effectiveness and return on government expenditure as it appears that the fiscal policy is not effective. There is a need for the government to come up with a fiscal rule that specify the percentage of mineral revenues that should be spent on capital formation and in particular beneficiation initiatives to ensure that the remaining mineral resources are used to build a robust fiscal position of Botswana and also to sustain economic growth and development. The exhaustible nature of minerals, diamonds in particular requires the government to combine the ability to tax with the ability to invest productively.