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Article

Gold Production and the Ghanaian Economic Performance

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Abstract: The paper investigates the contribution of gold production and export to the Ghanaian economy. In contract, our research findings demonstrate that, the availability of natural resources (gold) and its ability to attract foreign investment does not guarantee economic development. The establishment of appropriate institutions, mechanisms and policies would ensure efficient use of gold revenue for sustained economic growth. We identified vital policy options available to Ghana. Gold production could thus attract more foreign direct investment and contribute to the economic development of Ghana only on condition that appropriate gold revenue management policies are implemented.

Keywords: Gold Mining Industry, Gold Production, Gold Revenue Management, Economic Development, Gold Coast Colony.

1. Introduction

Ghana contains the second largest area of gold deposit in Africa. The country derives the bulk of its external revenue from gold mining which accounts for over 90 percent of Ghana's total mineral export. The mining sector has played a key role in the development of Ghana's economy with production increasing significantly; the contribution of the mining sector to GDP has risen steadily from about 13 percent in 1991 to 62 percent in 2008. The industry also contributed 44 percent of the country's gross export revenue in 2008 and accounted for about 14 percent of fiscal receipts. The

favourable investment climate introduced in the mid - 1980s attracted an estimated 250 local and foreign companies into mineral exploration. Yet gold mining tends to be perceived negatively in Ghana, and is seen as providing far less than it should in term economic development.

Mining is the process of digging into the earth to extract naturally occurring minerals. It is the world's second oldest and most important industry (Down & Stocks, 1977). It is currently the fifth largest industry in the world and it plays a crucial role in world economic development. The trade of mineral commodities represents a substantial part of international trade (Madeley, 1999). There are two kinds of mining: surface and underground mining. Surface mining, also called open-pit mining or strip mining is undertaken if the mineral deposit lies on the surface of the earth. This method is usually more cost-effective and requires fewer workers to produce the same quantity of ore than the underground mining does. Underground mining on the other hand is used when the mineral deposit lies deep below the surface of the earth. Mining investment, irrespective of the type or kind of mining being undertaken is capital intensive. It is a high-risk as well as a high reward business for mining companies and communities (Wood, 1999).

Ghana has fairly a checklist of mineral resources including gold. Issues of mining are in the wake because of the increasing demands for mineral products and diminishing nature of such minerals. This seemingly opportunity for developing countries like Ghana which have mineral deposits comes with its accompanying repercussions. This paper looks at the general mining industry especially gold mining in Ghana, the impact and contributions of gold production and export to the Ghanaian economy, as well as the emerging trends of the industry in terms of law enforcement.

This research identifies that, with the international mining industry becoming more cosmopolitan, developing countries like Ghana will have to develop a competitive mining regime based on greater economic equality, mutual benefit and in accordance with generally accepted notions of fairness.

The trade of mineral commodities represents a substantial part of international trade (Madeley, 1999). The historical importance of mining in the economic development of Ghana is considerable and well documented, with the country's colonial name Gold Coast, reflecting the importance of the mining sector, particularly, the gold trade to the country (Agbesinyale 2003; Akabzaa 2000). The country has a long tradition of gold mining with an estimated 2,488 metric tons (80 million ounces) of gold produced between the first documentation of gold mining in 1493 and 1997 (Kesse, 1985; Ghana Chamber of Mines, 1998). The country also accounted for 36% of total world gold output (8,153,426 ounces) between 1493 and 1600 (Tsikata, 1997).

To stimulate investment into the minerals economy in Ghana, from 1985 onwards, the government implemented series of laws and policy measures to create an effective regulatory

framework for the mining industry (Akabzaa, 2000; Iddrisu and Tsikata, 1998). This led to the liberalization of the mining sector with the government selling out the majority of shares of state owned mines to private companies most of which were of foreign decent.

Gold mining, in fact, is held to create impoverishment and environmental hazard in mining communities which scar rather than benefit the country. In very general terms, there is the believe that, a century after commercial mining began in what was then the Gold Coast, the country is still getting a raw deal" (Burgis, 2010). To this end, this research seeks to analyse the performance of the gold mining industry and its relative impact on the socio-economic development in Ghana.

The main objective of the study is to evaluate the relative impact of gold on the Ghanaian economy and its populace.

2. History and the Economy of Ghana

Gold has been produced for over 1,000 years in the territory of the Ancient Kingdom of Ghana, the Gold Coast Colony and post-independence Ghana. Large-scale industrial gold mining in Ghana dates back to the last quarter of the 19th Century (Hilson, 2002). After a period of decline under government control in the nationalist era in the twenty years from the early 1960s, the industry was restructured and modernised under the post-1983 Economic Recovery Programme (ERP), which prominently featured a revised mining code exemplified in new legislation, the Minerals and Mining Law (PNDCL 153) of 1986.

Since the mid-1980s, gold mining has seen sustained increases in foreign investment, output, and export volumes. From 1980 to 2000, production increased some 700%, with a record output, to that point, of 2.6 million oz. in 1999. Gold, which then comprised 97% of mineral exports, became the country's leading contributor to overall exports, at around 37% of their value. After a brief interruption during a period of gold price weakness at the turn of the century, the industry resumed its upward trajectory. The global rally in the gold price which began in 2001-2002 has not flagged since, as gold has risen from around $300/oz. in early 2002 to over $1,400/oz. in the last quarter of 2010. This level has been maintained through the first quarter of 2011, with record highs close to $1,500/oz. reached in March.

The Ghanaian industry has benefitted substantially from this boom, what the World Gold Council terms "the 10-year gold bull market" (2010). Production volumes were over 2 million oz. through the past decade, rising gradually to 2.62 million oz in 2007 and to 2.84 million oz in 2008.In 2009, the last year for which figures are currently available, there was an increase to a record 3.12 million oz., with gold revenues some $600 million higher than in 2008, at $2.8 billion.

Facilitated by a further revised mining code that was consolidated in the Minerals and Mining Act 703, 2006, investment in the industry increased to a figure of $3 billion for the four years to 2009. Gold now accounts for around 43% of Ghana's exports. Mining's contribution to Gross Domestic Product(GDP), of which gold still represents some 95%, was 5.8% in 2009, up only a percentage point from 1990, but still higher than Ghana's other main export commodities, cocoa (3.9%) and forestry (3.2%).

By 2009, then, Ghana had become the world's ninth largest producer of gold, at some 3.8% of global production, up from 2.6% five years earlier. The Birimian and Tarkwaian gold belts (known as greenstone belts) which characterise the western half of Ghana and which host gold mineralisation that contains both hard rock and placer (alluvial) gold deposits continue northwards and westwards into the broader region. Ghana is thus simultaneously at the forefront of an up-and-coming West African industry, as production increased significantly in the neighbouring countries.

3. The Gold Industry in Ghana

More than 90% of gold production in the early 1990s came from underground mines in western and Ashanti Region, with the remainder coming from river beds in Ashanti Region and Central Region. During the early 1990s, Ashanti Goldfield Corporation (AGC), Ghana's largest gold producer) saw its overall share of the domestic gold market decline from 80% to 60% as other operators entered the industry. In 1992, Ghana's gold production surpassed 1 million fine ounces, up from 327,000 fine ounces in 1987. In March 1994, the Ghanaian government announced that it would sell half of its 55% share in Ashanti Goldfields Corporation (AGC) for an estimated US$250 million, which would then be spent on development projects. The authorities also plan to use some of the capital from the stock sale to promote local business and to boost national reserves.

In the gold sector, Red Back Mining Inc. of Canada, [through its subsidiary Chirano Gold Mines Ltd. (CGML)] operated the Chirano gold mine; AngloGold Ashanti Ltd. of South Africa operated the Bibiani, the Iduapriem, and the Obuasi gold mines; Golden Star Resources Ltd. of Canada operated the Bogoso/Prestea, the Prestea Underground, and the Wassa gold mines; Gold Fields Ltd. of South A Africa operated the Damang gold mine; and Denver-based Newmont Mining Corp. had interest in the Ahafo and the Akyem gold properties.

In October 2005, Red Back Mining of Canada [through its subsidiary Chirano Gold Mines Limited (CGML)] commissioned a new mine in Ghana. The mine, known as the Chirano gold mine, was an open pit operation located about 21 kilometers (km) to the south of AngloGold Ashanti's Bibiani gold mine in western Ghana. The Chirano gold mine produced 941 kilograms (kg) (reported as 30,247 troy ounces) in 2005 and was 100% owned by Red Back; the Government had the option to

exercise its right to back into a 10% ownership in CGML. Chirano was scheduled to produce an average of about 3,800 kg (reported as 123,000 troy ounces) per year during a period of 8½ years. The designed capacity of the processing plant was 2.1 million metric tons per year (Mt/yr). In 2005, gold production at the Bibiani Mine came from the processing of ore from the mine's remaining pits, stockpiled ore, and tailings. Satellite pits were depleted in December 2005, and AngloGold Ashanti expected stockpiled ore to be depleted by January 2006. Beginning in February, the mill was to process only old tailings. The Bibiani Mine, which had operated between 1903 and 1968 as an underground mine, was reopened in 1998 as an open pit mine with a carbon-in-leach (CIL) plant. The mine included old tailings dumps, which were reclaimed in December 2004. These tailings were expected to yield about 3.9 million metric tons (Mt) of ore at an estimated recovery grade of 0.60 gram per metric ton (g/t) gold during a period of 18 months.

The company was studying the viability of restarting production from its main pit to a depth of about 60 meters below the current pit floor. Underground exploration was suspended in July 2005 and the underground mine continued to be on care-and-maintenance status

Gold production at the Iduapriem open pit mine increased to 6,380 kg in 2005 (reported as 205,000 troy ounces) from 4,570 kg in 2004 owing to an increase in throughput at the processing plant. AngloGold Ashanti held an 80% interest in the Iduapriem Mine; the remaining 20% was held by the International Finance Corporation. The company also held a 90% interest in the Teberebie Mine, which is adjacent to the Iduapriem Mine; the Government held the remaining 10% interest.

In 2005, gold production at the Obuasi underground mine was hindered by a breakdown at the main processing plant during the first quarter of 2005 and the failure of a primary crusher during the third quarter; production, however, increased to 12,200 kg (reported as 391,000 troy ounces) from 7,930 kg in 2004 mostly owing to the start of mining from the Kubi surface oxide deposit.

In terms of growth prospects, the company planned to develop the deep-level ore deposits at Obuasi known as the Obuasi Deeps, which were expected to extend the project's mine life to 2040. The development of Obuasi Deeps will require an initial investment of $44 million during the next 4 years to conduct further exploration and feasibility studies. The total capital expenditure for the development of the Obuasi Deeps was estimated to be about $570 million. AngloGold Ashanti held a 100% interest in the Obuasi Mine.

The Wassa open pit gold mine produced 2,149 kg of gold in 2005. The mine, which is located about 150 km west of Accra, was owned by Golden Star (90%) and the Government (10%). The mine had been in operation as an open pit heap-leach mine in the 1990s but was closed in 2001. Golden Star acquired the mine in 2002 after determining that conventional CIL processing was economically feasible. Plant feed in 2005 was a mixture of newly mined ore from the Wassa pit blended with

material from the heap-leach pads left by the previous operation. Golden Star's planned to increase production at Wassa to about 3,700 kg (reported as 120,000 troy ounces) in 2006 and to produce about 4,000 kg (reported as 130,000 troy ounces) in 2007 as higher grade ores are reached at deeper levels. As of December 31, 2005, total probable mineral reserves at Wassa were reported to be 21.9 Mt at a grade of 1.34 g/t gold.

In addition to the Wassa Mine, Golden Star operated the Bogoso/Prestea open pit mine, which is located about 300 km west of Accra. Bogoso/Prestea produced 4,103 kg of gold in 2005. Golden Star held a 90% interest in the property, and the Government of Ghana held the remaining 10%. About 75% of the remaining ore reserve at Bogoso/Prestea is sulfide. Because this type of ore cannot be processed using the company's existing CIL plant, the company decided in June 2005 to build a new 3.5-Mt/yr processing plant which will use biooxidation to treat the remaining sulfide ore.

The Prestea Underground gold mine, which is also 90% owned by Golden Star, remained idle during the year. Prestea Underground was closed in early 2002 owing to low gold prices. During 2005, a total of 8,096 meters of underground exploration drilling was completed at the mine; drilling was to continue in 2006. Golden Star planned to complete a prefeasibility study by the end of 2006 to evaluate the economic potential of restarting production at Prestea Underground. As of December 31, 2005, inferred mineral resources at the mine were estimated to be 6.1 Mt at an average grade of 8.1 g/t.

In 2005, Newmont announced that the company was advancing the Ahafo and the Akyem gold properties to production. The Ahafo property, which is located about 300 km northwest of Accra between the towns of Kenyase and Ntotoroso, was expected to begin production during the second half of 2006. Production of gold was expected to be about 17,100 kilograms per year (kg/yr)(reported as 550,000 troy ounces), with a mine life estimated to be more than 20 years. The company was awaiting the issuance of a mining license for the development of the Akyem property, which is located in Ghana's eastern region, about 130 km northwest of Accra between the towns of New Abirem and Ntronang. Newmont expected to begin production at Akyem in 2008 and to produce about 15,500 kg/yr of gold (reported as 500,000 troy ounces).About 19.6 Mt of ore was processed at Tarkwa in 2005 from which 21,051 kg of gold was produced (Gold Fields Limited, 2006§).

In November 2005, a new semi autogenous grinding (SAG) mill and Carbon-In-Leach (CIL) plant were commissioned at the Tarkwa Mine. The Tarkwa Mine, which is located in southwestern Ghana about 300 km west of Accra, consists of several open pit operations, one Carbon-In-Leach (CIL) plant, and two heap-leach facilities. Some underground mining had been conducted in the past, but underground operations ended in 1999.

As of June 30, 2005, proven and probable reserves at Tarkwa were estimated to be about 417,000 kg of gold (reported as 13.4 million troy ounces) and to last until 2025 at current production rates.

The Damang Mine, which is located in the Wassa West District in southwestern Ghana about 360 km west of Accra and 30 km northeast of Tarkwa Mine, consists of an open pit operation, a SAG mill, and a Carbon-In-Leach (CIL) plant. The mine processed about 5.2 Mt of ore in 2005 and produced about 7,700 kg of gold. Owing to the depletion of the high-grade ore in the main Damang pit, an exploration program to seek for alternative ore sources was launched during the year. The exploration program resulted in the establishment of the Amoanda, the Rex, and the Tomento pits, and the extension of an old pit at Kwesie-Lima.

Gold Fields and its partners reported that production from the new pits was to be processed along with stockpiles of lower grade ore. Mining of the Tomento pit began in July 2005 and mining of the Amoanda pit began during the fourth quarter of 2005; production from the Rex pit was scheduled to begin in 2007.

As of June 30, 2005, proven and probable reserves at Damang were estimated to be about 40,000 kg of gold (reported as 1.3 million troy ounces).

4. Government Policies and Programs

The legislative framework for the mining sector in Ghana was provided by the Minerals and Mining Act 703 of 2006. Under the law, all minerals are owned by the state, and the holder of a mining lease or small-scale mining license must pay a royalty of not less than 3% and not more than 6% of their gross revenues.

In the metals sector, reconnaissance licenses may be granted for an initial period not exceeding 12 months and may be extended only once for a period not exceeding an additional 12 months. A prospecting license may be granted for an initial period not exceeding 3 years and may be extended only once for a period not exceeding an additional 3 years. Upon the expiration of a reconnaissance or prospecting license, the holder may apply for a mining lease. A mining lease may be granted for an initial term not exceeding 30 years and may be extended only once for a period not to exceed an additional 30 years. The Government is entitled to a free-carried equity interest of 10% in all mineral ventures (Parliament of the Republic of Ghana, 2006)

In the industrial minerals sector, reconnaissance and prospecting licenses and mining leases can be granted only to Ghanaian citizens unless the proposed investment exceeds $10 million. Small-scale mining licenses are also reserved for Ghanaian citizens only and are granted for a period not to exceed

5 years and, upon the expiration of the license, it may be renewed for a period to be determined by the Minerals Commission (MC) (Parliament of the Republic of Ghana, 2006).

On November 24, 2009, a workshop organized by the Ghana Chamber of Mines to discuss Government policy on artisanal and small-scale mining was held in the capital city of Accra. The workshop included representatives from the different Government agencies, departments, and ministries that oversee the mining sector, as well as representatives from private industry, the National Association of Small-Scale Miners, and several nongovernmental organizations. The Small Scale Mining Law PNDCL 218 of 1989, which legalized the operations of small-scale miners, was repealed under the country's current mining law and the Chamber of Mines advocated for the reestablishment of the 1989 law, claiming that it would benefit local economic development and help curtail illegal mining (Ghana Chamber of Mines, 2009).

Airborne geophysical surveys and detailed geologic field mapping were being conducted on about one-third of Ghana's surface area with the support of the European Union under a program known as the Mining Sector Support Program (MSSP). The program was to include the development of an information management system, which would involve the development of various databases, the creation of an intranet to link the various Government agencies involved in the mining sector, and the creation of a Ghanaian mining Web site. During the year, the Ministry of Finance and Economic Planning reported that about 45% of the country's available geological data, which was to assist prospective investors in the timely capture, analysis, and provision of mineral-related data, and entered into one of the planned database systems.

Other projects completed under the MSSP included surveys of the Keta and Voltarian Basin conducted using satellite imagery and magnetic spectrometry; regional time domain electromagnetic airborne surveys for six selected areas (not specified); map sheets for the Central, the Upper West, the Western, and the Volta Regions; and the collection of 1,200 geochemical samples to assist in the exploration of prospective mineral deposits.

In addition, the first phase of a mercury pollution abatement project under which 14 training sessions were organized for small-scale miners was completed for seven mining district centers.

5. Contribution of the Mining Industry to the Ghanaian Economy

The mining sector of Ghana received priority attention unrivalled by any other sector in the country under the Economic Recovery Program (ERP) in 1983. Apart from the general macro-economic policy reforms for the country, there were specific sector policy reforms that sought to boost investor interest in the mining sector. For instance, between 1984 and 1995, there were significant institutional development and policy changes that offered generous incentives to investors to reflect the

new paradigm. The establishment of the Minerals Commission in 1984; the promulgation of the minerals and mining code in 1986; the promulgation of the small scale mining law in 1989 and the establishment of the Environmental Protection Agency in 1994 were all to boost the mining industry in Ghana.

In addition to the regulatory framework developed via the laws and institutions, generous incentives were provided to foreign investors to boost foreign direct investment in mining. For example; corporate income tax on mineral production of private companies in Ghana decreased from 50-55% in 1975 to 45% in 1986 and 35% in 1994 (Campbell, 2003; Akabzaa, &Darimani, 2001). Companies received breaks on import duties on equipment and accessories necessary for mining production. Additionally, mining companies were allowed to keep a minimum of 25% of foreign exchange in an external account for various purposes including acquiring physical capital requirements necessary for production and dividend payments as well as for expatriate labour.

The benefits accrued to mining companies as a result of the dynamic evolution of mineral laws and policies have led to a rapid growth of Ghana's mining economy. Between 1983 and 1998, the mining industry brought approximately US$ 4 billion in FDI to Ghana, representing more than 60% of all such investment in the country (Ghana Minerals Commission, 2000).

The mining sector is credited with bringing in a significant amount of foreign exchange earnings, employment generation, mineral royalties, employee income, taxes payments etc. It is noteworthy that mining's contribution to GDP increased from 1.3% in 1991 to an average of about 5.2% between the years 2001-2004 (Ghana Minerals Commission, 2006).

The sector's contribution to the nation's gross foreign exchange earnings has also increased progressively from 15.60% in 1986 to 46% in 1998. In absolute terms, the sector generated US$ 124.4 million in 1986, and US$793 million in 1998 (Ghana Minerals Commission, 2000).

The sector continues to be one of the highest contributors to the Internal Revenue Service through the payment of mineral royalties, employee income taxes, corporate taxes and ancillary levies. The sector however, has a relatively limited capacity to generate employment. This is because most of the mining companies in the country have surface mining operations which are capital-intensive with relatively low labour requirements.

Employments in the minerals sector though not the best as compared to other sectors of the economy surged, at least up to the close of 1995. The total labour force of the sector rose from 15,069 in 1987 to 22,500 in 1995 (Ghana Minerals Commission, 2000). Direct employment by producing members of the Ghana Chamber of Mines as at December 2004 according to figures from the Chamber stood at 10,624. Of this, expatriate staffs constituted only 1.4% and the rest were all Ghanaians. This level of employment excludes employees in exploration, contractors, mining support service

companies as well as suppliers to the large-scale mining companies, not to talk about those companies not registered with the Chamber of Mines.

Although the direct employment generated by the mining industry is a relatively small part of the Ghanaian labour market, it is a very important source of both direct and secondary employment in the regional areas of the main mining regions of Western, Ashanti, Eastern and Brong-Ahafo.

The sector has attracted a significant number of sector support companies such as security services, transport companies, explosive manufacturers, and mineral assay laboratories among others in these regions. Mineral production in the country has been on the ascent after the reforms and this is reflective in the export earnings accrued to the state.

Ghana recorded a significant increase in all mineral productions in 2005 with gold taking over from cocoa as the leading foreign exchange earner for the country.

Mineral revenue went up from 798 million dollars in 2004 to 995.2 million dollars in 2005 contributing about 13% of the total collection of the Internal Revenue Service. Gold production recorded an increase of 63% with its export revenue increasing from 731.2 million dollars to 903.9 million dollars. Though the Ghanaian economy is not by the United Nations definition, a mining economy, the minerals sector has made noteworthy contributions to foreign exchange earnings and Gross Domestic Product (GDP). Currently, Ghana's mining sector contributes approximately 40% of Gross Foreign Exchange (GFE) earnings and accounts for approximately 5.2% of GDP (Ghana Minerals Commission, 2006). In 2000, minerals accounted for 38.96% of total export earnings. Indeed, mining remains a key industry for the growth and development of the Ghanaian economy.

6. Impact of Mining Operations in Ghana

Almost all the large scale mining companies in the country employ the open-pit method of mining in addition to cyanide heap leach operations. These methods have far-reaching consequences for human health and environmental safety (Akabzaa, 2000). The use of heavy machinery in exploiting the minerals also has a destructive effect on the vegetation as it generates more dust (ILO, 2005) and noise pollutants. While mining projects may generally have weak links with the rest of a host national economy, they can have a decisive impact on the communities in which or near which they are located (Anyemedu, 1992). Reforms in the Ghanaian mining industry have not received corresponding reforms in the other sectors (e.g., the environment and health sectors) to accommodate the potential impacts arising from an accelerated growth in the mining industry. This situation has led to adverse effects not only on mining communities but the economy at large. An attempt to quantify annual losses to the economy through environmental degradation by the Environmental Protection Council in 1988 put

conservative estimates at 41.7 billion cedis, the equivalent of 4% of total GDP. Just as the benefits accrued from the industry appear enormous so are the problems that emanate from mining operations. The impact of mining operations in Ghana both from the large and small scale miners are diverse and quite devastating for it touches on the livelihood and the very existence of people.

The principal elements of the environment (i.e., land, water and air) have been severely affected by mining activities in Ghana. Large tracts of land for farming activities have been acquired by mining companies for large scale surface mining operations depriving mining communities of their source of livelihood (Akabzaa and Darimani, 2001). Sporadic cyanide contamination of water bodies by large scale surface mining operations and mercury contaminations from small-scale and illegal mining activities are common features of mining communities.

Statistics from the Inspectorate Division of the Minerals Commission on occupational health problems caused by mining activities from 2000-2004 includes malaria and upper respiratory tract infection, the two topmost causes of outpatient morbidity between 2000- 2006 (Ghana Health Service, 2007). Quite informative on the statistics of diseases is the inclusion of sexually transmitted diseases particularly HIV/AIDS.

This situation coupled with the increased migration to mining communities in search of jobs has worsened the unemployment situation in these areas. It has also created other social problems as overpopulation, congestion, and pressure on social amenities among others. Thus the "gains" from the sector in the form of increased investment and foreign exchange earnings are being achieved at some significant environmental, health and social costs to the people living in mining communities and the nation as a whole.

7. Challenges Posed by the Mining Industry

In spite of the positive economic implications of mining in the development of an economy, some researchers and other Non-Governmental Organisations (NGOs) continue to be on the heels of mining companies trying to discourage their operations in developing countries.

Sachs and Warner (1999) indicate that natural-resource intensity is negatively associated with both the quality of legal and government institutions in a country and the degree to which an economy is open to international trade. According to them the more dependent a country is on natural-resource exports, the poorer the quality of institutions and the more closed an economy tend to be to international trade (Sachs and Warner, 1999).

Mining exploration and production activities inevitably cause physical and material damage not only to the environment but also to the inhabitants therein (Veiga, and Beinhoff, 1997; Warhurst, 1994; 1999). The creation of large scale surface disturbances, the generation of volumes of waste

materials and the exposure of previously buried geological materials to the forces of oxidation and precipitation are intrinsic to the mining industry and may continue to present complex environmental and health problems even when the best available practices are conscientiously followed (Chiaro and Joklik, 1998).

The use of chemicals and explosives in many areas of mining also create health and safety hazards by exposing the environment to pollutants like chemicals, dust, and fumes. In the past two decades, environmental issues have received an impetus in mining operations; taking a centre stage in mining related issues (Omalu and Zamora, 1999). The environment's costs of mining are now being viewed as an additional tax.

9. An Overview of Industry Structure and Organisation in Ghana

In broad terms, gold mining current industrial structure in Ghana features eight large mines which are owned and managed by five principal large-scale international producers; a small number of far smaller producers; and a significant contribution of registered semi-formal, small-scale producers which generate some 9 to 10% of national output in the present day (triple the level of 20 years ago, but statistical capture of their production has also improved). This by and large excludes the contribution to production from the unregistered, informal and technically illegal small-scale artisanal miners known as *galamsey*, whose activities spread through gold mining areas and which employ in an estimated range of 50,000 to 200,000 people (Hilson, 2004).

10. Methodology

The growth theory has evolved over the years as a major feature of development economics. One of the earliest attempts to model economic growth is popularly referred to as the 'Harrod-Domar' Model associated with the English economist, Sir Roy Harrod and American Economist, Evsey Domar. The model is an early attempt to show that growth is directly related to savings and indirectly related to the capital/output ratio.

According to the model, growth (G) can be written symbolically as:

$$G = \frac{s}{k} \quad (1)$$

Where,

k - incremental capital-output ratio and;

s - the average propensity to save.

The model indicated that saving affect growth directly, while the incremental capital/output ratio affects growth indirectly or inversely.

But Solow's model of economic growth is based on the premise that output is an economy and is produced by a combination of labour (*L*) and capital (K), under constant returns, so that doubling input results in doubling output. Contemporary versions distinguish between physical and human capital. Thus, the quantity of output (*Y*) is also determined by the efficiency (A) with which capital and labour is used.

Mathematically:

$$Y = A\, f\,(L, K) \qquad (2)$$

Solow assumed that this production function exhibits constant returns to scale, that is, if all inputs are increased by a certain multiple, output will increase by exactly the same multiple.

The Solow neoclassical growth model uses a standard aggregate production function in which

$$Yt = At\, K_t^{\alpha}\, L\, t^{1-\alpha},\ 0 < \alpha < 1 \qquad (3)$$

In this case, Y is gross domestic product, K is stock of capital, L is labour and Are presents the productivity of labour, assumed to grow at exogenous rates n and g.

$$Lt = L_0 e^{nt} \qquad (4)$$

$$At = A_0\, e^{gt} \qquad (5)$$

The number of effective units of labor, *At Lt* grows at rate *n+g*. For developed countries, these rates have been estimated at about 2 % per year. For developing countries, it may be smaller or larger depending on whether they are stagnating or catching up with the developed countries. In the equation (3) above, α represents the elasticity of output with respect to capital (the percentage increases in GDP as a result of a 1 % increase in human and physical capital). It is usually measured statistically as the share of capital in a country's national income accounts.

The model assumes that a constant fraction of output, *s*, is invested.

Defining *k* as the stock of capital per effective unit of labour, i.e. $k = \frac{K}{AL}$ and *y* as the level of outputper effective unit of labour, $y = \frac{Y}{AL}$, the evolution of *k* is governed by:

$$Kt = syt - (n + g + \delta)\, kt = sktn - (n + g + \delta)\, kt \qquad (6)$$

Where δ is the "rate of depreciation", equation (6) above implies that *k converges* to a steady-state value *k** defined by

$$sk^{*}\alpha = (n + g + \delta)\, k^{*},$$

or

$$k^{*} = [s/(n + g + \delta)]^{1/(1-\alpha)} \qquad (7)$$

The steady-state capital-labor ratio is related positively to the rate of saving and negatively to the rate of population growth. The central predictions of the Solow model concern the impact of saving

and population growth on real income. Substituting (5) into the production function and taking logs, we find that steady-state income per capita is

$$\ln\left(\frac{Y^t}{L^t}\right) = \ln A_0 + g\,t - \frac{\alpha}{1-\alpha}\ln(s) - \frac{\alpha}{1-\alpha}\ln(n+g+\delta) \quad (8)$$

Based on the fact that the model assumes that factors are paid their marginal products, it predicts the magnitudes alongside the signs of the coefficients on savings and population growth.

In the case of competitive markets being assumed, the growth rate of the economy can be seen as a weighted sum of growth rates of efficiency parameter *g*A (sometimes referred to as technical progress, of the labor force *gL*, and of the capital stock *gK*. The weights on labour and capital are the shares of payment to labour and capital in Gross Domestic Product (GDP).

$$gY = gA + algL + akgK \quad (9)$$

The Solow Growth model assumes that the marginal product of capital decreases with the amount of capital in the economy. In the long run, as the economy accumulates more and more capital, gK, approaches zero and the growth rate is determined by technical progress and growth in the labour force. However, in the short run, an economy that accumulates capital faster will enjoy a higher level of output. The above argument relates to the entire economy, but can also be extended to subsectors of the economy such as education.

According to the traditional neoclassical growth theory, output growth results from one or three (3) factors which includes increases in labour quality and quantity (through population growth and education), increases in capital (through saving and investment), and improvement in technology [Todaro and Smith 2004].

Following up from the neoclassical viewpoint which is based on a technological relationship between output and productive inputs as considered in the pioneering work of Robert Solow, its extensions finds an empirical variant in the Cobb-Douglas production function. Solow's method of the residual and his estimate were disapproved on many grounds; that the residual approach was not of much use in understanding the growth process because it is based on the concept of a stable production function; his approach was based on the unrealistic assumptions of perfect competition, constant returns to scale and complete homogeneity amongst other criticisms.

In the light of the shortcomings of Solow's growth model, the amplified version of the model was specified by Mankiw, Romer and Weil (1992). In this augmented version of the model, a Cobb-Douglas production function is assumed. This started off by adding human capital accumulation to the Solow model. According to Mankiw, Romer and Weil (1992), the aggregate output of the economy can be written as:

$$Y_t = A_t K_t^{\alpha} H_t^{\beta} L_t^{1-\alpha\beta} \quad (10)$$

Where,

A index of technical change that varies overtime but for the moment held constant,

K represents the capital stock,

L represents labour supply and

H is stock of human capital

Note that the coefficients α and β are assumed to lie between 0 and 1 and (α+β) < 1, implying that there are decreasing returns to all capital.

Assuming *sk* to be the fraction of income invested in physical capital and *sh* the fraction invested in human capital, the evolution of the economy is determined by:

$kt = skyt - (n + g + \delta)\, kt$ (11)

$ht = shyt - (n + g + \delta)\, ht$ (12)

Where $y = \frac{Y}{AL}$, $k = \frac{K}{AL}$, and $h = \frac{H}{AL}$ are quantities per effective unit of labour. It is assumed that the same production function applies to human capital, physical capital, and consumption. In other words, one unit of consumption can be transformed at no cost into either one unit of physical capital or one unit of human capital. Human capital (*H*) is the knowledge acquired by workers, often as a result of specific investment in education. Since human capital involves investment just as physical capital, it also depreciates.

In a case where $\alpha + \beta = 1$, then there are no constant returns to scale in the reproducible factors and there will be no steady state for the model. It is implied in equations (11) and (12) that the economy converges to a steady state defined by:

$$k^* = \left(\frac{s_k^{1-\beta} s_h^{\beta}}{n+g+\delta}\right)^{\frac{1}{1-\alpha-\beta}} \quad , \quad h^* = \left(\frac{s_k^{\alpha} s_h^{1-\alpha}}{n+g+\delta}\right)^{\frac{1}{1-\alpha-\beta}} \tag{13}$$

Substituting (13) into the production function and taking the natural logs gives an equation similar to equation (3.8) above:

$$\ln\left(\frac{Y^t}{L^t}\right) = \ln A_0 + g\,t - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta) + \frac{\alpha}{1-\alpha-\beta}\ln(s_k) + \frac{\beta}{1-\alpha-\beta} \tag{14}$$

This equation shows how per capita income (proxy for economic development –a superset of economic growth) depends on population growth and accumulation of physical and human capital. In implementing the model above, focus was restricted to human capital investment in the form of gold, ignoring investment in health, among others.

11. Model Specification and Analysis

The econometric model we considered in this study includes gold prices, external reserve, gold export as the explanatory variable and gross domestic product as dependant variable respectively. These variables are used at constant prices. This is used to obtain a reliable parameter estimates in the time series regression. Following from the theoretical propositions explored in the theoretical framework, for the successful examination of the relative impact of gold production and export on the Ghana economy, with regards to the work of Milbourne, Otto and Voss (2003), which is based on studies by Mankiw, Romer, Weil (1992), we specify our model in an attempt to determine the impact of gold production ultimately on economic growth in Ghana.

The model adopted can be explicitly specified as follows:

$$RGDP = F(L, K, GE) \quad (15)$$

Where,

RGDP - represents the real gross domestic product,

L represents labour,

K represents the capital,

GE represents gold export,

Note that Real *GDP* is *GDP* at factor prices deflated by the consumer price index (at constant factor cost) Incorporating the variables into the Cobb-Douglas production function, we have:

$$RGDP = A L^{\beta 1} K^{\beta 2} GE^{\beta 3} \quad (16)$$

This can be specifically expressed in explicit econometric (linear equation) of the form:

$$RGDP = \beta 0 + \beta 1 L + \beta 2 K + \beta 3 GE + \varepsilon \quad (17)$$

Where, ε represents the stochastic or random error term (with usual properties of zero mean and non-serial correlation).

Adopting a log-linear specification, taking the natural logarithm of both sides of the equation and assuming linearity among the variables gives:

$$Log\ RGDP = \beta 0 + \beta 1 Log\ L + \beta 2 Log\ K + \beta 3 Log\ GE + \varepsilon \quad (18)$$

Note that $Log\ A = \beta 0$.

A priori **Specification**: the expected signs of the coefficients of the explanatory variables are: $\beta 1 > 0$, $\beta 2 > 0$, $\beta 3 > 0$.

12. Data Analysis and Discussion of Results

Table 1 shows the data collected and it will be used to obtain the regression analysis, whereby L, K, GE and RGDP represents Labour, Capital, Gold production and export and Real Gross Domestic Product respectively in Ghana between 1991- 2009.

Table 1: Data showing Labour, Capital, Gold Production and Real Gross Domestic Product between 1991 – 2009

YEAR	L	K	RDGP	GE
1991	12712	279.49	242491400	845908
1992	15694	595.40	279136200	998195
1993	14721	263.90	345690000	1261424
1994	17125	98.33	468589000	1430845
1995	19557	164.96	703930000	1708531
1996	19375	774.76	1006650000	1583830
1997	13678	593.02	1260850000	1752452
1998	16632	267.54	1548230000	2371108
1999	18261	214.77	1844004000	2608102
2000	15120	231.78	2429890000	2457152
2001	15730	275.53	3411770000	2381345
2002	11876	313.72	4379900000	2236833
2003	14883	330.43	6008580000	2274627
2004	16257	556.44	7297559000	2031971
2005	13766	661.98	8898690000	2138944
2006	15783	799.50	17809660000	2342722
2007	16978	670.22	21754950000	2625500
2008	17829	765.30	28664140000	2839802
2009	17322	762.26	35663010000	3119823

SOURCE: Ghana Statistical service, Ghana mineral commission (2012)

13. Analysis

This analysis was performed using MINITAB Statistical software in relation to table of Least squares method, analysis of variance and test for significance of individual parameters.

Dependent Variable: LOG (RGDP)

Method: Least Squares

The regression equation is

LOG (RGDP) = - 8.25 - 0.59 LOG (L) + 1.25 LOG (K) + 2.70 LOG (GE)

Predictor	**Coefficient**	**SE Coefficient**	**T**	**P**
Constant	-8.255	5.377	-1.54	0.146
LOG(L)	-0.591	1.268	-0.47	0.648
LOG(K)	1.2481	0.2717	4.59	0.000
LOG(GE)	2.7026	0.4948	5.46	0.000

R-Sq = 81.9% R-Sq(adj) = 78.3%

Durbin-Watson statistic = 1.28

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	6.2031	2.0677	22.67	0.000
Residual Error	15	1.3683	0.0912		
Total	18	7.5714			

TEST FOR SIGNIFICANCE OF INDIVIDUAL PARAMETERS

Predictor	**Coefficient**	**SE Coefficient**	**T**	**P**
Constant	-8.255	5.377	-1.54	0.146
LOG(L)	-0.591	1.268	-0.47	0.648
LOG(K)	1.2481	0.2717	4.59	0.000
LOG(GE)	2.7026	0.4948	5.46	0.000

Critical values: $T_{0.01} = 5.84$ $T_{0.05} = 3.18$ $T_{0.1} = 2.35$

The T- statistics of all the variables appear to be relatively low compared to the critical values at 1% and 5% and therefore we accept the null hypothesis and conclude that, the variables labour, capital and gold export are not individually statistically significant on the dependent variable (RGDP) at the stated levels of significance

Hypothesis 1

In order to carry out the necessary empirical analysis, the following hypothesis were formulated and tested.

H_O: Gold has not significantly improved the growth of the Ghanaian economy.

H_1: Gold has significantly improved the growth of the Ghanaian economy.

Considering the production and export of gold, the result shows that, there is enough statically evidence to suggest that, gold production and export has not significantly improved the Ghanaian economy at 1% and 5% level of significance. We therefore accept the null hypothesis (H_o) and reject the alternative hypothesis (H_1)

Predictor	**Coefficient**	**SE Coefficient**	**T**	**P**
Constant	-8.255	5.377	-1.54	0.146
LOG(L)	-0.591	1.268	-0.47	0.648
LOG(K)	1.2481	0.2717	4.59	0.000
LOG(GE)	2.7026	0.4948	5.46	0.000

Hypothesis 2

H_O: There is no statistically significant relationship between gold production and export and economic growth in Ghana.

H_1: There is statistically significant relationship between gold production and export and economic growth in Ghana.

Following from the results of the individual tests of significance, it is observed that-statistics of the variable GE, is lower that its relative critical value at 1%, 5% and 10% levels of significance. Hence we accept the null hypothesis (H_o) and reject the alternative hypothesis (H_1)

14. Discussion of Results

A close observation of the results indicates that the specified model has a high coefficient of determination. This can be seen from the R- squared value of 81.9% and adjusted R-squared value of 78.3%.The R-squared shows the percentage of variation in the dependent variable that was accounted for by variations in the explanatory variables. The fitness of every regression results base on its R-squared.

The F- statistic value of 22.67 shows that the overall model is statistically significant at 1% and 5% levels of significance. This is because it is greater than the critical values of (4.94) and (3.10) at 1% and 5% respectively.

This means that all the explanatory variables simultaneously explain the variations in the real demand of money .Also all our variables are statistically significant at 95% confidence interval with the exception of Labour (L)

Furthermore, the DW statistics which is a measure of autocorrelation shows that the error correction model is free from the problem of serial correlation at 1% level of significance due to its value of 1.28.As a result of this our model estimates can be confidently relied upon for making inferences.

15. Conclusion

The research explored the relationship between gold production and export and the economic performance in Ghana. Our results have shown that capital, labour and gold production and export can surely lead to economic growth. However, whether or not gold production and export have actually led to a positive improvement in the economy of Ghana, the government must participate actively by investing and making policies that will encourage the private sector to participate actively in the economy.

Reviews were conducted extensively on various literatures and existing works regarding gold production and export on economic growth. Consequently, a Cobb-Douglas production function model was specified following from Solow's growth model regarding human capital with labour force and gold export as the independent variables, while Real Domestic Product was used to proxy economic growth as the dependent variable with data on each variable from 1991-2009The variables were estimated using the Ordinary Least Square method to derive the relative regression coefficients.

The research explored the relationship between gold production and exportation and the economic performance in Ghana. The results have shown that capital, labour, gold export can surly lead to economic growth.

However, whether or not the various impacts in the gold industry as regard production and export have actually led to positive improvements in the economy, the government must participate by investing and making policies that will encourage the private sector to participate actively in the economy.

16. Recommendations

Base on the findings of this research work, the following recommendations are provided for consideration.

(i) The provisions of the mining laws that enable mining companies to shed a minimum of 50% of their concessions must be vigorously enforced. This is particularly important because many mining companies hold large tracts of land that would otherwise be available to farmers. This will increase productivity and enhance the GDP.

(ii) The legal and policy framework relating to mining should be reviewed in order to impose stronger environmental and social responsibility and accountability on the mining companies.

(iii) Incentive packages similar to those provided for by the laws for the mining companies should be designed for communities affected by mining projects in order to reduce poverty and improve lives.

(iv) There should be effective co-ordination among public sector mining support institutions and other stakeholders such as the Traditional Councils, opinion leaders and members of the communities affected by mining. This would promote transparency and ensure harmonious enforcement of policies governing Ghana's gold mining sector.

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