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Implications of Gold Trading for the Global Economy

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Abstract:
One of the precious metals found in the earth's crust, whose economic value dates back several centuries and remains relevant in our contemporary socio-economic settings, is gold. Society's veneration for the precious metal surges from one generation to the other. However, most developing economies endowed with large quantities of gold are plagued with unbridled activities of warlords, foreign-backed militias, rebels, and illegal artisanal miners, some of whom operate on behalf of political stalwarts who mask their true identity. The purpose of this research was to examine how trading activities related to gold tend to affect gross domestic product (GDP) values at the national and global levels. The quantitative approach to scientific inquiry was adapted and used in the study. Specifically, the cross-sectional design formed the basis of the research. Data required for the conduct of the research were obtained mainly from secondary sources. These included textbooks, peer-reviewed articles published in journals and grey literature. Other sources were the Google Search Engine, including databases of Macrotrends and World Bank, databases and archives of the United States Geological Survey, among other significant sources. Respective data on Ghana's annual gold production volumes, gold revenues and GDP values from 1980 through 2020 and respective data on annual average closing prices per ounce of gold, global gold production volumes, global gold revenues and global GDP values from 1969 through 2020 were used in the research. Descriptive statistics and regression models were used to describe the research variables and to evaluate their behaviour over the stated time frame on national and global GDP values. The study revealed gold as a viable source of alternative investment and an effective portfolio diversifier in periods of volatility in the global equity markets. The average closing price per ounce of gold in 2020 was the highest since 1969. More than a third of the world's total gold reserves (34.26%) were held by Australia, Russia and South Africa, and China remained the world's largest producer of gold in 2019. For most developing economies with large production volumes, the percentage and monetary contribution of gold revenue to GDP was determined to be significant. However, for most advanced economies, percentage contribution was insignificant, albeit monetary contribution was found to be quite colossal and capable of impacting positively on national expenditures. Findings from the research revealed a positive and significant relationship between Ghana's gold revenue and GDP (coefficient value = 9.574151593; p = 0.000, p < 0.05); and a positive but non-significant relationship between global gold revenue and global GDP (coefficient value = 527.3364872; p = 8.111, p > 0.05). Gold revenue accounted for nearly 97.64% of the variation in Ghana's GDP from 1980 through 2020, while global gold revenue accounted for about 88.16% of the variation in global GDP from 1969 through 2020. During 2019, Ghana was the leading producer and highest-earner from gold sales in Africa; and the economy with the fifth-highest percentage contribution of gold revenue to GDP (9.52%); after Burkina Faso (17.37%), Mali (15.87%), Sudan (11.25%) and Guinea (10.02%) respectively. The statistical analysis confirmed and validated, to a large extent, the valuable contribution of gold revenue to national GDP, a clarion call for regulation and control of the activities of illegal artisanal miners to improve and actualise annual national estimates for total gold production volumes and revenues; the need for minerals and mining policy reforms and expeditious implementation of same to control environmental pollution and hazards. Dramatic transformation and an increase in recycling technologies are required to curb the accelerated depletion rate of gold reserves. It is imperative for the major gold-producing economies to take proactive steps towards the creation of economic parsimony in supply to positively affect the price per ounce of gold in the global market.

Keywords: *Environment, GDP, gold, measurements, mining, production, investment theory*

1. Introduction

One of the metals discovered in human history with sparkle, popularity, nobility and immense value is gold. It is often argued that the glittering pace of gold is unequalled in the world of precious metals. This precious metal is believed to be elegant, extremely soft in its pure form, and corrosion-resistant. Due to its softness, gold is often hardened by adding other metals, including silver, copper, zinc, palladium and nickel. Experts described this process of combining metals as an *alloy*. The corrosion resistance of gold is improved through an alloy, and the higher the proportion of other metals, the harder the gold alloy becomes. However, this process reduces the original colour of gold while the additional metal tints gold to different shades (Bullion by Post, 2021).

Gold comes in varieties. These include yellow gold, pure gold, gold layers, coloured gold, rolled gold, gold-filled, electroplated gold, vermeil gold and gold plating (Hustedt Jewelers, 2021). Yellow gold compares very strongly with pure gold; the former is derived from the mixture of pure gold with zinc and silver. This combination of alloy strengthens yellow gold and helps it maintain its golden colour, but not as shiny as pure gold. Yellow gold alloy is ranked by the carat system. This system helps to measure the ratio of pure gold to other metals. Highly-rated yellow gold suggests the presence of more gold, which makes it more elegant-looking, fragile and expensive. Unlike jewellery made from pure gold, jewellery manufactured with yellow gold is not easily bent out of shape; they are scratch-resistant and more durable. The foregoing qualities render yellow gold jewellery wearable daily, implying yellow gold is ideal for manufacturing watches, engagement and wedding rings, and timeless jewellery that could be bequeathed to generations. Jewellery manufactured with yellow gold alloys is comparatively more affordable because it is not manufactured with 100% gold.

Pure gold is noted for its unique features. It is fragile in nature, has a rich yellow colour and is made of 100% gold metal, which is why it is sometimes called 24-carat gold. Pure gold has dominated the manufacturing of royal jewellery throughout the ages. It is possible for one to scratch pure gold with the fingernail or bend it out of shape with the fingers. Due to its fragility, pure gold, in contemporary periods, is reserved for plating or manufacturing of gold decorative sheets, known as *gold leaf*. These decorative sheets tend to be very useful in manufacturing indulgent alcoholic drinks or show-stopping desserts (Hustedt Jewelers, 2021).

Varied gold layering techniques allow jewellery manufacturers to enhance the brilliance and elegance of gold ornaments; the elegance attracts the attention of jewellery lovers to the "neglect" of the price tags. The foregoing implies that gold layers inform the decision of jewellery consumers to purchase jewellery more than the prices affixed to them. Coloured gold or yellow gold alloy is often used in gold layering techniques. This increases their resistance to surface scratches and bending. Since gold layering techniques do not employ pure gold in the manufacturing process, the end products are relatively less costly and affordable (Hustedt Jewelers, 2021).

Coloured gold is not too distinct from yellow gold. However, in the case of coloured gold, metals other than silver and zinc are mixed with pure gold. The final colour of coloured gold is influenced by the different metals that are combined with pure gold. The most common types of coloured gold are rose gold and white gold. Hustedt Jewelers (2021) described rose gold as a coloured gold alloy with a unique rosy pink hue. It is manufactured when pure gold is blended with copper. World Gold Council (2021a) described pink gold, the synonym for rose gold (Peridot, n.d.), as an alloy that is derived from the mixture of more copper with pure gold in the manufacturing process. The appearance of *white gold* is pale silvery, which is similar to sterling silver or platinum. White gold is derived from pure gold and white metal. Examples of white metal combined with pure gold in manufacturing white gold include platinum, manganese, nickel or palladium (Hustedt Jewelers, 2021). However, World Gold Council (2021a) identified that nickel is the other metal that is often included in the alloy composition of white gold. The foregoing notwithstanding, it is possible for silver, copper, or zinc to be added to the alloy composition. The blend of pure gold with zinc, copper and silver helps create green gold, a less common coloured gold alloy. A more common composition of green gold alloy is pure gold blended with silver and zinc (Hustedt Jewelers, 2021; World Gold Council, 2021). Akin to yellow gold, coloured gold is ranked based on the carat system. The quality mark on a piece of jewellery derived from coloured gold indicates the percentage of pure gold contained therein (Hustedt Jewelers, 2021).

Rolled gold is another form of gold layering technique that is common in the manufacturing of watches. Generally, rolled gold is created with thin sheets of gold blend secured to a brass core. It has a lower gold content and is similar to a gold filling, albeit rolled gold only requires half of the gold mixture by weight. Jewellers' brass, a mixture of zinc and copper covered in two or three layers of the gold blend, is normally used in the manufacture of gold-filled jewellery. The stick of the gold blend layers to the jewellers' brass is facilitated by heat and pressure. Gold-filled jewellery could come in the form of double-clad or single-clad. Double-clad gold-filled jewellery has a gold finish all over the ornaments, whereas single-clad gold-filled jewellery has a gold finish on the side that shows out. Mostly, 14- or 12-carat gold is used in manufacturing gold-filled jewellery. Information on the hallmark of a piece of gold-filled jewellery must include its weight, which is typically a 5% gold blend (Hustedt Jewelers, 2021).

Electroplated gold-layering is a modern technique applied to the manufacture of jewels. This contemporary gold-layering technique relies on electrical conductors to charge the base metal, and this process is called electroplating. The charged base metal is subsequently submerged into a solution of ions that is positively charged, and the latter becomes attracted to the negative charge of the base metal. A gold layer is formed when the positively charged ions become attached to the base metal. Electroplated gold jewels are relatively cheaper, though this gold-layering technique increases the speed of manufacturing or production of jewels. The gold blend layer created by this technique is believed to be very durable (Hustedt Jewelers, 2021; World Gold Council, 2021).

Vermeil is another form of gold with distinct features. It is manufactured entirely with precious metals and is very affordable. Vermeil gold jewellery is derived from the application of a gold alloy layer over a sterling silver base. In the United States of America (USA), the gold layer of vermeil gold jewels is stronger and thicker than most gold layers, owing to an existing law. The minerals law of the United States stresses the need for vermeil to contain at least two microns of gold mixture. Hustedt Jewelers (2021) noted that only gold-filled jewellery has superior gold content to vermeil gold jewellery. The premium materials used in manufacturing vermeil gold jewellery tend to reflect their final prices. Comparatively, prices of jewels made from vermeil gold are lower than those of pure gold but higher than the prices of jewels manufactured with other gold layering techniques.

In the gold processing and selling markets, the terms gold-dipped jewellery and gold-plating jewellery are used interchangeably to explain a common concept. That is, jewellery is derived from the application of a gold mixture to brass or another base metal. The volume of gold in gold-plated jewellery is less than rolled gold or gold-filled jewellery. The gold content of gold-plated jewellery normally measures up to one-tenth of the gold blend by weight of gold-filled jewellery. The popularity of gold-plated jewellery stems from its affordability. However, the quality of gold-plated jewellery extends to a certain period; the coating on the gold mixture is likely to wear off over time (Hustedt Jewelers, 2021).

As noted earlier, the carat system helps to denote the proportion of pure gold to other metals in gold alloys. As stated differently, a carat is a unit that facilitates the measurement of gold purity or content in an alloy. A higher caratage connotes purer gold and vice versa (World Gold Council, 2021). Fourteen-carat remains the dominant yellow gold alloy in the United States (Hustedt Jewelers, 2021), inferring 58.3% pure gold ((14 ÷ 24) x 100% = 0.58333 x 100% = 58.333 = 58.3%) and 41.7% (100% - 58.3% = 41.7%) other metals.

1.1. Background of the Study

Gold is one of the precious metals found in the earth's crust, whose economic value dates back several centuries and remains relevant in our contemporary socio-economic settings. This precious metal has a face-centred cubic crystal structure (Hoffmann, n.d.) and is described by some other experts, including Davis (n.d.), as one of the pioneer metals known to humankind, with its origin predated 3400 BCE by the Egyptians. Hoffmann (n.d.) argued that the history of gold discoveries that were identified as the earliest and most realistically documented was dated about 6,000 years ago. These earliest gold finds were believed to have occurred in Egypt and Mesopotamia c. 4000 BC. By 3000 BC, the popularity of gold had grown in leaps and bounds; gold rings were accepted as a medium of payment. Wall reliefs in Egypt dating from 2300 BC depict various stages of mechanical working and refining of gold. By 2000 BC, ancient technological processes had been developed to ensure salt was effectively used to extract silver from gold-silver alloys.

In addition to alluvial deposit mining, vein or layer deposit mining later became apparent. However, this mining process demanded considerable amounts of manpower as crushing was needed prior to the extraction of gold. The *amalgamation technique* was developed during the 10th century. This technique facilitated blending with mercury to increase the gold recovery rate. The Bulgarian shores of the Black Sea near the present city of Varna were a source of major gold discovery in the earliest periods. Similarly, gold was discovered in the Iberian Peninsula, Gaul, India and Ireland. However, Egypt remained the epicentre of gold manufacturing prior to the era of Christ (Hoffmann, n.d.).

Davis (n.d.) and Hoffmann (n.d.) noted that the elemental abbreviation of gold is Au. This is derived from the Latin term "aurum," which means "shining dawn." The atomic number of gold is 79. The foregoing affirms the universal acclamation and recognition of gold as a very potent and precious metal capable of influencing the lives of people on planet Earth. The authors described gold as a precious metal that consistently symbolises beauty, value and wealth and that beauty and value are two significant images derived from two distinguished properties of gold. These include the colour and chemical stability of gold. Hoffmann (n.d.) revealed that gold mining in the olden days was dominated by alluvial placers. Craftsmen found and picked particles of elemental gold in streams and river sands. To concentrate the gold, lighter river sands were washed away with water to leave behind the dense gold particles. These gold particles were melted for further concentration and other uses.

In gold measurements, a carat represents 1/24th part of the entire gold. This is equivalent to 4.167% ((1 ÷ 24) x 100% = 0.41666 x 100% = 4.1666 = 4.167%). The purity of gold alloy is expressed as the number of parts of the gold it contains. To illustrate, 18-carat gold refers to jewellery that contains 18 parts gold and 6 parts other blended metals. Measurement of the relative proportion of gold in alloys was believed to have originated with a medieval coin known as "mark." However, it was difficult to use pure gold to produce marks due to its softness. It was, therefore, imperative for gold to be blended with other metals to create a hard blend. The weight of a mark was 24 carats; this carat was the same as the one used in weighing gemstones and was theoretically believed to be equal to the weight of the seed of the Coral tree. The purity of gold coin alloy was expressed as the actual contribution of gold to the weight of the carat (Britannica, n.d.).

The Royal Mint (2020) shared some revealing facts about gold and its discovery in ancient times. It is noted that in 560 BC, the Lydians, located in Asia Minor, learnt how to refine gold and other metals. During this period, the maiden bi-metallic coinage, made up of silver and gold, was manufactured. These coins were called *croesids*; they were named after the king of the Lydians, King Croesus. The gold content in the production of these bi-metallic coins was very consistent. As a result, croesids became an acceptable form of currency and were traded with confidence.

The earliest known map was dated from 2600 BC. The map depicted the plan of a gold mine; the first gold jewellery was seen during this period, and Egyptian hieroglyphs described gold as being more in terms of quantity than dirt. Gold was first smelted in ancient Egypt in 3600 BC. However, earlier in 600 BC, the first gold coins comprising a crude blend of gold and silver were strutted in Lydia in Asia Minor (The Royal Mint, 2020). Egyptians were believed to have often accumulated significant quantities of gold during the reigns of Pharaohs with the sole aim of covering the coffin of the deceased Pharaoh. A classic example is the containment of gold equivalent to 112 kilograms or 247 pounds in the coffin of King Tutankhamun (popularly called King Tut) following his demise and burial in Egypt in 1223 (Davis, n.d.; The Royal Mint, 2020).

In the ancient Chinese state of Chu, Ying Yuan was circulated as a gold square coin in 500 AD, and eight hundred (800) years later, the Goldsmith's Hall in London hosted the establishment of the first hallmarking in 1300. Between 1370 and 1420, mining activities in Europe became very prevalent to such an extent that mines were almost empty. This fifty-year period (1370 through 1420) became known as *The Great Bullion Famine*. In 1717, the gold standard was set by the United Kingdom to link currency to gold at a fixed rate, and between 1870 and 1900, the world, with the exception of China, adopted the gold standard (The Royal Mint, 2020).

Prior to 1816, the world witnessed dramatic changes to the entire financial system and how money was produced. This dramatic transformation was attributed to the industrial revolution. During this period, inventions by Matthew Boulton and James Watt introduced seamlessness and more efficiency to the money production process. These renowned inventors introduced the steam-powered coining presses machine to facilitate money production (The Royal Mint, 2020).

Eastern slopes of the Ural Mountains in Russia and Brazil were major sources of significant gold finds during the early to mid-eighteenth century. In 1840, Siberia was found to have large alluvial deposits (Hoffmann, n.d.). Eight years later, James W. Marshall discovered gold at Sutter's Mill in Coloma, California (The Royal Mint, 2020). This discovery attracted many people from far and near to California in 1848. To wit, the 1848 gold discovery formed the basis of a mass exodus of people to California during the period. This mass exodus was known as the California Gold Rush (Davis, n.d.; Dowd, 2016).

The number of slaves employed in various gold mines in Spain by AD100 was estimated at forty thousand (40,000). However, demand for gold during the period was believed to have been negatively impacted by the introduction of Christianity. This notwithstanding, gold demand began to surge during the 10th century (Hoffmann, n.d.).

Prior to independence, Ghana was called the Gold Coast. Allen (1958) revealed that the maiden authentic record of gold mined from the Gold Coast dates from 1471, when the Portuguese commenced trading in gold dust along the banks of River Pra. Gold trading in the 15th and 16th centuries was believed to be brisk. However, the trade took a nose-dive following the introduction of the slave trade in the 18th century. Effective gold trading was not recorded until the slave trade was abolished in the 19th century.

Junner (as cited in Allen, 1958) presented estimates for gold exported by sea from the Gold Coast from 1471 to 1880. As noted earlier, 1471 was when official figures for gold exports first became available. The statistics revealed that from 1471 to 1750, about 40,000 ounces of gold were exported annually. These translated into 11.2 million ounces (40,000 x 280 years = 11,200,000 ounces) over the 280-year period. Further, approximately 10,000 ounces were exported annually from 1751 through 1800, implying total exports of 500,000 ounces (10,000 x 50 years = 500,000 ounces) over the 50-year period. Similarly, 40,000 ounces of gold were believed to have been exported each year from 1801 to 1850, inferring 2 million ounces (40,000 x 50 years = 2,000,000 ounces) were exported over another 50-year period. Finally, 25,000 ounces of gold were exported annually from 1851 to 1880, implying total exports of 750,000 ounces (25,000 x 30 years = 750,000 ounces) over the 30-year period. The data revealed that about 14.45 million ounces (11,200,000 + 500,000 + 2,000,000 + 750,000 = 14,450,000 ounces) of gold were exported from the Gold Coast over a period of 410 years (1471 through 1880).

Hoffmann (n.d.) noted that the discovery of gold in the Witwatersrand in South Africa in 1886 remains the single largest discovery in human history. However, the discovery was believed to have been made in June 1884 by Jan Gerrit Bantjes on farm Vogelstruis Fontein. Later, in September of the same year (1884), the Struben brothers made another gold discovery on farm Wilgespruit, situated near present-day Roodeport (South Africa History Online (SAHO), 2016). Though Hoffmann (n.d.) and SAHO (2016) present contrasting dates, they hold one thing in common. That is, a significant gold discovery was made in the Witwatersrand area of South Africa. By 1889, production from the Witwatersrand constituted 25% of global gold production, and by 1985, its contribution to total gold production at the global level had skyrocketed to 40%. The Witwatersrand's gold discovery was believed to be very timely; it coincided with the development of the *cyanidation process*, a technique that facilitated the recovery of gold values that could not be accounted for through *amalgamation* and *gravity concentration techniques*. Kamituga is a mining town in South Kivu Province in the Democratic Republic of Congo. It has been a mining town since gold was first discovered in commercial quantities in the 1920s. The discovery attracted a succession of large mining firms to the town (Smith, 2020).

In 1914, many countries adopted fractional standards to neglect the gold standard so they could pay for the cost of World War I. The fractional standards allowed countries to inflate their respective currencies. These countries did not return to the gold standard until 1925. The Bretton Wood Agreement was signed after World War II in 1944. During this period, the American dollar began gradually to replace gold as the base reserve currency. However, the American dollar was linked to the price of gold, and central banks continued to hold portions of their liquid reserves in gold. It was during this period that the International Bank for Reconstruction and Development (World Bank) and International Monetary Fund (IMF) were established (The Royal Mint, 2020).

Between 1971 and 1973, the Bretton Wood Agreement was abandoned by former President Richard Nixon of the United States. This initiative implied that the American dollar and other currencies across the globe were no longer linked to the value of gold and that the United States could effectively print more currency notes as and when necessary. Twenty-six years later, the first Central Bank Gold Agreement (CBGA) was signed in 1999. After the signing, European banks pledged continuous use of gold as part of their monetary reserves and capped annual gold sales at 400 tonnes over a five-year period. In 2010, the World Bank's President, Mr. Robert Zoellick, suggested the need for global economies to revert to the use of the gold standard to help strategically address challenges posed by the floating exchange regime (The Royal Mint, 2020).

1.2. Problem Statement

Societies throughout the world were believed to have witnessed a tremendous increase in the use of various metals, including gold, in the twentieth century. However, the demand in recent periods has skyrocketed due to the pace of technological advancements witnessed globally, accelerated development of notable economies such as China and India with very large and distinct populations, strong tastes and demands for gold jewellery by these and other economies, among other significant factors. Indeed, the world has experienced considerable expansions in the activities of gold mining and a considerable increase in total volumes of gold mined and used relative to the volumes in reserves underground (Lumen, n.d.).

The US Geological Survey's (n.d.a) data on gold for 2019 depicted estimated total volume in stocks at 197,576 metric tonnes, equivalent to 6,352,216,582 troy ounces (197,576 metric tonnes x 32,150.75 troy ounces = 6,352,216,582 troy ounces); while total volume in reserves underground was estimated at 54,000 metric tonnes, equivalent to 1,736,140,500 troy ounces (54,000 metric tonnes x 32,150.75 troy ounces = 1,736,140,500 troy ounces). Evidently, the stocks of gold mined and available for use were equivalent to 3.66 times (197,576 metric tonnes ÷ 54,000 metric tonnes = 3.6588 = 3.66) the total volume of gold in reserves during the period, implying gold mining across the globe is nearing depletion, controlling for new discoveries in both small and large commercial quantities in the immediate-, medium- and long-term.

Most developing economies endowed with large quantities of gold are plagued with unbridled activities of illegal artisanal miners. Official figures for total volumes of gold produced annually by developing economies are understated due to non-accounting or improper accounting for volumes of gold produced by illegal artisanal miners and miners in rebel-controlled areas and other conflict zones. The implications of these challenges are dire for efficiency in the mobilisation of gold revenues for developments at the national and global levels. Moreover, effective assessment of the contribution of gold revenue to national, regional and global gross domestic product (GDP) values may be impaired. Equally worrying is the end-social-product of the activities of small scale illegal miners. Activities of illegal artisanal miners often lead to loss of lives through the sudden collapse of mine pits, as recorded at Kamituga in South Kivu Province in the Democratic Republic of Congo (Smith, 2020), pollution of water bodies through the use of heavy metals including cadmium, lead, mercury and copper, among others, during mining in rivers and streams (Duncan, 2020; Attiogbe & Nkansah, 2020) and adverse effect on the health of people living in mining areas, suburbs and the environment (Stewart, 2020; Matschullat & Gutzmer, 2012).

In 2017, about 60% of Ghana's water bodies were believed to have been polluted, integrally, as a result of the activities of illegal artisanal miners. For every GH¢10,000.00 worth of gold mined and not accounted for by illegal artisanal miners, an estimated US$100,000.00 was required to treat the drain of water polluted during the mining process. The permutations and computations revealed a colossal amount of funds quantifiable in millions of American dollars required by the government of Ghana to ensure polluted water bodies were treated to mitigate harmful effects on the health and lives of people resident along the banks of the polluted rivers and streams; and who rely on same for daily domestic activities, including drinking, cooking, washing and bathing.

The threats posed by illegal mining activities tend to have dire implications for total gold earnings; they defeat the economic viability of the precious metal as governments are compelled to channel a substantial portion of their earnings into the treatment of contaminated water bodies and the rehabilitation of the environment. Similarly, waste dumps created by some large-scale mining firms are not effective, and the risk of collapse impacts negatively on human lives and the environment.

- *The general management problem* is the inability of regulatory bodies in mining economies, especially those in developing economies, to formulate implementable mining codes and regulations that would assure effective co-ordination, monitoring and integration of the activities of illegal artisanal miners, so their operations become regularised to enhance annual quantitative measurements and estimates for total volume and value of gold produced; and to provide the requisite protection for key stakeholders including mine workers, inhabitants of mining communities and suburbs; and the environment; while assuring governments' share of total gold revenues is channeled into productive use, rather than expended on perennial environmental and health challenges occasioned by the activities of illegal artisanal miners and non-compliant large scale mining companies. The near-depletion of gold reserves is affecting quality and earnings from operations by mining firms and economies. In 2019, nearly 71% of total mining operations in South Africa depicted marginal profits or losses. Despite evidence of the phenomenon, there are limited empirical studies to clearly establish the effect of gold trading activities on national and global gross domestic product (GDP) values over extended periods.
- *The specific management problem* is the level of innovativeness and technological standards required to invent new techniques to assure accelerated recycling rates of rare precious metals such as gold, considered critical to the manufacture of key consumables such as cell phones. This critical metal does not deplete entirely, impacting severely its availability for use in contemporary technology in the near and distant future. The present study sought to examine how trading activities related to gold tend to affect gross domestic product values at the national and global levels.

1.3. Research Objectives

1.3.1. General Objective

The underlying objective of this research was to assess how activities related to gold trading impact on the measurements of total economic output values at the national and global levels.

1.3.2. Specific Objectives

Specifically, the research sought to achieve the following objectives:

- Assess the impact of mining on the environment.
- Evaluate the contribution of national gold revenue to national GDP.
- Examine the effect of global gold revenue on global GDP.
- Make recommendations for stringent enforcement of mining codes and regulations by regulatory bodies in mining economies to assure effective monitoring, integration and regularisation of activities of illegal artisanal miners and to promote environmental preservation and protection. Implementation of the recommended measures would draw equilibrium among operating profits, recycling rates; and protection of human lives and the environment in the immediate-, medium- and long-term.

2. Literature Review

The underlying topic for the development of the present study was: "*Implications of Gold Trading for the Global Economy*." The main purpose of this research was to examine how revenues derived from gold trading impact the measurements of total economic output values at the national and global levels during the research period. This section presents a review of existing literature and a synthesis of literature for the research. In a scientific inquiry such as this, it is imperative to identify relationships between the reviewed literature and research objectives and between the research problem and reviewed literature. Further, it behoves the researcher to ensure these relationships exist, and this is evidenced in the current research. The fundamental question that underpinned the current research was: "*How could leaders of gold mining economies initiate proactive steps to assure practical implementation of codes and regulations related to gold mining to assuage the adverse impact of mining on the environment while improving on the precious metal's contribution to national and global GDP?*

Data required for the development of discussion in this section were obtained from textbooks, peer-reviewed articles published in journals and grey literature. Other sources were Google's search engine, including macro trends and databases from the United States Geological Survey and the World Bank. The following key phrases were used to generate relevant information from the Google Search Engine and other relevant databases for the discussion: gold measurements, gold mining, gold production, mining and the environment, and types of gold.

Extended discussion in this section was facilitated under five major sub-themes. These included gold colours and measurements, the use of gold as a symbol and investment, the types and durability of gold, gold mining and concentration techniques, and the effect of mining on the environment. Discussions in this section contributed significantly to the purpose of the research. That is the identification of various mining techniques, the effect of mining on the health of individuals and the environment, and the usefulness of gold to investment and social lives. A theoretical framework preceded discussions on reviewed literature in this section.

2.1. Theoretical Framework

Some of the novel and captivating theories of investment propounded and introduced to the domain of macroeconomics include the *Profits theory of investment*, *Duesenberry's theory of investment*, *Financial theory of investment*, *Jorgenson's neoclassical theory of investment*, *Tobin's Q theory of investment* and *Accelerator theory of investment* (Chand, n.d.). Other theories include the *Naïve accelerator theory* and *Flexible accelerator theory or lag in investment*. These theories facilitate the analysis and establishment of a relationship between output and investment (Agarwal, n.d.; Chand, n.d.). The Naïve accelerator theory of investment is so called because it remained indifferent to the availability of funds or size of the required change in the stock of capital. The theory was advanced prior to the emergence of Keynesianism but was popularised during that period (Agarwal, n.d.).

One of the assumptions underlying the Simple acceleration principle is the tendency to make optimal adjustments to capital stock without any time lag. However, this assumption and a set of others underlying the Simple acceleration principle were considered tenuous (Chand, n.d.). This perceived weakness in the assumption of the simple acceleration principle is "healed" by the flexible accelerator theory through the identification of lags in the process of adjustment between the levels of capital stock and output (Koyck as cited in Agarwal, n.d.; & Chand, n.d.). The *flexible accelerator theory* or *lags in investment* formed the basis of discussion in this section.

The flexible accelerator theory was developed on the premise that the firm's rate of investment would be greater if the identified gap between desired capital stock and actual capital stock was wider. The proponents argued that due to the limited availability of resources, it may be impossible for the firm to fill the investment gap within one year. To this end, the firm may complete or plan to complete only a fraction of the existing investment gap in each period. Thus, net investment is a function of the difference between existing capital stock for the previous year and planned stock of capital for the current year. To illustrate, assume the stock of capital for the previous year is denoted by Kt-1; the desired stock of capital for the current year is denoted by Kt, and a fraction of the investment gap is denoted by α. The following equation expresses the firm's actual capital stock (Kt) at the end of the current financial year:

$Kt - \alpha = (Kt^* - Kt\text{-}1)$ … (i)

It is worth noting that the desired capital stock during the current year is dependent on expected output. The rate at which adjustments to net investment occur is explained by the coefficient, $1 - \lambda$. An adjustment to the net investment in the unit period is determined to have occurred if $\lambda = 0$ [i.e. $(1 - \lambda) = 1$] (Koyck as cited in Chand, n.d.). Suppose Firms A and B have different decisions and delivery lags. In aggregate, the effect of the rise in demand on the stock of capital would be distributed over a given period. The implication is that the stock of capital at time t depends on previous output levels. That is:

$Kt = ƒ (Yt, Yt-1 … Yt-n)$ … (ii)

The relationship between output level and stock of capital during time period t0 is fixed. Thus, the two variables maintain a fixed relationship at the initial stage of investment and production or output demand. Increases in demand for output are met with a gradual increase in the stock of capital after the decision and delivery lags and levels of previous output are determined. Due to limited availability of resources, it is more likely than not for the firm's investment in each period to be planned in a manner that would allow for at least, a fraction of the current capital gap to be filled. As a result, Equation (i) could be rewritten as follows:

$Kt = Kt-1 + α (K^* - Kt-1)$ … (iii)

The above equation (iii) is indicative of the fact that the firm would have to make a net positive investment in order to fill the gap between the end-of-current year's stock of capital and the stock of capital for the previous year. This is mathematically expressed as:

$In = Kt - Kt-1$… (iv)

Relative to Equation (i), the firm's net investment could be expressed as:

$In = α (Kt^* - Kt-1)$ … (v)

Where $1 > α > 0$

Where:

In symbolises net investment;

α represents a fraction of the investment gap;

Kt is the stock of capital at the end of the current year;

Kt-1 represents the stock of capital for the previous year.

Indeed, Equation (v) affirms the underlying premise or prediction of the flexible accelerator theory. That is, the net investment would be greater when the identified gap between the desired stock of capital and the actual stock of capital is wider. Suppose Firm A has the following data: Kt = GH¢500,000; Kt-1 = GH¢300,000; and α = 0.4. Firm A's net investment during the period would be:

In = 0.4 (GH¢500,000 - GH¢300,000) = 0.4 (GH¢200,000) = GH¢80,000.

The computations reveal an increase in actual capital stock by GH¢80,000 during the current year. If the desired stock of capital remains fixed at GH¢500,000 in the following year, the net investment to be required would be lower. When investments are made year after year, over time, the firm's desired capital stock would equal actual capital stock. This is how the theory derived its name as a flexible accelerator, and the investment's dynamic behaviour is expressed in Equation (v), which affirms year-on-year changes in the economic variables, Kt and Kt-1 (Koyck as cited in Agarwal, n.d.; & Chand, n.d.).

We observe that the analysis of investment, as outlined in the flexible accelerator theory, transcends current financial periods to include future or long-term periods. Investments in the current year have an influence on investments in subsequent years. The theory assumes a constant relationship between expected output and desired stock of capital, and the latter depends on the former at any given time period. Expected deflationary conditions in future years may be met with future decreases in production or output levels. When this occurs, the desired capital stock would decrease and possibly fall below the actual capital stock, thereby resulting in negative net investment. That is a considerable reduction in replacement investment (Koyck as cited in Agarwal, n.d. & Chand, n.d.).

Conversely, an expected future increase in output levels would result in a surge in desired capital stock in excess of actual capital stock. The marginal efficiency of capital (MEC) has a strong influence on future output levels; whether future output levels will increase or decrease is dependent on the marginal efficiency of capital. Attainment of desired capital stock is determined to a large extent by variations in the marginal efficiency of capital. The inference is that future changes in business operations and output are factored into the analysis of the gap between desired capital stock and actual capital stock. Due to the foregoing function, the flexible accelerator theory is also referred to as a study centred on the dynamic behaviour of investment (Koyck as cited in Agarwal, n.d. & Chand, n.d.).

The past capital stock is strongly considered when the level of investment is determined. The former is invariably dependent on the level of output in the past. Given that the determination of investment for the current financial year is influenced by output level in the past or stock of capital in the previous year (Kt-1), the flexible accelerator is also termed as *investment lag* (Koyck as cited in Agarwal, n.d.; & Chand, n.d.). Explanations of the *dynamic accelerator* are facilitated by the Cobb-Douglas Function, which states:

$In = α [αY ÷ (ic - Kt-1)]$ … (vi)

Where:

In represents net investment;

α denotes a fraction of the investment gap;

Y represents income;

αY denotes capital parts of income (Y);

ic is the cost of investment;

Kt-1 is the stock of capital for the past year.

Generally, a positive relationship between net investment (In) and income (Y) is established when the stock of capital in the past (Kt-1), cost of investment (ic), capital parts of income (αY) and a fraction of the investment gap (α) remain constant. However, it is feasible for the existing gap between the actual stock of capital and the desired stock of capital to be closed through increases in the actual stock of capital. The latter objective could be achieved by increasing net investment in subsequent years (Koyck as cited in Agarwal, n.d. & Chand, n.d.).

We know K* remains the desired stock of capital, and Kt-1 represents the actual capital stock recorded in the past period (t-1). The identified gap between the two variables could be closed through a year-on-year increase in net investment until, say, time period t+3. All else held constant, and increases in net investment over a given period would close the gap between actual stock and desired stock. This closeness in the gap would imply a decrease in net investment in subsequent years (Koyck as cited in Agarwal, n.d. & Chand, n.d.).

The flexible accelerator theory is also called the *capital stock adjustment model*. Chand (n.d.) noted the contribution of various versions of the flexible accelerator theory of investment by Koyck, Chenery, Junankar and Goodwin. However, the approach propounded by Koyck remains the most acceptable and underpinned the discussion in this section. The usefulness of the flexible accelerator theory is exemplified in its ability to resolve challenges related to lags in demand for investment and its considerations for excess capacity and depreciation in the adjustments for stock of capital, among others.

2.2. Gold Colours and Measurements

Davis (n.d.) described gold as one of the most precious metals in the world. It is a member of the transition of metals; it sits in the same periodic table column as copper and silver; it is glamorous, shiny and the subject of numerous bank robberies in movies; and it is found in the *coinage metal* group. The latter is a collection of precious metals used in the production of currencies. King (2021) argued that none of the minerals mined from the earth is as useful as gold, and the diversity of special properties forms the basis of its socio-economic usefulness. Other uses include its ability to conduct electricity and be drawn into wire, making it very easy to work and be hammered into thin sheets and easy to blend with other metals.

King (2021) termed gold a precious and memorable metal that occupies a special place in the minds of humankind; it has a dazzling gleam and magnificent colour; and could be melted and cast into highly detailed figures or forms. Today, gold plays a crucial role in the manufacture of significant objects such as Olympic medals, Grammys, wedding and engagement rings, crucifixes, ecclesiastical art and money, among others. The author argued that the prominence and visibility of gold in our contemporary society are simply unheralded by the other precious metals in the same category. Davis (n.d.) labelled gold as highly pliable and ductile and an easy conductor of heat and electricity.

Hustedt Jewelers (2021) noted that the volume of pure gold in yellow gold alloy with a lower-carat rating is less; this mutes the colour and increases its affordability. However, its durability is not compromised. Constellation of information on jewellery's quality mark or hallmark includes its carat rating. As a result, every piece of jewellery manufactured with yellow gold alloy has the carat rating engraved on it by the jeweller. However, the fragility of pure gold weakens its practical use among contemporary consumers; its use is facilitated when blended with other metals to ensure a thick and strong surface (Don Roberto, 2018).

Hoffmann (n.d.) attributed the colour of gold to the structure of the gold atom. The latter is noted for absorption of electromagnetic radiation with wavelengths less than 5,600 angstroms but reflects wavelengths in excess of 5,600 angstroms, the wavelength of yellow light. The chemical stability of gold is dependent on the relative instability of the compounds it forms with water and oxygen. The foregoing is a feature that facilitates gold refinery from less important metals through the oxidation of the other metals and their separation from the molten gold as waste or dross. Generally, sophisticated metalworking equipment is not required to shape pure gold into required intricate structures, owing to its malleability or softness.

The foregoing notwithstanding, Hoffmann (n.d.) affirmed the possibility of ready dissolution of gold in a number of solvents, including dilution of solutions of sodium cyanide and oxidisation of solutions of hydrochloric acid. The formation of very complex and stable ions facilitates the dissolution of gold in these solvents, and it is possible for gold to melt at a temperature of 1,064 degrees Celsius or 1,947 degrees Fahrenheit. The amenability of gold to recovery through placer mining and gravity concentration techniques is enhanced by its relatively high density, that is, 19.3 grams per cubic centimeter.

Eternity Rose (2020) observed a minute difference between rose gold and white gold. It argued that the obvious difference between these two gold alloys lies in the distinct volume of gold and other metals that are mixed together to transform the shade or colour from pure gold to either rose gold or white gold. White gold could be manufactured in different carats, including 9-, 14- and 18-carat. Nine-carat white gold contains less quantity of pure gold; it has 62.5% of silver in its blend. As a result, it appears whiter than 14- and 18-carat white gold, which are relatively more yellowish because they contain more gold in their respective blends. Conversely, 18-carat white gold is a blend of pure gold containing a minimum of one other white metal, usually nickel or palladium. The common blend of other metals with pure gold in the manufacture of 18-carat white gold includes 17.3% nickel, 5.5% zinc and 2.2% copper.

Bullion by Post (2021) referred to silver as a noble metal. Its component in a gold blend makes it very tarnish resistant and increases the level of hypo-allergenic. That is, it reduces the level of allergic reaction or eliminates its occurrence. White gold is popular for its common use in the creation of jewellery. Mostly, platinum or palladium is blended with pure gold to derive white gold, though snippets of zinc and nickel could be added. White gold alloys are believed to be scratch-resistant compared to yellow gold (Peridot, n.d.) and very durable, owing to the inclusion of hard metals such as palladium or platinum in the alloy composition. In terms of price differentiation, yellow gold is less affordable than white gold. World Gold Council (2021a) noted that electroplating could be adapted to provide surface colour for gold items. However, this gold decoration is likely to peel off over a period of time since it remains only a surface finish.

Peridot (n.d.) identified different gold-plating options available to jewellers in the gold markets. These include gold layered, gold leaf, gold-overlay or rolled gold-plated, gold-filled, vermeil and gold-plated options (Hustedt Jewelers, 2021). In the United States, there are no standard Federal laws on how gold should be layered, implying layered gold jewellery could have very thin gold layers. In some cases, it is possible for gold to be hammered manually into very thin layers and be glided or wrapped around the metal. This is known as gold leaf. For artworks and jewellery-decoration purposes, 22- and 24-carat are used as thin gold sheets or layers. Recognition of gold leaf jewellery is facilitated by irregularities of the foil surrounding the items (Peridot, n.d.).

Eternity Rose (2020) averred that variations in the properties of white gold depend to a large extent on the quantities of gold and other metals used in the alloy. The number of other metals that jewellers decide to blend with pure gold is predicated on their purpose. For instance, a combination of gold and nickel helps create a hard blend or alloy that is suitable for rings, ornaments, and brooch pins. Similarly, gemstone settings in which malleable gold blends are needed are often created when softer metal, such as palladium, is mixed with gold. Further, rose gold is created when gold is blended with copper. The latter adds a red tinge to the blend. A higher copper content increases the redness of the final gold alloy. The blend of gold with other metals makes it impossible to manufacture pure, undiluted 100% or 24-carat white gold or rose gold. As an example, a common blend for rose gold is 25% copper and 75% gold. Roberto (2018) noted that the pinkish colour of rose gold is a result of the inclusion of 25% copper in the alloy composition.

Bullion by Post (2021) revealed that one of the major components of common currency coins prior to the 1930s was gold. However, there was no actual gold in the gold-coloured coins circulated during the period. Today, these gold coins are sought-after for collection purposes. Moreover, for investment purposes, refineries throughout the world continue to mint gold bullion coins with legal tender face value. Bullion by Post (2021) noted that in the event of financial settlement or court action, the face values of these gold bullion coins serve as minimum guarantee price. The legal tender values of the mint gold and silver coins are comparatively less than the value of the physical metal they contain; the true values of these gold and silver coins are expressed in the metal, which is priced per ounce.

In some cases, gold is mixed with other metals to create gold alloys in colours that are rarely encountered but found in the markets. For instance, a blend of pure gold with metals such as iron, aluminium, cadmium or silver could result in purple, blue and green gold. Eternity Rose (2020) affirmed the popularity of red gold in the Middle East and its high copper content. To illustrate, 14-carat red gold usually contains 41.7% copper and 58.3% gold. Though there are many gold colours, Roberto (2018) identified rose gold, yellow gold and white gold as the most sought-after in the global jewellery markets.

Roberto (2018) postulated that colour remains the biggest choice that jewellery consumers are confronted with when choosing the preferred type of gold. Thus, the colour of gold to be chosen remains a personal preference for the consumer. When decisions are made on the purchase of gold jewellery, it is imperative for consumers to consider their respective preferences or the preferences of persons for whom the gifts are being bought. Further, it is instructive for consumers to consider the colour that visually appeals the most to them and the colour that best suits their clothing style and skin tone.

Bullion by Post (2021) observed that gold generally appears in four basic colours or shades. However, the colour appearance is contingent on the blend. The four fundamental colours of gold include white gold, yellow gold, green gold, and rose gold, albeit it is possible to derive other colours, such as black gold, purple gold, blue gold and grey gold (Hustedt Jewelers, 2021; World Gold Council, 2021a). Examples of other common metals mixed with gold in the creation of gold alloys include nickel, iron, cadmium, aluminium, platinum, silver, palladium, copper and zinc. Generally, there are two pure-coloured metals. These include gold and copper. The latter is reddish brown, and the former is yellow. All other metals remain grey or white in colour but have varying effects on the eventual colour of gold blends (Bullion By Post, 2021).

Naturally, platinum is a white metal. U.S. Geological Survey (n.d.e) believed white gold was developed originally to mimic platinum. White gold blend contains 25% nickel and zinc and 75% pure gold in its composition. U.S. Geological Survey (n.d.c) noted the existence of a *fool's gold*. That is, the tendency for consumers to mistake other metals as gold. Examples of these metals include pyrite, chalcopyrite and mica. When poked with the tip or point of a metal, these gold-like metals could crumble, flake or reduce to powdered form. However, poked gold is likely to indent or gouge like soft lead. Further, scrapped pyrite or chalcopyrite on a piece of unglazed porcelain would most likely leave a dark green to black streak, whereas pure gold would leave a golden yellow streak, and common mica would leave a white streak.

Roberto (2018) shared that the types of metals and their respective quantities in the alloy influence the extent of variation in the properties of gold. The jewellers' purpose and intended final price per piece of jewellery determine the quantities of other metals alloyed with gold in the production process. In gemstone settings, a malleable gold blend is often needed, and this idealises the alloy of gold with softer metals such as palladium. Yellow gold appears unique among the various gold colours due to its popularity and remains the colour that most consumers consider to be truly golden, while electrum or green gold is believed to have a natural colour. When alloyed, yellow gold has a composition of zinc, copper, silver and pure gold. Similarly, Peridot (n.d.) described yellow gold as the purest colour, the one that requires the least maintenance of all the gold colours, and the most hypo-allergenic. That is, yellow gold is not likely to cause any allergic reaction. Roberto (2018) described yellow gold as not only the purest form of precious metal but also naturally occurring.

Peridot (n.d.) noted a wane in the popularity of yellow gold in prior years when its unit price skyrocketed in the gold markets, and consumers had to search for alternatives or alternatives with good quality at affordable prices. Thus, the hike in the price of yellow gold compelled many consumers to purchase more white gold than the former. This new trend in demand increased the popularity of white gold in the last twenty to thirty years. The author noted increased demand for white gold alloy for the manufacture of wedding and engagement rings, among others, in recent years.

Eternity Rose (2020) noted that, similar to yellow gold, the purity of white gold is measured in carats. A carat is expressed as 24ths of gold. To illustrate, white gold that is 18-carat contains 75% gold ($(18 \div 24) \times 100\% = 0.75 \times 100\% = 75\%$); 14-carat has 58.33% gold ($(14 \div 24) \times 100\% = 0.58333 \times 100\% = 58.33\%$); 12-carat contains 50% gold ((12 ÷ 24) x

100% = 0.5 x 100% = 50%); 10-carat includes 41.7% gold ((10 ÷ 24) x 100% = 0.41666 x 100% = 41.7%); and 9-carat has 37.5% ((9 ÷ 24) x 100% = 0.375 x 100% = 37.5%) gold content. World Gold Council (2021a) affirmed that in the West, carat is expressed in fineness. The formula for measuring fineness could be expressed simply as: ((x-carat ÷ 24-carat) x 1000), where x-carat refers to the gold caratage to be measured, and 24-carat is constant. The fineness is expressed in decimal. To illustrate, 24-carat gold is expressed as 1000 parts of 1000 pure or fineness 1.000. Similarly, 22-carat is expressed in fineness as 0.9167 ((22 ÷ 24) x 1000 = 0.91666 x 1000 = 916.7); and 21-carat expressed as 0.875 ((21 ÷ 24) x 1000 = 0.875 x 1000 = 875). The respective fineness for 18- and 14-carat gold are 0.750 ((18 ÷ 24) x 1000 = 0.750 x 1000 = 750) and 0.583 ((14 ÷ 24) x 1000 = 0.58333 x 1000 = 583.33).

World Gold Council (2021a) underscored the need for us to appreciate and understand the differences among 18-, 22- and 24-carat gold. Similar to rose gold alloy, 18-carat gold is a blend of 75% gold and 25% other metals, such as silver and copper, among others. The colour of 18-carat gold is slightly dull, and it is less expensive compared to the costs of 22- and 24-carat gold. Recognition of 18-carat gold jewellery in the market is relatively easy; the jewels are usually engraved with 18k, 18k, 18Kt or variations that are similar to the foregoing. In some cases, 18-carat gold jewellery is stamped with 0.75, 750 or related stamp. This implies that the gold content in the jewellery is 75%. Some diamond jewellery and studded jewellery are examples made in 18-carat gold.

Jewellery made in 22-carat gold means twenty-two parts of the jewellery are gold, and the remaining two parts comprise other metals than gold. Twenty-two-carat gold is commonly used in the manufacture of plain gold jewellery. In percentage terms, 22-carat gold tells us the pure gold content is equivalent to 91.67% ((22 ÷ 24) x 100% = 0.91666 x 100% = 91.67%); other metals such as zinc, nickel, silver, and others, constitute the remaining 8.33% (100% - 91.67% = 8.33%). The texture of pure gold is hardened by the additional metals, and this extends the durability of the final product (jewellery). Unlike 18-carat gold, 22-carat gold is not preferable for heavily studded and diamond jewellery (World Gold Council, 2021a).

In 24-carat gold, all the 24 parts contain pure gold. It is the highest form of gold caratage; it has a distinct bright yellow colour, and no traces of other metals are found. To this end, it is often called 100% gold or pure gold. Although it is called 100% gold, the purity of 24-carat gold is believed to be 99.9%. Naturally, the highest gold content and purity make 24-carat gold more expensive than 22- and 18-carat gold. These qualities notwithstanding, 24-carat gold is lesser in density compared with 22- and 18-carat gold. This makes it soft and easily pliable and not suitable for regular types of jewellery. However, it is useful for gold coins and bars and in manufacturing electronic equipment and medical devices, such as gold tympanostomy tubes, used to improve the aeration of the middle ear (World Gold Council, 2021a).

Peridot (n.d.) emphasised the need for consumers to always search for the carat mark "c" or "k" when buying gold jewellery. The carat mark usually provides valuable information on the volume of gold contained in the jewellery. This lends credence to the argument that the search for the carat mark must be primary. That is, it must precede any other information that the consumer may be interested in knowing about the piece of jewellery at issue. The quality stamp on a piece of jewellery indicates its type of gold coating; without the quality stamp, it is pretty difficult to ascertain the type of gold used in the manufacturing process, whether gold-filled, gold-plated or rolled gold and many more.

Peridot (n.d.) averred that a manufacturer's trade mark on a piece of jewellery provides essential information on the accuracy of the carat mark. The trade mark, which is found next to the carat mark, accentuates and assures the consumer of the quality of the jewellery as indicated. It maintained that pure gold is a soft metal and susceptible to bend and scratches. To this end, it is seldom that pure gold is denoted as 24-carat. The durability of pure gold is improved when it is alloyed with other metals. Consistent with Hustedt Jewelers (2021), Peridot (n.d.) affirmed the frequent use of 14-carat gold in the manufacture of jewellery in the United States. That is, most jewellery in the markets comprises 58.3% pure gold and 41.7% other metals. Under the Minerals law of the United States, it is forbidden to sell or denote a piece of jewellery as "gold" if the gold content is less than 10 carats. Thus, in terms of caratage, existing Minerals law in the United States approves the sale of "gold jewellery" manufactured with 10-carat gold and above.

Consistent with Eternity Rose (2020) and World Gold Council (2021a), Bullion by Post (2021) maintained that the purity of gold is generally measured in fineness or carat. Pure gold is presumed to have twenty-four parts, and carats constitute all the parts. Fineness is measured in parts per thousand, with 999.9 indicating pure gold. When measured in carats, 24 carats connote pure gold. Bullion by Post (2021) argued that neither the measurement in carats nor fineness gives a clear indication of the quantity of other metals or metals in the composition of the alloy. Rather, this information is furnished or facilitated through mints.

2.3. Use of Gold as Symbol and Investment

Gold proved to be a unifier in the medieval ages. For instance, King (2021) recalled the Spanish explorers, led by Hernan Cortes, the renowned Spanish Conquistador (Dowd, 2016), who met the native people of South America when they first arrived in the "New World" in the 16th century. The Spanish explorers realised that indigenous civilisation had been established in the New World for millennia. The vast ocean remained a firm block between these two distinct cultures; they lived entirely different lives, spoke different languages, and had never come into contact with each other. Despite this plethora of socio-cultural differences, they were found to have one thing in common. That is, both cultures held gold in the highest esteem and were already using it to create some of their most significant objects.

King (2021) and Dowd (2016) recounted the symbolic use of gold as an accomplishment, purity, beauty and power in every established culture throughout human history. Hoffmann (n.d.) acknowledged the use of gold in medieval periods for coinage and integrally for decorative purposes. Precious metal served as a raw material for the manufacture of ornaments, jewellery, statuaries, monuments, goblets, glasses, artilleries, and weapons. Further, the colonisation of the

New World during the 16th century facilitated gold mining and refineries in Central and South America prior to shipment to Europe. However, the mines in the New World were a greater source of silver than gold.

The National Mining Association (as cited in Dowd, 2016) described gold as an antiquated precious metal whose usage among cultures as decorative objects in modern-day Eastern Europe dates back to 4000 BC. Ancient Egypt benefited tremendously from its gold-bearing region called Nubia. It was during this era that the fire assay method was discovered by the Babylonians. The fire assay method remained one of the effective means of testing the purity of gold. Due to its efficacy, the method is still applicable today.

Dowd (2016) added that for several centuries, gold was used essentially to manufacture jewellery and to create idols for worship. This trend continued until around 1500 BC when the ancient Egyptian empire first declared gold as an official medium of exchange for international trade. The popularity of Egypt surged when it created the coin called shekel, and it was accepted as a standard unit of measurement in the Middle East. The shekel weighed about 11.3 grams; it was manufactured from a naturally occurring blend known as electrum, and its alloy composition was one-third silver and two-thirds gold.

Bullion by Post (2021) hinted that jewellers' decision to include copper in the composition of gold alloy helps rose gold to obtain its reddish colour. Another metal included in the rose gold alloy is silver. Both copper and silver are relatively cheaper. Generally, this makes the unit price of rose gold quite affordable in the precious metals markets. Green gold is found in the earth's crust with trace quantities of copper and other metals. It is called electrum and could also be manufactured with cadmium. Further, green gold has a very subtle green colour, which is attributed to the silver component. Green gold is described by experts as the only blend that occurs naturally. It is worth noting that green gold alloy with cadmium components is toxic to the skin.

Bullion by Post (2021) maintained that pure gold could be supplied in the form of ingots or bars as raw materials. These gold bars could be blended with other metals for specific purposes. In addition to their wealth as raw materials, gold bullion ingots and bars are often described by investment experts as safe-haven for stores of value. Moreover, they are easily traded and free from counterparty risks. Inarguably, the inclusion of gold in investments improves the diversification of the portfolio and serves as a strong hedge against risk inherent in other investments. However, minted gold bullion coins as legal tender tend to have tax advantages over gold investment bars and ingots.

The Minerals Commodity Summaries for 2019, released by the United States Geological Survey (as cited in King, 2021), depicted how gold was utilised in the United States during the period. The percentage distribution showed that jewellery manufacturing consumed 50% of all gold mined and imported into the country in 2019. During the same period, gold used for electronics-related items constituted 37%, while the remaining 13% was spread between the minting of official coins (8%) and other uses (5%). Conspicuously missing from the summary analysis during the period was data on gold bullion. Though not explicitly stated, one may be impelled to infer that gold bullion formed part of the other uses, which constituted 5%.

Peridot (n.d.) argued that gold jewellery is usually not pure gold. Simply, it is a blend or combination of various metals. Different gold colours are created when pure gold is alloyed with copper, zinc, silver, nickel and palladium. These colours represent different gold jewellery. Peridot (n.d.) reiterated that green, rose, white and yellow are the most common gold colours in vogue, though there are many other colours that are derived from gold alloys (Hustedt Jewelers, 2021; World et al., 2021a).

Dowd (2016) reaffirmed the global adaption and implementation of the gold standard several decades ago. The author described the gold standard as one of the limited commodities that could readily be taught of and considered as a monetary asset or currency and affirmed its continuous use as a safe-haven investment asset in perilous economic times and as a strategic way of preserving wealth. Inarguably, gold's sterling features and qualities transcend its natural beauty to include its role as the most useful precious metal across the globe. IG (2020) noted the presence of volatilities even when equity markets are characterised by marked stability.

2.4. Types and Durability of Gold

Nuggets are generally found in and on the banks of streams. King (2021) affirmed that craftsmen could employ primitive tools to transform gold nuggets into valuable ornamental objects. Thus, transforming gold nuggets into economic utility does not require sophisticated tools and technology. However, it could assure jewellers of decent earnings and improved living standards. Similarly, Hoffmann (n.d.) revealed that it is possible for jewellers to transform pure gold into desired intricate structures and shapes in commercial quantities with less sophisticated metalworking tools.

Davis (n.d.) identified the resilience of gold and its ability to resist oxidation as some of its major properties. Due to exposure to oxygen at room temperature and room conditions, metals often form oxides later on their respective surfaces. However, gold does not form this layer with ease. Further, gold is not affected by most bases and acids. It is possible for an ounce of gold to be stretched to cover more than 300 square feet. The density of gold is extremely high; it is measured at 19.3 grams per cubic centimeter, which is slightly greater than lead.

In terms of pricing in the gold markets, pink or rose gold is more affordable than the other gold colours. This is because copper, a relatively less expensive metal, is alloyed with pure gold in the creation of rose gold. The copper component in the alloy composition increases the durability of rose gold relative to white and yellow gold. Silver has proven to be a very strong and influential metal in the alloy composition of pure gold. For instance, the green nuance of the gold blend is facilitated by the silver component (Peridot, n.d.).

Roberto (2018) observed a relationship between generation and fashion trends. He noted that fashion trends are reinvented by every generation to suit the members' tastes and preferences. The foregoing holds true for the popularity and choice of gold colours among generations. The growing taste for white gold was believed to have increased in the

1990s after a surge in the popularity of yellow gold from the 1960s through the 1980s. The author noted the growing popularity of rose gold in recent years and that all jewellery is timeless. To this end, the choice of a particular gold colour is contingent on the consumer's taste and preference and what he or she seeks to showcase to the rest of the world.

Generally, jewellery with the inscription gold-electroplated or gold-plated implies they have very thin layers of gold on the surface of the base metal. The latter could be either brass dipped into gold or stainless steel. Electroplating enables the jewellery to have the appearance of gold. Peridot (n.d.) indicated that for a gold layer to be named electroplated or gold-plated, it must be of at least 10-carat gold quality and must have a thickness of at least seven million ths of an inch. The durability of very thin-layered jewellery cannot be guaranteed; it is more likely than not for extremely thin-layered gold jewellery to wear off over time.

It is possible for some bullion gold coins to be minted from pure gold that weighs 24 carats. Notable among these include the one-ounce gold Britannia, which weighs 31.10 grams. To ensure other coins are hardened, they are minted from blends. However, the final weights of these blends do not determine their respective market prices. Rather, the gold content in the alloys determines their market prices. To illustrate, a one-ounce gold Krugerrand has a fineness of 916.7 and weighs more than an ounce; the gold content is estimated at 31.10 grams in addition to the weight of other blending metals or metals. The market price is not contingent on its weight but on the gold content in the alloy. However, it is imperative to note that gold coins are a member of the *pure gold bullion investments family. S*imilar to gold bars and ingots, gold coins serve as a safe haven for stores of value; they are free from counterparty risks of government or bank actions and have the potential to diversify investment portfolios (Bullion By Post, 2021).

The quality of gold-plated jewellery is determined by the stamp – "GP; GP; GEP; GEP" for 10-carat gold-plated jewellery, "GO; GO; RGP; RGP" for 10-carat gold overlay jewellery, and "GF; GF" for 10-carat gold-filled jewellery. For 10-carat gold-plated jewellery, consumers are likely to come across the following stamps: "10K GEP; 10K GP" or" 10K GP." Consumers of 10-carat gold overlay jewellery may see stamps such as "1/40 10RGP; 1/40 RGP" or" 1/40 10K GO" while 10-carat gold-filled jewellery may be affixed with either of these stamps: "1/20 10K GF" or "1/20 10K GF" The modern stamp for sterling silver is S925; previous versions (which are still in use) are .925 or 925. The number on each stamp stands for 7.5% blended metals and 92.5% pure silver (Peridot, n.d.).

Peridot (n.d.) asserted that for individuals with skin allergies, vermeil gold jewellery is a better choice than the other gold-plated metals because the former has a thicker gold layer and adapts sterling silver as its base metal. Unlike many other gold-plated pieces of jewellery, vermeil gold jewellery is usually not marked. However, gold jewellery with a "925" stamp may imply they are vermeil. Contrary to the claims of Hustedt Jewelers (2021), Peridot (n.d.) argued that vermeil jewellery has thicker gold layers than gold-filled jewellery.

Peridot (n.d.) hinted that the base metals for gold-filled jewellery are either copper or brass, covered by sheets of gold, implying gold-filled jewellery is actually not filled with gold. This notwithstanding, it has some good qualities. For instance, gold-filled jewellery remains the safest choice for most people with sensitive skin. The gold content in the alloy must be at least 5% (or 1/20) of the total weight, and the gold content must be of at least 10-carat gold quality. With reasonable care, the gold layer on gold-filled jewellery is not expected to wear off or fragment.

The fire refining process for gold was found to be less effective following the introduction of chlorine gas and electro-refining technologies in the 19th century. These novel technologies were very useful in refining impure gold and increased the pure gold extraction rates that had earlier been achieved through fire refining. Emil Wohlwill invented the electro-refining technology and introduced it in Hamburg, Germany, in 1878. E. B. Miller invented the chlorine gas technology and patented it in Great Britain in 1867 (Hoffmann, n.d.).

Hoffmann (n.d.) revealed that gold contained in major gold ores is generally found in its natural form. Gold ores could be endogenetic and exogenetic. They are *endogenetic* when they are formed within the earth. Layered and vein deposits of elemental gold in quartzite or blends of quartzite and various iron sulfide minerals, especially pyrite (FeS2) and pyrrhotite (Fe1-x S) are examples of endogenetic gold ores. Usually, endogenetic gold ores found in sulfide ore bodies are still in their elemental form and very finely disseminated. This state of endogenetic gold ores makes it difficult, if not impossible, for the gold to be concentrated through the use of methods as applied to alluvial gold deposits.

However, gold ores are termed *exogenetic* when they are formed at the surface of the earth. Alluvial gold remains the most "celebrated" example of exogenetic gold ores and the type most commonly mined in ancient times. King (2021) and Hoffmann (n.d.) described alluvial gold as the type of gold commonly found in flood plains, riverbeds and streambeds. Invariably, alluvial gold is elemental and often made up of very fine particles. It is believed that weathering actions of rain, wind and changes in temperature on rocks that contain gold help in the formation of alluvial gold deposits. Further, it is possible for exogenetic gold to exist in the form of oxidised ore bodies formed through a process known as secondary enrichment. Under the secondary enrichment process, sulfides and other metallic elements are gradually leached away to leave behind insoluble oxide minerals and gold as surface deposits.

Peridot (n.d.) stressed that the durability of gold-overlay jewellery over time is assured by their thicker gold coatings. Unlike gold-filled jewellery, gold content in the alloy of gold-overlay jewellery may be less than 5% (or 1/20) of the total weight. However, the gold content must be of at least 10-carat gold quality, and the base metal could be stainless steel, copper or brass. Similarly, Roberto (2018) firmly believed that the durability and cost of a piece of jewellery are predicated on the quantity of gold in carats used in the manufacturing process. For instance, 14-carat gold jewellery has more other metals in the alloy and less gold than 18-carat gold jewellery. The inclusion of other metals in the blend makes 14-carat gold jewellery more affordable and durable for daily wear. However, the high gold content in 18-carat gold jewellery makes it more expensive and durable for daily wear as well.

2.5. Gold Mining and Concentration Techniques

Hoffmann (n.d.) maintained that the most common gold mineral is natural or native gold. It accounts for nearly 80% of the gold found in the earth's crust. Occasionally, it is possible to find natural gold as nuggets as large as half of an inch or 12 millimetres in diameter. However, on rare occasions, it is possible to discover natural gold nuggets that weigh up to 50 kilograms; the largest found thus far weighed 92 kilograms. The content of silver in natural gold is estimated between 0.1 and 4.0%; silver content in electrum, which is a gold-silver blend, is believed to be between 20% and 45%. The colour of the electrum is believed to vary from pale yellow to silver white and is typically linked to mineral deposits of silver sulfide.

Dowd (2016) noted that around 1200 BC, the Egyptians began to experiment with the casting method known as lost-wax casting. Under this method, duplicate gold sculptures were cast from original wax sculptures. This process allowed for the creation of sculptures that were characteristically intricate. The effectiveness of the casting method called for its retention in the contemporary gold manufacturing industry.

Hoffmann (n.d.) asserted that it is possible to blend gold with tellurium to form other minerals. Notable among these include sylvanite ($AuAgTe4$) and calaverite ($AuTe2$). There are many other gold minerals that could be derived from. However, they are sufficiently rare and have little economic significance. South Africa is home to 50% of the total gold ore mineral reserves known across the globe. Imperatively, the world's largest single body of gold ore is found in the Witwatersrand in South Africa. Most part of the remaining 50% is divided among the United States, Russia, Brazil, Canada, China and Australia.

Smith (2020) reviewed mining activities across the globe with special emphasis on gold mining and its related activities in Africa. The author found a positive relationship between environmental destruction, corrupt political activities, increased risk of human lives, illicit financing of conflicts and increased smuggling on the one hand and increased demand for gold on the other. The narratives painted a gloomy picture of the immediate-derived benefits of African economies from gold exploration, while advanced and emerging economies effectively account for their respective mining and production levels to accelerate development at various levels. However, in the mining town of Kamituga, Smith (2020) recounted that the activities of transporters, artisanal miners, traders and toolmakers were the main drivers of the local economy.

Hoffmann (n.d.) affirmed that the mining and mineral processing technique that is adapted is contingent on the nature of the gold ore deposits. For instance, economic justification for the use of extensive mineral mining techniques for oxide ore deposits is not feasible since these deposits are usually of low grade – between 3 and 10 parts per million. The appropriate technique for oxide ores is the use of explosives to shatter the deposits and pile them into heaps for extraction by cyanidation. The author noted that these heaps could be 15 to 30 metres in height and hundreds of metres long.

Extraction of gold from alluvial deposits, Hoffmann (n.d.) revealed, could be carried out through dredging from underneath rivers and ponds or through sluicing from flood plains and river banks with high-pressure hydraulic hoses. The concentration of alluvial deposits requires little or no comminution; rather, gravity techniques such as tabling or jigging suffice for the extraction process. The tabling or jiggling technique allows slurry to be channelled through jigs or over ridged or grooved tables. The latter retain the denser gold particles while permitting the much less dense sand and gravel to pass over.

Hoffmann (n.d.) hinted that it is not uncommon to find deposits of endogenetic gold ores containing elemental gold that are highly disseminated within a base metal sulfide mineral. The gold ore deposits are mined, crushed, ground and finally, concentrated. The concentration process commences with separation through gravity. The latter allows for coarse particles of natural gold to be recovered. The process concludes with froth flotation to concentrate the sulfide mineral fraction containing the gold.

Hoffmann (n.d.) averred that the *cyanidation process* allows more gold to be recovered than any other process. The cyanidation process allows for the oxidisation and dissolution of metallic gold in a solution of alkaline cyanide. Atmospheric oxygen is the oxidant employed in the cyanidation process. The atmospheric oxygen, in the presence of aqueous solution of sodium cyanide, causes the dissolution of gold. Further, it affects the formation of sodium hydroxide and sodium cyanoaurite, as claimed by the so-called Elsner reaction, which states that the gold-bearing solution is separated from the solids when gold dissolution is complete.

The cyanidation technique of vat-leaching has been found to be more appropriate for ores with higher gold content. That is content in excess of 20 grams of gold per tonne of ore. The vat-leaching process allows a slurry of ore and solvent to be held for several hours in large tanks equipped with agitators. Heap-leaching is adapted to extract gold from low-grade ores. A dilute solution of sodium cyanide is used to spray the heaps, which infiltrates through the piled ore, causing the dissolution of the gold. Usually, vat-leaching circuits have tremendous amounts of solids and solutions associated with them. This is attributed to the very low concentrations of gold in the ores (Hoffmann, n.d.).

Lebert (as cited in Smith, 2020) noted that the transportation of gold in the East African region during the COVID-19 outbreak became a challenge. The perceived challenge led to the attraction of many middlemen who ostensibly facilitated the shipment of the mined gold from the point of production to the preferred market destination. This development affected the eventual earnings of miners; a greater part of the overall gold value was earned by middlemen and final buyers who, in turn, sold to final consumers.

Hoffmann (n.d.) asserted that capital costs associated with the purchase and installation of liquids and solids equipment for gold processing are very huge. This affects production costs and eventual price per ounce of gold both in the domestic and global markets. In order to eliminate these huge costs, novel technologies have been developed to circumvent the entire separation process. One of the novel techniques involves adding granular activated carbon to the ore slurry during or after the gold solubilisation process is complete. The dissolved gold is readily absorbed into the carbon, thereby extracting it from the solution and allowing for the granular carbon to be separated from the current unproductive ore by running the slurry through a screen.

After the foregoing process is complete, gold is leached from the carbon particles through a strong solution of sodium hydroxide and sodium cyanide, and electro-winning is used to recover the gold directly from the solution onto steel wool. The Merrill-Crowe process could also be used to recover the gold directly from the solution. Generally, the Merrill-Crowe process facilitates the deoxygenation of the gold-bearing solution and its passage through a filter press, where the gold is extracted from the solution by reduction with zinc metal powder (Hoffmann, n.d.).

Gold has its chemical compounds. These include potassium dicyanoaurite, $K[Au(CN)2]$, and chloroauric acid, $HAuCl4$.The latter is used occasionally for ceramics colouring; and as an intermediate in the production of other gold compounds. The former is mostly used in gold electroplating baths. Gold salts have proven to be very useful to the human body; they are often used as anti-inflammatory drugs in the treatment of rheumatoid arthritis (Hoffmann, n.d.).

Following the outbreak of COVID-19 in 2020, the World Gold Council (as cited in Smith, 2020) predicted that investors would adopt gold as a key portfolio hedging strategy and that the pandemic was more likely than not to have a lasting effect on the allocation of investment assets in global economies. Further, COVID-19 was likely to reaffirm the value of gold as a strategic investment asset. Indeed, the price per ounce of gold on the global markets witnessed upward adjustments during the pandemic outbreak in 2020. However, prices offered to miners by local buyers in Africa witnessed a significant reduction. The level of exploitation in the Democratic Republic of Congo was believed to be dire; more middlemen were attracted instead of the regular reliance on the network of local traders in the supply chain (Lebert as cited in Smith, 2020).

2.6. Effect of Mining on the Environment

Attiogbe and Nkansah (2020) noted that the degree and rate of changes observed in our native environment are often accelerated by mining activities. Thus, mining in various forms contributes immensely to observed changes in our immediate and distant environments. These changes include indiscriminate felling of trees to prepare stretches of land for illegal mining and using chemicals with adverse impacts on water bodies, among others. The impact of pollution through mining activities on the environment could extend over several years, owing to the use of chemicals and substances with harmful effects.

Similarly, Duncan (2020) lamented on the closure of some water treatment plants in Ghana at a time when the activities of illegal small-scale miners were on the rise, and the quality of water bodies was severely impacted. Public concerns heightened due to the foregoing challenges, which were identified as inimical to the development of most communities along the affected rivers, streams, and other water bodies.

Stewart (2020) bemoaned the continuous dangers posed to human health and the environment by the activities of both small-scale miners and large-scale miners. The activities of these miners are characterised by accidents, exposure to toxins and dust, pressures from management, and stress emanating from the working environment. The foregoing activities result in a range of diseases that impact negatively on the health of mine workers.

Matschullat and Gutzmer (2012) outlined six major compartments of the environment, including lithosphere, cryosphere, pedosphere, biosphere, hydrosphere and atmosphere. Mining activities have damaging effects on any of these environmental components. However, scientists experience difficulties in the prediction of facts; and extent of damage caused by mining to these compartments.

Attiogbe and Nkansah (2020) drew on the mixed methods approach to examine the contribution of Newmont Mining Company to the pollution of various water bodies in the Akyem District in the Eastern Region of Ghana. The physico-chemical parameters test conducted for various water bodies revealed compliance with standards set by the Environmental Protection Agency (EPA) of Ghana, save the test for River Pra in which high levels of TSS were recorded. The high concentration of TSS was indicative of illegal mining activities upstream. These activities have the potential to affect the quality of the water. The researchers suggested the need for small-scale miners to be supported through training and supply of mining equipment to improve mining activities and standards and to minimise the eventual impact on the environment. The research outcomes add to the body of knowledge in the study area.

Duncan (2020) was interested in examining the effect of illegal mining activities on heavy metal pollution in the Fena River in the Amansie Central District in the Ashanti Region of Ghana. In all, seventy-two samples were collected from six distinct sampling sites and included in the research. The collection of samples was spread over a twelve-month period. That is, from January to December. The study involved the investigation of six heavy metals from the Fena River. These included copper (Cu), zinc (Zn), iron (Fe), cadmium (Cd), mercury (Hg) and lead (Pb). The researcher presented ranges of the heavy metals in water as follows: BDL for Fe, Cu, Pb, Cd, Hg and Zn; BDL – 1.041, 0.01-0.703; and BDL – 0.24, 0.17-16.43, 0.46-1.02. Analysis of the samples revealed that three metals were in excess of the standard guidelines, rendering the polluted water unsafe for domestic and drinking purposes.

Results from analysis of Nemerow's pollution index identified metals such as Fe, Cd and Pb as the main metal pollutants. However, other metals, including Zn, Hg and Cu, were found to have no contributory effect. That is, they did not contribute to the pollution effect on the water bodies. Further analysis revealed that only cadmium polluted all six sampling sites, and lead impacted five of the six sampling sites. However, mercury, which is often used in mining activities, was absent from all six sampling sites. The water quality index analysis indicated that the water quality in the two sampling sites was marginal. Conversely, the water quality recorded for the remaining four sampling sites was poor. Illegal mining activities within and around the Fena River were identified as the major cause of pollution and constant deterioration in the quality of the water. The pollution was attributed to the use of heavy metals in the water bodies (Duncan, 2020).

Aboka, Cobbina and Dzigbodi (2018) were interested in reviewing the effects of mining activities on the environment and health of individuals living in mining communities and the suburbs and identifying policy options and responses related to mining in Ghana that could lead to improvements in the health of individuals; and promote environmental quality. Aboka et al. (2018) acknowledged the valuable contribution of mining to Ghana's development and the risks and benefits accruing to individuals residing in mining communities. The authors argued that improvements in the environmental and health conditions of people living in mining areas are predicated on how effectively the impacts of mining activities are managed by the mining companies, government and adjoining communities.

The twentieth century was believed to have been characterised by a significant increase in society's use of various metals, including precious metals. However, demand for metals in general in recent years has increased considerably due to the accelerated development of notable economies such as China and India and the pace of technological advancement witnessed across the globe. Lumen (n.d.) noted expansions in the activities of metal mining and a tremendous increase in mined metals compared to stocks of metal reserved underground. An example is the volume of copper mined and available for use above ground level globally, particularly in the United States. Lumen (n.d.) affirmed the surge in the use of copper in the United States from 73 kilograms or 161 pounds per person in 1932 to 238 kilograms or 525 pounds per person in 1999.

Haddaway, Cooke, and Raito (2019) sought to examine the effects of metal mining and the effectiveness of measures related to mining mitigation on ecological and social systems in the boreal and Arctic regions and to provide evidence of this. The researchers identified mining activities as exploration, prospecting, operation, construction, expansion, maintenance, repurposing of a mine, decommissioning, and abandonment. These activities could have a profound impact on structured systems of the environment and society in diverse ways. The effect could range from direct to indirect and from positive to negative.

Stewart (2020) observed that degradation and contamination of the environment often result in ill health in adjoining mining communities. However, the costs of health treatments associated with mining are not limited to mine workers or the mining industry; they extend to everyone who shares in the socio-economic benefits of mining. The author further noted that the concentration of key actors in the contemporary global economy is focused essentially on how to derive profits from the neglect of the health conditions of workers in the mining sector. To stem the tide, the development of evidence-based solutions should be the primary focus of any partnership constituted by government, industry and academia with communities to address teething environmental issues saddled with the mining industry.

Matschullat and Gutzmer (2012) postulated that the effect of mining on the environment relates to the influence of mining activities on native conditions and the globe, which serves as residences for all biota and human kinds. The effect could manifest in diverse ways; it may be damages or changes to the environment, ranging from short- to long-term impacts and from highly spatially restricted to long-distance consequences. Further, mining activities, as comparable to any human activities, have some effects on the environment that are inherent and partly unavoidable. It is more likely than not that risks and hazards with detrimental consequences on the environment will be encountered in the mining process, and it is equally imperative that remedial measures be taken to address the phenomena as they unfold. However, those mining challenges that could be envisaged and predicted require pre-emptive solutions. That is, they should be addressed before their occurrence. The researchers indicated that the potential effects and long-term aftermath of mining activities are manifold.

Aboka et al. catalogued the environmental impacts of mining, including pollution of water bodies resulting from the application of chemicals such as cadmium, arsenic, and mercury when refining mined minerals. Other impacts include the tendency for heavy metals and other pollutants to contaminate agricultural soils, leading to erosion of agriculture, and noise pollution caused by heavy trucks from mining centres.

It is instructive, in the opinion of Attiogbe and Nkansah (2020), for the Environmental Protection Agency to enforce and ensure strict adherence to environmental laws to increase protection for water bodies and the environment in general. Finally, the development of alternative livelihoods for communities ceding lands for mining activities would reduce the number of people actively involved in illegal small-scale mining and the impact of the latter on water bodies and the environment.

Lumen (n.d.) affirmed that environmental issues emanating from mining activities could include loss of biodiversity, erosion, formation of sinkholes, and contamination of surface water, soil, and groundwater by chemicals from the mining processes. It is commonplace to observe large-scale mining companies and artisanal miners engaging in additional forest logging in the mining area. Therefore, space could be created for the storage of the debris and soil created. The health of the local population could be impacted by contamination resulting from leaked chemicals if the leakage is not properly controlled. The author described extreme examples of pollution from mining operations, including coal fires, which could last for years or decades and consistently produce significant amounts of damage to the environment.

Rajaee, Obiri and Green (2015) noted some global mining factors which can contribute to recurring health-related issues among populations in local mining communities. These include deforestation, soil erosion, loss of biodiversity, sinkholes, ponded waters and dammed rivers, significant use of water resources, contamination of surface and underground water, contamination of soil and acid mine drainage, and issues related to the disposal of wastewater.

Mondal (n.d.) noted the valuable contribution of natural resources, including gold, to the economic development of countries. These benefits notwithstanding, communities have to contend with environmental issues emanating from mining and extraction of natural resources. Consistent with Rajaee et al. (2015), Mondal (n.d.) confirmed contamination of underground water through mining. The contamination occurs as a result of seepage and infiltration of leached drainage.

Mondal (n.d.) further noted the contribution of mining to air pollution through the suspension of gases and particles and the emission of dust.

Duncan (2020) confirmed growing concerns among Ghanaians about the activities of illegal small-scale miners and the need for immediate- and medium-term remedial measures to stem the tide through improvements in methods of operation and the introduction of alternative employment opportunities, among others.

Haddaway et al. (2019) shared that though environments in mining areas could be altered through surface and underground mining, it is possible to ensure restoration through mitigation and remediation. Despite the numerous socio-economic benefits that could be derived from mining, it is often argued that mining has the tendency to engender conflicts, which, in most cases, have no direct relationship with the decision to subject the land to underground and surface use. The researchers found the Arctic and boreal regions to be sensitive to the effects of development on both systems of the environment and society. Further, multiple stressors such as pollution and climate change were found to have a strong impact on aboriginal human communities and natural ecosystems.

Matschullat and Gutzmer (2012) summarised the steps involved in mining operations, including exploration through exploitation, processing of ore, decommissioning, and rehabilitation. The last two are found at the final stages of the mining process. Generally, these activities are economically beneficial to the mining industry, mine workers, governments and mining communities through profit maximisation, earned income, tax revenue, service provision, job creation, and job opportunities. The foregoing benefits notwithstanding, the enumerated activities tend to have detrimental consequences on the environment. In some cases, the environmental impact may take several decades to rehabilitate, as noted by Lumen (n.d.): for some waste dumps to become acid-neutral or acid-free and stop leaching to the environment, it may take hundreds to thousands of years.

Mondal (n.d.) revealed that surface water is contaminated when harmful trace elements such as lead and cadmium are released. This corroborates Rajaee et al., who found mining as inimical to the safety and purity of surface water and the eventual effect on the health of inhabitants of local mining communities and the suburbs. Another profound threat posed by mining to the environment is the loss of soil fertility and quality, rendering the affected land toxic and not suitable for farming and agricultural activities in general (Mondal, n.d.; Aboka et al.; Rajaee et al.).

Lumen (n.d.) indicated that ore processing generates a significant volume of waste known as tailings. For instance, for every tonne of copper mines, ninety-nine tonnes of waste are generated. Nonetheless, the ratio is even higher for gold mining, and the tailings can be very harmful. Tailings are often produced in the form of slurry. Mining companies create ponds in valleys that exist naturally and, most commonly, dump the tailings therein. Usually, impoundments such as embankment dams or dams secure the ponds. The total number of tailings impoundments estimated to exist as of the year 2000 was three thousand and five hundred (3,500). Further assessment revealed the occurrence of two to five major failures and thirty-five minor failures annually. To illustrate, the Marcopper mining debacle resulted in the release of at least two million tonnes of tailings into a local river.

Stewart (2020) emphasised that a holistic approach is required to address pertinent mining-related issues such as health, protection of the environment, employment and economic stability. Collective involvement of all members of society is required. To achieve the desired results, each of the foregoing issues need not be addressed as mutually exclusive; they must be perceived as interrelated and intertwined, requiring an integrated approach. Thus, finding lasting solutions to challenges confronting the mining industry must be the prime responsibility of all and sundry and should not be restricted to a few stakeholders, including the government, firms in the mining sector, and affected mining communities. The author affirmed the indispensable role of minerals in the lives of individuals by emphasising the containment of mined elements in some cell phones, houses and cars.

Aboka et al. affirmed the significance of precious metals such as gold in the stimulation of economic growth and spurring infrastructure development, including the construction of schools, road networks and health centres in towns and cities. They found the following activities related to mining to be harmful to human health and the environment: depletion of soil nutrients, destruction of wildlife habitat, pollution of water bodies, degradation of forest resources, reduction in water quality and threats to the lives of humans.

Mondal (n.d.) was concerned about the effect of leached-trace elements on our environment. Leached-trace elements adversely impact natural vegetation, while deforestation, in the course of mining, leads to significant loss of fauna and flora. The author described this development as a major consequence of mining. Consistent with Aboka et al., Rajaee et al. and Stewart (2020), Mondal (n.d.) noted that some major consequences of mining on the environment include loss of habitat and toxicity of soil and water, leading to the killing of many species and creation of instability in the ecosystem. Moreover, land used for mining activities loses its soil nutrients. It becomes wasteful and no longer suitable for agricultural purposes or industrial use. The beauty and landscape of human habitat are lost directly to mining activities; land reclamation and other identified strategies are unable to ensure the effective restoration of the land to its original form.

Lumen (n.d) noted that the waste generated from ore mills is classified as either mineralised or sterile. The former has the potential to generate acid and its movement and storage form an integral part of the planning process for mining activities. It is possible for the mineralised package to be determined by an economic cut-off. When this occurs, mining companies ensure the mineralised waste with near-grade is disposed of or dumped separately so it can be treated later and become economically viable due to changes in market conditions. It is not uncommon for mining firms to rehabilitate waste dumps to meet international specifications. When this occurs, the waste dump standards are elevated above the local standards, and the former conform to or meet standards that are set and acceptable at the international level. The author stressed the need for each mining economy to ensure strict compliance with codes and regulations related to mining by the various mining firms within her jurisdiction.

After mining activities are ended due to depletion or other factors, the area is subjected to rehabilitation. Waste dumps created during the mining period are contoured to facilitate their flattening and stability of the environment. It is possible for the ore mined to contain sulfides. When this occurs, it is covered with a layer of clay. The latter prevents access to oxygen and rain from the air, which have the potential to oxidise the sulfides to produce sulfuric acid, a process commonly called *acid mine drainage*. Generally, the acid mine drainage is covered with soil, while consolidation of the material is ensured through vegetation planting. The vegetation is protected with fences, so livestock do not denude it. Lumen (n.d.) noted that eventual erosion of the layer was created. However, it is hoped the cover would slow the rate of leaching to such an extent that it would allow the environment to handle the load of leaching and accompanying heavy metals.

3. Research Methodology

The quantitative approach to scientific inquiry was adapted and used in the current research. Specifically, cross-sectional design, an example of survey design, formed the basis of the research. This design allowed the researcher to gather relevant research data over a specific time frame (Ashley, Takyi & Obeng, 2016; Creswell, 2009; Frankfort-Nachmias & Nachmias, 2008). Data required for the conduct of the current research were obtained mainly from secondary sources. These included textbooks, peer-reviewed articles published in journals and grey literature. Other sources were the Google Search Engine, including databases of Macrotrends and World Bank, databases and archives of the United States Geological Survey, among other significant sources. Respective data on Ghana's annual gold production volumes, gold revenues and GDP values from 1980 through 2020 and respective data on annual average closing prices per ounce of gold, global gold production volumes, global gold revenues and global GDP values from 1969 through 2020 were used in the research.

3.1. Analytical Tools

Descriptive statistics and regression models were used to describe the research variables and to evaluate their behaviour over the stated time frame on national and global gross domestic product values. Measures such as standard deviation and range were employed to describe the extent of dispersion about the central tendency (Ashley et al., 2016; Creswell, 2009; Frankfort-Nachmias & Nachmias, 2008). These measures were useful in the description of trends in national and global GDP values during the research period.

3.2. Research Variables

The independent research variables were gold revenues at the national and global levels*,* while the dependent research variables *were* GDP values at the national and global levels*.*

3.3. Regression Model

A regression statistical model was adapted to measure the effect and level of interaction of national gold revenues on national GDP values and global gold revenues on global GDP values over the research period. Recent trends depict relative stability in the price per ounce of gold in the world market and, by extension, some level of stability in total revenue derived from the exports and local use of the commodity by mining firms and economies. However, available data on the performance of the precious metal in prior years revealed fluctuations in the prices per ounce and corresponding fluctuations in revenues derived from operations by mining firms and economies. As a result, it was imperative to measure the extent to which gold revenue influences economic output values at the national and global levels so we could determine the significance of the contribution of gold revenues to national and global GDP values, confirm or reject the clarion call for regulation and control of the activities of illegal artisanal miners to improve and actualise annual national and global estimates for total gold mined and revenues; whether or not there is the need for minerals and mining policy reforms; and expeditious implementation of same to control environmental pollution and hazards. The Microsoft Excel analytical software was adapted and used in the research. Diagrams and tables were derived from Microsoft Excel to explain the research data.

3.4. Research Hypotheses

The current research tested causal relationships between national gold revenues and national gross domestic product values and between global gold revenues and global gross domestic product values, using the following null and alternative or research hypotheses:

3.4.1. Research Hypothesis One

- Ho: $\mu1 = \mu2$; this implies that national gold revenue has no significant effect on national GDP.
- H1: $\mu1 \neq \mu2$; this implies that national gold revenue has a significant effect on national GDP.

3.4.2. Research Hypothesis Two

- Ho: $\mu1 = \mu2$; this implies global gold revenue has no strong effect on global GDP.
- H1: $\mu1 \neq \mu2$; this implies global gold revenue has a strong effect on global GDP.

4. Research Findings and Discussions

4.1. Performance of Gold from 2010 to 2020

The mining of a precious metal called gold is a lucrative business with operations spread across various continents, with the exception of Antarctica (Metals Focus as cited in World Gold Council, 2020a). The foregoing affirms, to a large extent, that not all regions across the globe have been explored for gold mining; there are few regions that remain outstanding. This exudes some iota of hope for increased current reserves and increased availability of the precious metal for use in the near and distant future. However, we could not be absolutely certain about discoveries in the untapped or unexplored regions. The US Geological Survey (n.d.b) estimated the quantum of gold discovered thus far to be 244,000 metric tonnes. These include historical total production at an above-ground level of 187,000 metric tonnes and total reserves of 57,000 metric tonnes, which have been kept underground. However, as of December 2019, the total gold stocks in reserves had decreased to 54,000 metric tonnes. Experts believed the total volume of gold discovered so far could fit in a cube that measures up to 28 metres wide on every side. Although relatively many global economies are noted for gold production, most of the gold discovered thus far has been produced by three economies, including China, Australia and South Africa.

Year	Price Per Ounce in US$	Annual % Change
2010	1,652.87	-
2011	1,748.40	5.78
2012	1,861.37	6.46
2013	1,332.18	-28.43
2014	1,324.19	-0.6
2015	1,165.48	-11.99
2016	1,230.02	5.54
2017	1,356.14	10.25
2018	1,314.97	-3.04
2019	1,527.57	16.17
2020	1,895.10	24.06

Table 1: Annual Price of Gold from 2010 – 2020
Data Sources: Macrotrends (2020), Goldprice.org (2021)

In 2019, forty-three (43) countries produced a total of 3,272.7 metric tonnes of gold (see table 3 and figure 3). Stability in the price of gold per ounce has been a major concern to some investment analysts in the global market in recent years. Data on the inflation-adjusted price per ounce recorded for gold from 2010 through 2020 are presented in table 1 and figure 1. Data in the table and figure reflect closing prices, that is, the price of gold per ounce from 31st December 2010 to 31st December 2020. The gold market commenced the 2010 financial year with an initial price per ounce of US$1,113.00 and ended with an average closing price of US$1,226.66 (Macrotrends, 2021b), implying the closing price was one of the highest recorded during the financial year. The closing price per ounce in 2012 (US$1,861.37) was 6.46% and 12.61% increase over the respective prices at the end of 2011 (US$1,748.40) and 2010 (US$1,652.87). Gold trading in 2012 started with an ounce being sold at US$1,590.00 and ended with an average closing price of US$1,668.86, which was less than the closing price (US$1,861.37) and indicative of price volatilities throughout the period.

The performance of gold in 2013 and 2014 was not impressive, as evidenced by the closing prices (2013 = US$1,332.18; 2014 = US$1,324.19) during the period. At the beginning of 2013, gold traded at US$1,681.50 per ounce. However, the price decreased to US$1,192.75 before rebounding to end the financial year with a closing price of 1,332.18. The respective highest price and average closing price per ounce recorded in 2013 were US$1,692.50 and US$1,409.51. The unimpressive performance of gold continued in 2014 as trading began at US$1,219.75, a price which was 8.44% or US$112.43 shy of the closing price in 2013 (1,332.18). The highest and lowest gold prices in the year were US$1,379.00 and US$1,144.50. The year ended with an average closing price of US$1,266.06 (Macrotrends, 2021b).

The expected recovery in the price per ounce of gold in 2015 to affirm the positive performance of the precious metal in the global market was not realised as the price continued to dip. Trading in gold commenced at US$1,184.25 per ounce during the 2015 financial year. However, the price dropped to US$1,049.60 and rebounded to US$1,298.00 before concluding the year at US$1,165.48. The average closing price per ounce during the period was US$1,158.86. The analysis thus far reveals a steady decrease in average closing prices from 2013 (US$1,409.51) through 2015 (US$1,158.86).

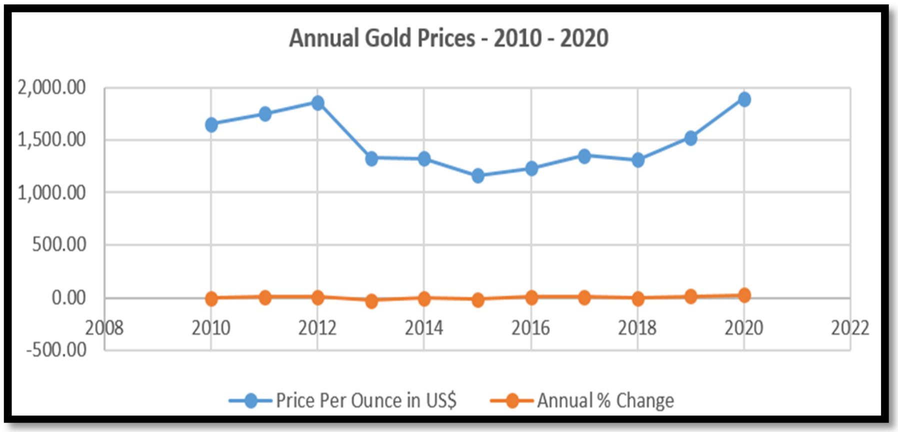

Figure 1: Annual Price of Gold from 2010 – 2020
Data Sources: Macrotrends (2021); Goldprice.org (2021)

Conversely, the performance of the precious metal in 2016 was a shade improvement over its performance in 2015, though 2016 began with a price (US$1,075.20) below the closing price for the previous year (US$1,165.48). The lowest gold price recorded in 2016 was US$1,073.60; this was US$1.60 short of the opening price (US$1,075.20). This notwithstanding, gold rallied to trade at US$1,372.60 before dropping to US$1,230.02 per ounce at year-end. The average closing price for 2016 was estimated at US$1,251.92 (Macrotrends, 2021b).

The 2017 financial year started with gold trading at US$1,162.00 per ounce. Comparatively, this price was US$68.02 or 5.53% deficient of the closing price for 2016 (US$1,230.02). The respective lowest and highest prices at which gold was traded in 2017 were US$1,162.00 and US$1,356.14. The average closing price per ounce was US$1,260.39, while the annual percentage change in closing price was 10.25%. The latter was about twice the rate recorded in 2016 (5.54%). The lowest gold price per ounce in 2018 was US$1,176.70. This was approximately US$136.10 or 10.37% less than the opening price (US$1,312.80) and 10.52% adrift of the average closing price (US$1,268.93). The highest price per ounce of gold in 2018 was US$1,360.25; the latter was US$45.28, or 3.44% more than the closing price (US$1,314.97) (Macrotrends, 2021b).

The performance of the precious metal in the investment markets during the 2019 and 2020 financial years was better than the performance recorded in 2018. Data accessed from Macrotrends (2021b) revealed that gold commenced trading in 2019 at US$1,287.20. This was US$25.60 or 1.95% shy of the opening price in 2018 (US$1,312.80) but US$125.20 or 10.78% superior to the opening price in 2017 (US$1,162.00). The highest price at which gold traded in 2019 was US$1,542.60. The precious metal ended the financial year at US$1,527.57 per ounce. The latter was 16.17% higher than the closing price in 2018 (US$1,314.97).

The financial year 2020 was characterised by the outbreak of the menacing COVID-19 pandemic during the first quarter. The ferocious spread of COVID-19 had a debilitating effect on the performance of the global stock markets but a positive omen for gold, as the precious metal assumed its enviable role as one of the immediate investment alternatives to stocks. Restrictions in movements and border closures invariably impacted negatively on day-to-day operations and, by extension, on the financial performance of many organisations and other investment assets. Since upward movements in stock prices are tied with real performance, it was nearly impossible for dormant organisations to maintain or command higher stock prices during the pandemic outbreak period. Many stocks lost substantial value while global financial institutions, including the Organisation for Economic Co-operation and Development (OECD), were compelled to review their forecasts and projections for the 2020 financial year (Lee, 2020). For instance, a historic sell-off, resulting in a 2,000-point historic loss to the Dow Jones Industrial Average, was recorded in the United States stock markets during the first quarter of 2020, whereas Newcrest gold mine, one of the mining firms with a very large market capitalisation in Australia, witnessed about 8% decrease in value of its price per share during the pandemic outbreak (Al Jazeera News, 2020; IG, 2020).

Nonetheless, the pandemic period was a defining moment for gold to prove its mettle in the investment world, as many investors channelled their financial resources to purchase gold to mitigate perceived risk in their respective investment portfolios, believed to have been occasioned by the outbreak of COVID-19. Further, while the stock prices of many corporate bodies suffered losses, many companies in the global mining industry were spared. IG (2020) noted the tremendous performance of stocks of other mining firms, such as Evolution Mining and Saracen, listed on the Australian Stock Exchange during the pandemic period. IG (2020) acknowledged these mining companies' ability to outperform the benchmark of the Australian Stock Exchange: Evolution Mining witnessed a more than 30% increase in the value of price per share, while Saracen recorded about a 23% increase in the value of its price per share during the period. The lowest price at which gold traded in 2020 was US$1,472.35. Expectedly, the price per ounce increased to US$2,058.40 before witnessing a sharp decrease to US$1,895.10 on 31st December 2020. The respective opening price and average closing price during the period were US$1,520.55 and US$1,773.73.

Conclusively, the closing price per ounce of gold for 2020 (US$ 1,895.10), as depicted in table 1 and figure 1, is unique in varied ways. It reflects the sterling performance of the precious metal in a financial year characterised by economic vicissitudes occasioned by the occurrence of natural disasters such as the COVID-19 pandemic. The closing price per ounce and performance of gold in 2020 has been unequalled since 2010. Stated in different words, the performance of gold in terms of price per ounce in 2020 was the highest since 2010. We observe about a 23.97% surge in the price of gold per ounce between 31st December 2019 and 31st December 2020. This exceeds the respective annual percentage increases recorded in 2019 (16.17%), 2017 (10.25%), 2012 (6.46%), 2011 (5.78%), and 2016 (5.54%); and far in excess of the respective annual percentage changes recorded in 2014 (-0.6%), 2018 (-3.04%), 2015 (-11.99%) and 2013 (-28.43%). The data depict fluctuations in gold prices between periods, with stable and consistent price increases from 2010 to 2012, between 2016 and 2017 and between 2019 and 2020. Historically and more importantly, the average closing price per ounce of gold in 2020 was the highest since 1969 (Macrotrends, 2021b).

4.2. Monthly Price of Gold

It was imperative to assess the monthly-price performance of the precious metal during the 2020 financial year to facilitate our understanding, appreciation and confirmation or otherwise, of the widely-held notion of improved performance of gold, in terms of price per ounce, during periods of stock markets downturn. Available monthly data for 2020 presented in table 2 and figure 2 indicate that the inflation-adjusted price of gold per ounce in January 2020 was US$1,579.27**.** This was about 3.39% more than the closing price (US$1,527.57) in December 2019 and US$42.20 short of the price (US$1,621.47) recorded in February 2020. The gold price per ounce in February 2020 (US$1,621.47) reflected about a 2.67% increase over the price per ounce in January 2020 (US$1,579.27). The price in March 2020 was (1.14%) less than the price recorded in the previous month. Recall that March 2020 marked the commencement of the intensity of the COVID-19 outbreak with its attendant sporadic negative effects on individual economies and on the entire global financial system.

Month	Price Per Ounce in US$	Monthly % Change
January	1,579.27	-
February	1,621.47	2.67
March	1,603.05	-1.14
April	1,725.33	7.63
May	1,734.28	0.52
June	1,770.70	2.1
July	1,974.70	11.52
August	1,966.38	-0.42
September	1,861.16	-5.35
October	1,878.67	0.94
November	1,786.86	-4.89
December	1,895.10	6.06
Average	1,783.08	-

Table 2: Monthly Price of Gold – 2020
Data Sources: Macrotrends (2021); Goldprice.org (2021)

IG (2020) recounted the abysmal performance of spot gold between the 10th and 20th of March 2020, as the price per ounce decreased by US$200, recording a price below US$1,500.00 per ounce. On the basis of the foregoing, it is no exaggeration to attribute the uninspiring performance of gold in March 2020 to the outbreak of the COVID-19 pandemic. However, the price per ounce of gold rebounded to US$1,725.33 in April 2020, reflecting approximately a 7.63% increase over the price recorded earlier in March 2020 (US$1,603.05) and a US$8.95 or 0.52% decrease over the price per ounce recorded in May 2020 (US$1,734.28).

Overall, statistical values in the table and figure depict a steady increase in gold prices over the twelve-month period, save the respective prices per ounce recorded in March 2020 (US$1,603.05), August 2020 (US$1,966.38), September 2020 (US$1,861.16) and November 2020 (US$1,786.86) which fell short of the respective prices recorded in their preceding months. During the 2020 financial year, the most significant percentage increases in price per ounce of gold were recorded in three distinct months. These included July (11.52%), April (7.63%) and December (6.06%). The remarkable increase in price per ounce of gold from US$1,603.05 in March 2020 to US$1,725.33 in April 2020 could be linked to investors' decision to seek investment refuge in gold due to the sudden crush of the global stock markets occasioned invariably by the COVID-19 outbreak.

The subsequent price increase in May 2020 (0.52%) was marginal but peaked in July 2020 (11.52%) when the outbreak of COVID-19 was intense, and the possibility of the stock markets bouncing back in the immediate term was remote, or more of a mirage than reality. Gold price per ounce suffered marginal losses in August 2020 (-0.42%) and September 2020 (-5.35%) respectively. These were periods when some global economies announced and practically began to lift lock-down restrictions to increase the volume of trade and business activities first, within borders, and later across borders. The lift of trade restrictions increased the pool of investment eligible or options available to investors; stock markets began to regain their lost investment rhythms, and these affected the volume of trade in the precious metal.

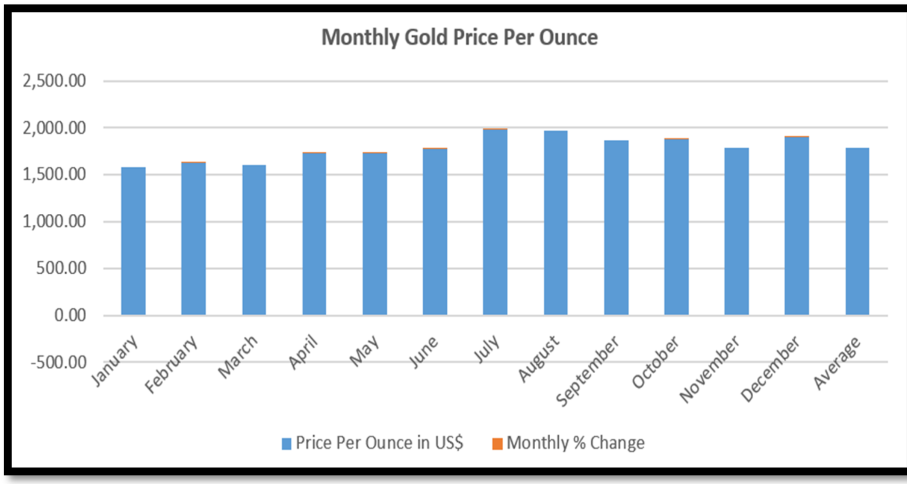

Figure 2: Monthly Price of Gold – 2020
Data Sources: Macrotrends (2021); Goldprice.org (2021)

However, the decision to lift some lock-down restrictions without adequate preparations and control measures led to increases in the number of reported and confirmed cases in some jurisdictions. Thus, the second wave of COVID-19 was experienced in some economies across the globe. This COVID-19 resurgence affected the performance of the stock markets but encouraged increased investments in gold during the last quarter of 2020. Data in table 2 and figure 2 affirm that the gold markets witnessed relative price stability and upward price adjustments in June 2020 (2.1%) and July 2020 (11.52%). However, the foregoing price increases and stability could not be sustained in August (-0.42%) and September (-5.35%). The last three months of the financial year saw gains and price appreciation in October (0.94%) and December (6.06%) and price decrease in November (-4.89%).

The average monthly price per ounce of gold recorded during the first and second quarters of 2020 (January to June 2020) was US$1,672.33. This was equivalent to 88.31% ((US$1,672.33 ÷US$1,893.81) x 100% = 0.883051 x 100% = 88.3051 = 88.31%); or US$221.48 (US$1,672.33 -US$1,893.81 = -US$221.48) short of the average monthly price (US$1,893.81) recorded during the third and fourth quarter (July to December 2020). The data in the table and figure reveal that the 2020 financial year ended with an average closing price of US$1,783.08. This figure is US$9.35 more than the average closing price per ounce of gold (US$1,773.73) released by Macrotrends (2021b) and presented in column 2 in Tables 5 and 6.

Some market analysts predicted the average closing price per ounce of gold at the end of the 2020 financial year would be over US$1,900.00. However, the average closing price on 31st December 2020 was US$1,773.73. This price was US$126.27, or 6.65% lower than the predicted amount (US$1,900.00). The foregoing notwithstanding, the closing price per ounce of gold during the period inched very close to the prediction. The 2020 financial year ended with a price of US$1,895.10, equivalent to 99.74% ((US$1,895.10 ÷ US$1,900.00) x 100% = 0.997421 x 100% = 99.74%); or US$4.90 (US$1,900.00 - US$1,895.10 = US$4.90) short of the year-end target (US$1,900.00). Indeed, gold has proven to be a major source of alternative investment in times of both volatility and stability in the global equity markets in particular and in the global financial and investments markets in general. Its socio-economic usefulness in countries across the globe does not wane. Rather, society's adoration and veneration for the precious metal surge from one generation to the other.

4.3. Leading Gold Producing Countries

As noted in the preceding section, a total of 3,272.7 metric tonnes, equivalent to 105,219,759.53 troy ounces of gold, were produced by forty-three economies in 2019. Total gold production volume in 2019 was up by 1.32% over the production volume in 2017 (3,230 metric tonnes, equivalent to 103,846,903 troy ounces); however, it was similar to the production volume in 2018. A list of these forty-three economies, their rankings, respective gold production capacities, and revenues derived from the same in 2019 are presented in table 3 and figure 3. Data in the table and figure indicate an estimated US$144.708 billion was realised from gold operations by the forty-three major producing countries in 2019. Statistics on the world's leading economies in gold production in 2019 affirmed China as the leading producer. The country's total gold stocks of 383.20 metric tonnes sufficed to assert her leadership in global gold production during the period. Geographically, China's total land area of 9,596,961 square kilometers is the fourth-largest in the world after Russia, Canada and the United States, respectively. The country has the second-largest economy globally, after the United States, with a total GDP of US$14.280 trillion in 2019.

Macrotrends (2021b) noted that the closing average price per ounce of gold in 2019 was US$1,393.34. This represented about 9.80% [((US$1,393.34 - US$1,268.93) ÷ US$1,268.93) x 100% = (US$124.41 ÷ US$1,268.93) x 100% = 0.098043 x 100% = 9.8043 = 9.80%] increase over the average closing price recorded earlier in 2018 ($1,268.93); and 27.30% [((US$1,773.73 - US$1,393.34) ÷ US$1,393.34) x 100% = (US$380.39 ÷ US$1,393.34) x 100% = 0.2730059 x 100% = 27.30059= 27.30%] decrease over the average closing price in 2020 (US$1,773.73).

The standard measurement for gold, as presented by Quora (2020) and FTX (2021), indicates that 32,150.75 troy ounces are equal to one metric tonne. That is 32,150.75 troy ounces = 1 metric tonne. The foregoing estimate was slightly at variance with Anderson's (2019) estimate (32,150.7 troy ounces = 1 metric tonne). However, the difference between the two estimates (0.05 troy ounce) [32,150.75 troy ounces - 32,150.7 troy ounces = 0.05 troy ounce] may be described as a rounding error. The research placed emphasis on troy ounces and not avoirdupois ounces. The latter estimates a metric tonne of gold at 35,273.96 ounces (Traditional Oven, 2021), while the former pegs the estimate at 32,150.75 ounces (Quora, 2020; FTX, 2021; Traditional Oven, 2021). Despite the high conversion rate for avoirdupois ounces (35,273.96 avoirdupois ounces = 1 metric tonne), grey literature (Anderson, 2019; Quora, 2020 & FTX, 2021; Traditional Oven, 2021) depicted more measurements in troy ounces than avoirdupois ounces during the research period. For the benefit of hindsight, the estimate by Quora (2020) and FTX (2021), that is, 32,150.75 troy ounces, equal to 1 metric tonne, was adapted and used in the analysis.

Statistics in table 3 and figure 3 indicate China's total gold production in 2019 amounted to 383.20 metric tonnes, equivalent to 12,320,167.4 troy ounces (383.20 metric tonnes x 32,150.75 troy ounces = 12,320,167.4 troy ounces). Therefore, the country's total earnings from gold during the period were approximately US$17,166,182,045.116 (US$1,393.34 x (383.20 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 12,320,167.4 troy ounces =US$17,166,182,045.116).

In percentage terms, China's total gold revenue (US$17,166,182,045.116) was equivalent to 0.12% ((US$17,166,182,045.116 ÷ US$14,280,000,000,000) x 100% = 0.0012021 x 100% = 0.12021 = 0.12%) of GDP (14.280 trillion); and the highest earnings from gold by any major gold-producing economy during the period. The foregoing notwithstanding, the analysis suggests that though China has made massive capital investments in gold exploration and production to assure the country's dominance in global gold production, annual earnings from gold, in percentage terms, do not suffice to have a strong effect on total economic output.

The value of Brazil's total economic output in 2019 was nearly US$1.840 trillion (World Bank, 2021a). This value (US$1.840 trillion) was sufficient to ensure Brazil remained the ninth-largest economy in the world (Silver, 2020). Data in table 3 and figure 3 indicate that the total gold production volume recorded by Brazil during the same financial year was 106.9 metric tonnes. This tonnage was enough to project Brazil as the tenth-leading gold-producing economy across the globe. Using the standard for conversion of troy ounces into a tonne (that is, one metric tonne = 32,150.75 ounces); and given an average closing price of US$1,393.34 in 2019 (Macrotrends, 2020b), one could infer Brazil's total proceeds from gold during the period were equivalent to US$4,788,791,389.935 (US$1,393.34 x (106.9 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 3,436,915.175 ounces = US$4,788,791,389.935), the tenth-highest globally. However, total gold proceeds represented only 0.26% ((US$4,788,791,389.935 ÷ US$1,840,000,000,000) x 100% = 0.0026026 x 100% = 0.26026 = 0.26%) of GDP (US$1.840 trillion). Evidently, total gold revenue, expressed in percentage terms, constituted an insignificant proportion of the country's total economic output value during the period under review.

Peru remained one of the worst-hit economies by the COVID-19 pandemic in terms of record cases and deaths during the peak period in 2020. However, prior to 2020 and its attendant economic crisis occasioned by COVID-19, the Peruvian economy witnessed good performance. The country ended the 2019 financial year with GDP valued at US$226.848 billion, one of the highest in the South American region. The total volume of gold produced by Peru during the financial year under review was 143.3 metric tonnes, the sixth-largest across the globe. Total gold revenue was equivalent to US$6,419,399,496.517 (US$1,393.34 x (143.3 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 4,607,202.475 troy ounces = US$6,419,399,496.517), the sixth-highest globally; and represented 2.83% ((US$6,419,399,496.517 ÷ US$226,848,000,000) x 100% = 0.028298 x 100% = 2.8298 = 2.83%) of GDP (US$226.848 billion) in 2019. Compared with advanced and emerging economies such as China (0.12%) and Brazil (0.26%), Peru recorded a higher percentage of gold revenue contribution to GDP (2.83%) in 2019.

Ranking	Country	Production Volume in Metric Tonnes	Total Gold Revenue in US$
1	China	383.2	17.166 Bill.
2	Russia	329.5	14.761 Bill.
3	Australia	325.1	14.564 Bill.
4	United States	200.2	8.968 Bill.
5	Canada	182.9	8.193 Bill.
6	Peru	143.3	6.419 Bill.
7	Ghana	142.4	6.379 Bill.
8	South Africa	118.2	5.295 Bill.
9	Mexico	111.4	4.990 Bill.
10	Brazil	106.9	4.789 Bill.
11	Uzbekistan	104	4.659 Bill.
12	Indonesia	82.6	3.700 Bill.
13	Kazakhstan	76.8	3.440 Bill.
14	Sudan	76.6	3.432 Bill.
15	Papua New Guinea	72.9	3.266 Bill.
16	Burkina Faso	62	2.777 Bill.
17	Mali	61.2	2.742 Bill.
18	Argentina	53.1	2.379 Bill.
19	Tanzania	48	2.150 Bill.

Ranking	Country	Production Volume in Metric Tonnes	Total Gold Revenue in US$
20	Colombia	46.3	2.074 Bill.
21	Congo, D.R.	45.6	2.043 Bill.
22	Côte d'Ivoire	41.9	1.877 Bill.
23	Zimbabwe	38.7	1.734 Bill.
24	Philippines	38.3	1.716 Bill.
25	Chile	37.8	1.693 Bill.
26	Turkey	37	1.658 Bill.
27	Suriname	32.8	1.469 Bill.
28	Dominican Republic	31.8	1.425 Bill.
29	Venezuela	27.8	1.245 Bill.
30	Guinea	27.5	1.232 Bill.
31	Guyana	25.5	1.142 Bill.
32	Kyrgyz Republic	24.2	1.084 Bill.
33	Senegal	16.8	752.588 Mill.
34	Mongolia	16.3	730.190 Mill.
35	Mauritania	15.1	676.434 Mill.
36	Egypt	14.9	667.474 Mill.
37	Madagascar	14.5	649.555 Mill.
38	Nigeria	14	627.157 Mill.
39	Iran	11	492.766 Mill.
40	Ecuador	11	492.766 Mill.
41	Sweden	8.1	362.855 Mill.
42	New Zealand	7.8	349.416 Mill.
43	Finland	7.7	344.936 Mill.
	Total	3,272.7	144.708 Bill.

Table 3: Major Gold Producing Countries in the World – 2019
Data Source: Metals Focus (As Cited in World Gold Council, 2020)

Geographically, Canada is adjudged the second-largest country in the world after Russia, with a total land area of 9,984,670 square kilometres (Mattyasovszky, 2019). Indeed, Canada commensurates its geographic size with appreciable economic output performance at the global level. In 2019, Canada recorded a total GDP of about US$1.736 trillion, which is enough to ensure the economy remained the tenth-largest globally (World Bank, 2021a; Silver, 2020). The country's total volume of gold production in 2019 was equivalent to 182.9 metric tonnes; this was the fifth-largest production globally. Gold earnings during the 2019 financial year were US$8,193,357,766.315 (US$1,393.34 x (182.9 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 5,880,372.175 troy ounces = US$8,193,357,766.315), equivalent to 0.47% ((US$8,193,357,766.315 ÷ US$1,736,000,000,000) x 100% = 0.00471968 x 100% = 0.471968 = 0.47%) of GDP (US$1.736 trillion).

Total gold revenue realised by Canada during the period (US$8.193 billion) was the fifth-highest globally and equivalent to 5.66% of global gold revenue (US$144.708 billion) during the period. The computations attest to a distinctive fact. That is, though Canada's total volume of gold production in 2019 (182.9 metric tonnes) sufficed to be acclaimed as the fifth-leading producer in the world, the total earnings rate (0.47%) was not high enough to significantly influence total GDP during the period. The percentage contribution of gold revenue (0.47%) to Canada's GDP was lower than the rate recorded by Peru (2.83%) but superior to the respective rates of the United States (0.04%), China (0.12%) and Brazil (0.26%) during the period.

From a geographical perspective, the United States remains the third-largest country in the world (after Russia and Canada, respectively), with a total land area of 9,833,517 square kilometres (Mattyasovszky, 2019). The country's GDP of US$21.433 trillion in 2019 was unequalled and sufficient to project the economy as the largest in the world (World Bank, 2021a; Silver, 2020). Arguably, "little" is known about the United States' exploits in global gold production, although the country's competitiveness in global crude oil production and other natural minerals remains a common knowledge. However, the United States has remained a dominant force or strong competitor in global gold production for centuries. Total gold production by the United States in 1900 was 119 kilograms, equivalent to 3,825.969 troy ounces (119 kilograms x 32.151 troy ounces = 3,825.969 troy ounces). This production volume was the largest and constituted 31% of total world gold production during the period. In essence, the United States led global economies in global gold production, followed by Australia, Canada, and Russia in 1900 (Amey, 2000).

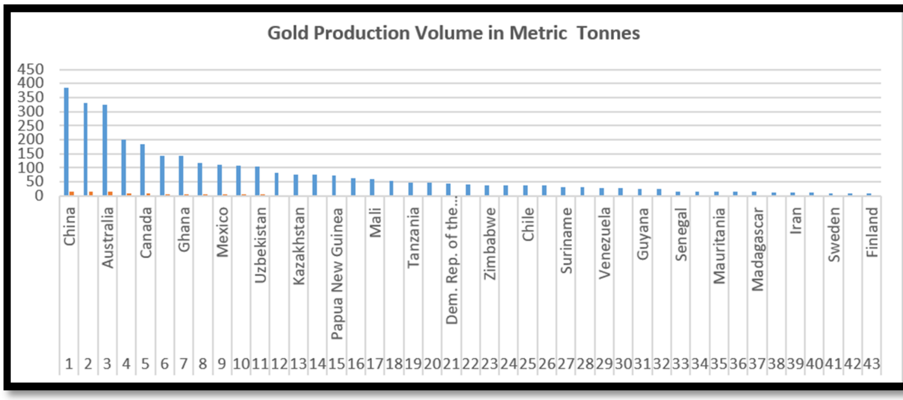

Figure 3: Major Gold Producing Countries in the World – 2019
Data Source: Metals Focus (as cited in World Gold Council, 2020)

Nonetheless, over the years, several economies, including China, Australia, Russia, South Africa and Canada, have evolved considerably in global gold production, compelling the United States to relinquish its leadership position in global gold production during the early 1900s. This notwithstanding, the United States economy continues to make giant strides and has been consistent in its ranking as the fourth-leading gold producer for several years. Statistics in the table and figure indicate that the total volume of gold produced by the United States in 2019 was equivalent to 200.2 metric tonnes. This implied total gold earnings of US$8,968,344,586.201 (US$1,393.34 x (200.2 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 6,436,580.15 troy ounces = US$8,968,344,586.201), equivalent to 0.04% ((US$8,968,344,586.201 ÷ US$21,433,000,000,000) x 100% = 0.00041844 x 100% = 0.041844 = 0.04%) of GDP (US$21.433 trillion); and approximately 6.20% of global gold revenue (US$144.708 billion) in 2019. The results suggest that the United States usually records one of the lowest rates of gold revenue contribution to GDP (0.04%). Indeed, the percentage contribution of earnings from gold to the GDP of the United States is insignificant, albeit the economy records one of the highest earnings from gold sales (US$8.968 billion) globally.

The Mexican economy robs shoulders with the United States and Canadian economies in the North American region and remains the second-largest in Latin America after Brazil. In 2019, Mexico recorded a GDP of US$1.26 trillion, the fifteenth-largest value among global economies, while the country's performance in global gold production was impressive during the period. Mexico was the ninth-largest gold producer after Ghana (142.4 metric tonnes) and South Africa (118.2 metric tonnes) and six other economies, as depicted in table 3 and figure 3. The average gold price per ounce in 2019, as released by Macrotrends (2020b), was US$1,393.34. With a total gold production volume of 111.4 metric tonnes and using the standard for troy ounces-tonne measurement, we could fairly estimate Mexico's total gold earnings during the period at US$4,990,377,556.957 (US$1,393.34 x (111.4 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 3,581,593.55 troy ounces = US$4,990,377,556.957), the ninth-highest globally.

Mexico's total gold revenue (US$4,990,377,556.957) was equivalent to 0.40% ((US$4,990,377,556.957 ÷ US$1,260,000,000,000) x 100% = 0.00396062 x 100% = 0.396062 = 0.40%) of GDP (US$1.26 trillion) in 2019. An important deduction from the foregoing computations is that the contribution of gold revenue, in percentage terms, to GDP in the Mexican economy is less significant. However, the percentage contribution of gold revenue to GDP in Mexico (0.40%) was ten times (0.40% ÷ 0.04% = 10.00) the rate contributed by gold revenue to the United States' GDP (0.04%) in 2019.

The Russian Federation is noted for occupying 11.48% of the total land area on Earth. Globally, Russia remains the largest country, with a total land area of 17,098,242 square kilometres (Mattyasovszky, 2019). In relation to national economic output, Russia recorded a GDP of nearly US$1.7 trillion in 2019 (World Bank, 2021a), the eleventh-largest value recorded by all global economies during the period (Silver, 2020). Data in table 3 and figure 3 affirm that the total gold production capacity of the Russian Federation in 2019 was 329.50 metric tonnes. This production capacity was 129.30 metric tonnes and 4.4 metric tonnes more than the respective production volumes of the United States (200.2 metric tonnes) and Australia (325.1 metric tonnes). This affirmed the second ranking of Russia and the respective third and fourth rankings of Australia and the United States during the period.

The average closing price per ounce of gold in 2019 (US$1,393.34) coupled with a total gold production volume of 329.50 metric tonnes implied total gold revenue of US$14,760,587,118.647 (US$1,393.34 x (329.5 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 10,593,672.125 troy ounces = US$14,760,587,118.647) was realised by the Russian Federation during the period. Total earnings from gold were equivalent to 0.87% ((US$14,760,587,118.647 ÷ US$1,700,000,000,000) x 100% = 0.00868270 x 100% = 0.868270 = 0.87%) of the country's GDP (US$1.7 trillion), implying the weak effect of gold revenue, percentage-wise, on GDP. Nonetheless, the rate (0.87%) was more than twice (2.18 times) the rate contributed by gold revenue to the Mexican economy (0.40%) during the period.

Ghana remains one of the dominant economic forces in the African region, alongside Nigeria, South Africa, Egypt, Ethiopia, Kenya and Morocco. The country's lower-middle income status places enormous responsibilities on current and successive governments to accelerate the pedestal on development and growth and facilitate swift upward movement on the economic ladder. That is, it is incumbent on the current and future leadership of the country to ensure Ghana's rapid transition from lower-middle income to upper-middle income economy in the medium- to long-term and, ultimately, to advanced economic status in the not-too-distant future. Available data from the World Bank (2021a) revealed that Ghana ended the 2019 financial year with a GDP value of US$66.984 billion. The country's total volume of gold production in 2019 was estimated at 142.40 metric tonnes, equivalent to 4.35% of total global gold production (3,272.7 metric tonnes) and the seventh-largest globally during the period.

The total volume of Ghana's gold production in 2019 was less than the respective volumes produced by China (373.2 metric tonnes), Russia (329.5 metric tonnes), Australia (325.1 metric tonnes), United States (200.2 metric tonnes), Canada (182.9 metric tonnes) and Peru (143.3 metric tonnes); but, compared favourably against the respective total volumes produced by South Africa (118.20 metric tonnes), Mexico (111.40 metric tonnes), Brazil (106.90 metric tonnes), Sudan (76.60 metric tonnes), Mali (61.20metric tonnes) and Colombia (46.30 metric tonnes), among other major gold-producing countries during the period; and listed in table 3 and figure 3.

Ghana's total earnings from gold production in 2019 amounted to US$6,379,082,263.112 (US$1,393.34 x (142.4 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 4,578,266.8 troy ounces = US$6,379,082,263.112). The total gold revenue (US$6,379,082,263.112) was equivalent to 9.52% ((US$6,379,082,263.112 ÷ US$66,984,000,000) x 100% = 0.095233 x 100% = 9.5233 = 9.52%) of GDP (US$66.984 billion); and the seventh-highest globally, in 2019. The inference is that the total proceeds from gold sales alone contributed close to 10% to Ghana's GDP in 2019. Given the number of exporting commodities and a number of other activities that aggregate GDP value for a given financial year, one could fairly state that gold revenue has a strong effect on Ghana's total economic output values. Undeniably, gold is one of the commodities that serve as the mainstay of Ghana's economy. This explains why the country's financial balance sheet is usually thrown out of economic gear whenever the price of the precious metal suffers a downward trend in the global market.

With an estimated population of 25.5 million people, Australia remains the leading economy among the fourteen countries and nine dependencies and territories in the Oceania region (Worldometer, 2021). The country's GDP for 2019 was estimated at US$1.397 trillion, and it remained the fourteenth-largest economy in the world during the period (World Bank, 2021a; Silver, 2020). Australia's total proceeds from gold in 2019 were equivalent to US$14,563,482,644.225 (US$1,393.34 x (325.1 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 10,452,208.825 troy ounces = US$14,563,482,644.225). The latter constituted approximately 0.86% ((US$14,563,482,644.225 ÷ US$1,697,000,000,000) x 100% = 0.00858190 x 100% = 0.858190 = 0.86%) of Australia's GDP (US$1.697 trillion); and equivalent to 10.06% of global gold revenue during the period. The evidence suggests that the percentage of gold revenue contribution to Australia's GDP is less significant. The computations lend strong credence to the significant contribution of other components to the measurement of Australia's GDP. This notwithstanding, the percentage contribution of gold revenue to Australia's GDP (0.86%) was about 3.91 times the rate contributed to the Turkish economy (0.22%) and 2.61 times the rate contributed by the same to the Indonesian economy (0.33%) during the period.

Available statistics on the world's leading producers of the precious metal (gold) revealed that Turkey was the twenty-sixth-leading producer in 2019. Turkey's total gold production volume of 37 metric tonnes affirmed the country's inclusion on the list of global gold producers in large commercial quantities. Turkey's production volume was superior to the respective total gold outputs from sixteen other economies listed in table 3 and figure 3, including Suriname (32.8 metric tonnes), Dominican Republic (31.8 metric tonnes), Venezuela (27.8 metric tonnes) and Guinea (27.5 metric tonnes), among others, during the period. The country's GDP at the end of the 2019 financial year was estimated at US$761.426 billion (World Bank, 2021a) while total earnings from gold were equivalent to US$1,657,486,262.185 (US$1,393.34 x (37 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 1,189,577.75 troy ounces = US$1,657,486,262.185).

In 2019, the value of Turkey's GDP (US$761.426 billion) was large enough to emerge as the nineteenth-largest economy across the globe and firmly projected the country to join the *trillion-dollar club* by 2023 (Silver, 2020). The two distinct figures (GDP of US$761.426 billion; and gold revenue of US$1,657,486,262.185) suggest weak percentage contribution of gold revenue to GDP; gold revenue accounted for only 0.22% ((US$1,657,486,262.185 ÷ US$761,426,000,000) x 100% = 0.00217682 x 100% = 0.217682 = 0.22%) of GDP. The analysis suggests that other external random economic components accounted for 99.78% (100% - 0.22%) of GDP during the period.

Indonesia is located in the South-Eastern part of Asia. The country has a fairly large population (over 273.52 million people) and a corresponding vibrant and progressive economy. The recent spate of tsunamis and other natural disasters and their debilitating effect did not deter managers of the Indonesian economy from pursuing and doing what is needed. That is, projecting the country to higher economic echelons. Through the dint of hard economic work, Indonesia is a member of the trillion-dollar club, as affirmed in the GDP recorded in 2019 (US$1.119 trillion) (World Bank, 2021a). The economy was the sixteenth-largest globally during the period (Silver, 2020). The Indonesian economy is endowed with natural resources such as gold in large commercial quantities.

Data in table 3 and figure 3 indicate that Indonesia's total gold production volume in 2019 (82.6 metric tonnes) was the twelfth-largest globally. The total volume of gold production translated into total earnings of US$3,700,226,088.013 (US$1,393.34 x (82.6 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 2,655,651.95 troy ounces = US$3,700,226,088.013), equivalent to 0.33% ((US$3,700,226,088.013 ÷ US$1,119,000,000,000) x 100% = 0.00330673 x 100% = 0.330673 = 0.33%) of GDP (US$1.119 trillion). The computations suggest a weak percentage contribution of gold revenue to GDP, albeit Indonesia's gold revenue was approximately 2.56% of global gold revenue during the period.

Uzbekistan is an economy located in Central Asia. The country was a member of the Union of the Soviet Socialist Republic (USSR) prior to the declaration of independence on 31st August 1991. Uzbekistan maintains a modest economy with an economic management strategy modelled essentially on socialist ideas. That is, the economy is socialist-driven with some emphasis on external aid. For instance, in 2005, an estimated US$172.3 million was received in aid from the United States. This notwithstanding, Uzbekistan has made some economic strides since attaining independence in 1991. With an estimated population of 33.58 million people, Uzbekistan's nominal GDP in 2019 was equivalent to US$57.921 billion, the seventy-eighth-highest in the world during the period. Other economic performance indicators included a GDP growth rate of 5.6%, GDP per capita of US$1,724.84, gross national income (GNI) of US$249.1 billion based on purchasing power parity (PPP), GNI per capita of US$7,420 based on PPP and estimated 52.3% of the total population having access to and using the Internet during the period. Moreover, the country was believed to be implementing ambitious market-oriented economic reforms (World Bank, 2021c).

Uzbekistan is one of the leading cotton-producing countries in the world. The country has substantial mineral, oil and gas in reserves and is noted for exporting natural gas in large commercial quantities (Britannica, 2021). In addition to the foregoing, the contribution of Uzbekistan to global gold production is quite significant. Data in table 3 and figure 3 indicate the country's total gold production in 2019 was equivalent to 104 metric tonnes, representing 3.18% ((104 metric tonnes ÷3,272.7 metric tonnes) x 100% = 0.0317780 x 100% = 3.17780 = 3.18%) of the world's total gold production (3,272.7 metric tonnes). The total volume of gold produced in 2019 (104 metric tonnes) suggests total gold earnings of US$4,658,880,304.52 (US$1,393.34 x (104 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 3,343,678 troy ounces = US$4,658,880,304.52), equivalent to 8.04% ((US$4,658,880,304.52 ÷ US$57,921,000,000) x 100% = 0.0804351 x 100% = 8.04351 = 8.04%) of GDP (US$57.921 billion); and 3.22% of global gold revenue (US$144.708 billion). Quantitative and percentage assessment affirms the valuable contribution of gold revenue (US$4,658,880,304.52 = 8.04%) to national economic development and growth in Uzbekistan. The computations suggest that the role of gold revenue in the socio-economic development and growth of Uzbekistan's economy cannot be overemphasised.

Data in table 3 and figure 3 indicate Mongolia was the thirty-fourth-largest gold producer in the world in 2019, with total production capacity of 16.3 metric tonnes. The country is bordered by Russia (the largest country in the world) and China (the fourth-largest country in the world). Mongolia attained Republican status on 26th November 1924, and remains a relatively small economy with an estimated total population of 3.2 million people. In 2019, the Mongolian economy recorded a GDP of US$14 billion, a GDP growth rate of 5.2%, and a GDP per capita of US$4,339.84. Further, a GNI of US$36.82 billion and a GNI per capita of US$11,420 based on PPP were recorded during the period. Approximately 51.1% of the country's total population had access to and used the Internet in 2019 (World Bank, 2021c).

Mongolia's total earnings from gold in 2019 were US$730,189,893.882 (US$1,393.34 x (16.3 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 524,057.225 troy ounces = US$730,189,893.882). These earnings were equivalent to 5.22% ((US$730,189,893.882 ÷ US$14,000,000,000) x 100% = 0.0521564 x 100% = 5.21564 = 5.22%) of the country's GDP (US$14 billion); affirming significant contribution of gold revenue in both quantitative and percentage terms to GDP during the period. The analysis suggests percentage contribution of gold revenue (5.22%) to the Mongolian economy in 2019 was comparatively 2.82% (5.22% - 8.04%) adrift of the rate recorded by Uzbekistan (8.04%); 4.3% (5.22% - 9.52%) deficient of the rate contributed to Ghana's economy (9.52%); and 3.3% (5.22% - 1.89%) superior to the rate recorded by Kazakhstan (1.89%) during the period.

Kazakhstan is geographically located in Central Asia and remains a former member of the USSR. The country gained independence in 1991 and has the largest economy in Central Asia, with an estimated nominal GDP of US$181.7 billion, the fifty-eighth-largest in the world, in 2019. During the period, the country recorded a GDP per capita of US$9,812.39, a GDP growth rate of 4.5%, a GNI of US$445.8 billion based on PPP, a GNI per capita of US$24,080 based on PPP and total Internet users were estimated at 81.9% of the country's total population of 18.51 million people during the period. The World Bank (2021c) described Kazakhstan as one of the few countries to have experienced tremendous improvements in their economic pursuits after independence.

Kazakhstan's total volume of gold production in 2019 (76.8 metric tonnes) was the thirteenth-largest and constituted 2.35% ((76.8 metric tonnes ÷ 3,272.7 metric tonnes) x 100% = 0.0234669 x 100% = 2.34669 = 2.35%) of the globe's total gold production (3,272.7 metric tonnes) during the period. Total gold revenue realised in 2019 was US$3,440,403,917.184 (US$1,393.34 x (76.8 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 2,469,177.6 troy ounces = US$3,440,403,917.184), representing 2.38% of global gold revenue; and 1.89% ((US$3,440,403,917.184 ÷ US$181,700,000,000) x 100% = 0.01893453 x 100% = 1.893453 = 1.89%) of GDP (US$181.7 billion). Compared with rates recorded by Uzbekistan (8.04%) and Mongolia (5.22%), we observe a relatively weak contribution of gold revenue, in percentage terms, to Kazakhstan's GDP (1.89%). However, the rate was about 2.20 times the rate contributed to the Australian economy (0.86%) during the period.

From an economic perspective, the World Bank (2021a) acknowledged the existence of approximately two hundred and eighteen economies globally. These include sovereign states or countries, dependencies and territories (Worldometer, 2021). However, data from Metal Focus (as cited in World Gold Council, 2020) and shared in table 3 and figure 3 affirmed the availability of forty-three leading gold-producing economies around the world as of 2019. The statistics suggest that only 19.73% ((43 major gold-producing economies ÷ 218 economies) x 100% = 0.197248 x 100% = 19.7248 = 19.73%) of the world's 218 economies are noted for producing gold in significant commercial quantities to meet the demands and needs of gold consumers across the globe. More narrowly, quite a chunk of the world's gold is supplied by China, Australia and South Africa (U.S. Geological Survey, n.d.a).

Remember, the 2020 financial year was marred by the COVID-19 outbreak and its attendant devastating impact on various business activities at the local, national, sub-regional, regional and global levels. These economic challenges notwithstanding, major gold-producing economies with significant gold reserves and production volumes were predicted to end the 2020 financial year with improvements, if not significant improvements, in their respective financial inflows from gold trading activities to "douse" the debilitating financial effect of the pandemic on total national expenditures;

including costs of preparedness, responsiveness and other COVID-19 mitigating measures; in addition to national debt servicing; and provision of social and institutional infrastructure, among other pertinent services.

4.4. Gold Reserves Ratio

Statistics released by the U.S. Geological Survey (n.d.a) showed total gold reserves for some selected economies across the globe. The list of economies and their respective gold reserves values in 2019 included: South Africa (3,200 metric tonnes);

- Peru (2,100 metric tonnes);
- Uzbekistan (1,800 metric tonnes);
- Kazakhstan (1,400 metric tonnes);
- Mexico (1,400 metric tonnes) and
- Ghana (1,000 metric tonnes).

Others included Canada (1,900 metric tonnes), China (2,000 metric tonnes), Indonesia (2,600 metric tonnes), the United States (3,000 metric tonnes), Russia (5,300 metric tonnes) and Australia (10,000 metric tonnes). Invariably, these economies formed an integral part of the twelve leading global gold producers in 2019. The world's total gold reserves were estimated at 54,000 metric tonnes during the period. For all the economies with available data on total gold reserves, it was imperative to compute the gold reserves-to-gold production ratio to determine, all else held constant, the number of years or times that each implied economy could produce at the same rate before the gold reserves are depleted. The ratio is expressed as follows:

Gold Reserves Ratio = (Total Gold Reserves ÷ Total Gold Production Volume in a given year) x 100%

To illustrate, Russia's total gold production volume in 2019 was 329.5 metric tonnes (as shown in table 3 and figure 3), while the country maintained total gold reserves of 5,300 metric tonnes during the period. The foregoing implies as of December 2019, Russia had a gold reserves ratio equivalent to 1,608.50% ((5,300 metric tonnes ÷ 329.5 metric tonnes) x 100% = 16.084977 x 100% = 1,608.4977 = 1,608.50%). The computations indicate that if Russia decides to maintain its annual gold production capacity at 329.5 metric tonnes, the economy will be able to produce 16.09 times or remain in production for the next 16.09 consecutive years before the gold reserves are completely depleted. Although the percentage contribution of gold revenue to GDP (0.87%) was determined to be insignificant, the monetary contribution (US$14,760,587,118.647) was found to be quite colossal and capable of impacting positively on national expenditures during the period. The foregoing holds true for most developed economies with significant volumes of gold analysed in this section. Thus, the complete exhaustion of the gold reserves may have adverse implications for the effective administrative functions of successive elected governments in Russia and other related economies.

Available statistics indicated Russia had total gold reserves of 8,000 metric tonnes as of January 2016, equivalent to 14.11% of the world's total gold reserves (56,700 metric tonnes) during the period. The figures suggest a 2,700 metric tonnes reduction in Russia's total gold reserves between January 2016 and December 2019, indicative of the absence of new discoveries or discoveries during the period and further affirming the potential exhaustion of the country's gold reserves over the next seventeen years. However, it is worth-emphasising that even when new discoveries are made, it may take a while to manifest, given the technologically laborious processes involved in arriving at near-accurate estimates for total volumes of new gold discovery.

South Africa's total gold reserves (3,200 metric tonnes) in 2019 were the third-largest globally after Australia and Russia and equivalent to 5.93% of the world's total gold reserves during the period. However, the volume of gold held in reserves (3,200 metric tonnes) during the period was approximately 53.33% of the country's total reserves as of January 2016 (6,000 metric tonnes). Further, the latter was equivalent to 10.58% of the world's total gold reserves (56,700 metric tonnes) as of January 2016. Thus, South Africa experienced depletion in reserves in both absolute (2,800 metric tonnes) [(6,000 metric tonnes – 3,200 metric tonnes = 2,800 metric tonnes)] and percentage terms (4.65%) [(10.58% - 5.93% = 4.65%)]. Similarly, Peru's total gold reserves depleted by 700 metric tonnes (2,800 metric tonnes – 2,100 metric tonnes) while the rate of contribution to the world's gold reserves dropped from 4.94% ((2,800 metric tonnes ÷ 56,700 metric tonnes) x 100% = 0.0493827 x 100% = 4.93827 = 4.94%) to 3.89% ((2,100 metric tonnes ÷ 54,000 metric tonnes) x 100% = 0.038888 x 100% = 3.8888 = 3.89%) during the period under review.

In 2019, the total volume of gold produced by Mexico was estimated at 111.4 metric tonnes. This production capacity sufficed for Mexico to be ranked the ninth-largest gold producer in the world. Further records revealed the country maintained total gold reserves of 1,400 metric tonnes during the period, suggesting gold reserves ratio of 1,256.73% ((1,400 metric tonnes ÷ 111.4 metric tonnes) x 100% = 12.56733 x 100% = 1,256.733 = 1,256.73%); or the country's ability to produce at the same rate (111.4 metric tonnes per year) for 12.57 times prior to depletion of the gold reserves. The inference is that Mexico could maintain an annual gold production capacity of 111.4 metric tonnes for the next 12.57 years before exhausting her gold reserves entirely and controlling for new gold discoveries during the estimated period and subsequent financial years.

Geographically, China, just like Russia, borders fourteen (14) different countries. Further records revealed that at the end of 2019, the People's Republic of China had approximately 2,000 metric tonnes of gold in reserves, while the country's contribution to global total gold production (3,272.7 metric tonnes) during the period was equivalent to 11.71% ((383.20 metric tonnes ÷3,272.7 metric tonnes) x 100% = 0.1170899 x 100% = 11.70899 = 11.71%). Remarkably, China's total gold reserves (2,000 metric tonnes) were about 5.22 times (2,000 metric tonnes ÷ 383.2 metric tonnes = 5.21921 = 5.22) the total production volume (383.20 metric tonnes) during the period. The gold reserves ratio of 521.92% (5.21921 x 100% = 521.92%) tells us that at a constant annual gold production rate of 383.20 metric tonnes, China could remain in operations over the next 5.22 years before experiencing complete depletion of her gold reserves. The computations suggest that in the absence of new discoveries, and if the economy maintains an annual gold production capacity of 383.20 metric tonnes, effective gold mining in China in large commercial quantities may cease after the next five and a half years.

Compared to the United States, gold revenue plays a more crucial role in China's computation of GDP. To illustrate, in 2019, the rate contributed by gold revenue to China's GDP (0.12%) was three times (0.12% ÷ 0.04% = 3.00) the rate contributed to GDP (0.04%) of the United States. The competitiveness of China in global gold production may be under threat in the next six or more years, should annual production be maintained at the current rate and no new discoveries are made. The country's total gold reserves (2,000 metric tonnes) were the seventh-highest and equivalent to 3.70% ((2,000 metric tonnes ÷ 54,000 metric tonnes) x 100% = 0.037004 x 100% = 3.70370 = 3.70%) of the world's total gold reserves (54,000 metric tonnes) in 2019.

The total gold reserves of the United States (3,000 metric tonnes) during the period under review was about 14.99 times the country's total production volume of 200.2 metric tonnes but less than half the ratio recorded by Australia (about 30.30 times). The gold reserves ratio for the United States (14.99 times) is indicative of the country's ability to maintain production at 200.2 metric tonnes annually over the next 14.99 years before depleting its gold reserves entirely. Thus, controlling for further gold exploration and discoveries, the competitiveness of the United States in global gold production may wane after fifteen years. However, even in the absence of new discoveries, the estimated period may be extended if current gold production levels are varied and maintained at rates less than 200.2 metric tonnes per year. The United States has been somewhat consistent in its ranking (4th) in world gold production and consistent in total gold reserves since 2016. At the end of December 2019, the United States had the fourth-largest quantity of gold reserves (3,000 metric tonnes) globally, equivalent to the reserves held as of January 2016 (3,000 metric tonnes) (Market Research.Com, n.d.). This was equivalent to 5.56% ((3,000 metric tonnes ÷ 54,000 metric tonnes) x 100% = 0.05555 x 100% = 5.5555 = 5.56%) of the world's total gold reserves (54,000 metric tonnes) and three times the reserves held by Ghana (1,000 metric tonnes) during the period (U.S. Geological Survey, n.d.a).

Australia's respective data for gold reserves and total gold production in 2019 were 10,000 metric tonnes and 325.1 metric tonnes, meaning the country had a gold reserves ratio of 3,075.98% ((10,000 metric tonnes ÷ 325.1 metric tonnes) x 100% = 30.75977 x 100% = 3,075.9766 = 3,075.98%). That is, the country could produce at the same rate (325.1 metric tonnes) for 30.76 times or remain in production at a constant rate of 325.1 metric tonnes annually for the next 30.76 years before experiencing complete exhaustion of her gold reserves. Controlling for new discoveries, the gold reserves in Australia could be mined over the next three decades or more, especially when production volumes are varied in response to internal and external economic factors. As of December 2019, Australia had the highest quantity of gold reserves globally (10,000 metric tonnes). This was equivalent to 18.52% ((10,000 metric tonnes ÷ 54,000 metric tonnes) x 100% = 0.1851852 x 100% = 18.518 = 18.52%) of the world's total gold reserves (54,000 metric tonnes) (U.S. Geological Survey, n.d.a); and 900 metric tonnes more than the total reserves as of January 2016 (9,100 metric tonnes).

Indeed, prospects for effective gold mining in Australia over the next thirty years are very bright and positive. Data on gold reserves at the beginning of January 2016 (9,100 metric tonnes) (Market Research.Com, n.d.) and at the end of December 2019 (10,000 metric tonnes) were indicative of further discoveries of the precious metal in the Oceania country. The total gold produced at the above-ground level in 2015 was estimated at 301.39 metric tonnes, approximately 9.69 million troy ounces, which is indicative of steady production capacity compared with the production level in 2014. Further, the volume of gold produced by mining firms located in Western Australia, such as the Super Pit and Boddington, was enough to offset production losses occasioned by the closure of the Henty mine in Tasmania. Although the United States showed consistency in total gold reserves from 2016 through 2019 (3,000 metric tonnes), Australia depicted a steady increase in reserves by 900 metric tonnes during the period. There were no adverse reports on the quality of gold mined in Australia during the research period, as was the case for South Africa. This further accentuates the strong gold potential of Australia in the long-term, though South Africa remains a major force in the regional and global mining markets.

Ghana is situated in the western part of Africa, with an estimated population of 31 million people. The country is endowed with many natural resources in large commercial quantities including gold. Statistics released by the U.S. Geological Survey (n.d.a) estimated Ghana's total gold reserves at one thousand (1,000) metric tonnes in 2019. This reserve's value was the least among the twelve leading gold-producing countries in the world during the period. Ghana's gold reserves (1,000 metric tonnes) were 2,200 metric tonnes and 800 metric tonnes short of the respective reserves of South Africa (3,200 metric tonnes) and Uzbekistan (1,800 metric tonnes) and 1,100 metric tonnes less than the total reserves of Peru (2,100 metric) during the period.

Data on total volume of gold production (142.4 metric tonnes) and gold reserves (1,000 metric tonnes) suggest Ghana's gold reserves ratio during the period was 702.25% ((1,000 metric tonnes ÷ 142.4 metric tonnes) x 100% = 7.02247 x 100% = 702.24719 = 702.25%); implying the country's ability to produce about 7.02 times at constant production rate of 142.4 metric tonnes annually prior to depletion of the entire gold reserves. Stated in different terms, Ghana could ensure effective gold production and maintain its global competitiveness at a constant production rate of 142.4 metric tonnes annually over the next 7.02 years. The analysis paints a gloomy picture for gold exploration in Ghana, controlling for new discoveries in addition to the existing gold reserves after seven years, and should total production volume be maintained and not varied below 142.4 metric tonnes annually. Ghana's total gold reserves (1,000 metric tonnes) translated into 1.85% ((1,000 metric tonnes ÷ 54,000 metric tonnes) x 100% = 0.0185185 x 100% = 1.85185 = 1.85%) of the global gold reserves (54,000 metric tonnes); and nine times less than the reserves of Australia in 2019.

As of December 2019, Mexico had an estimated 1,400 metric tonnes of gold in reserves. This tonnage was equal to the gold reserves of Kazakhstan (1,400 metric tonnes) but 1,200 metric tonnes and 500 metric tonnes less than the respective gold reserves of Indonesia (2,600 metric tonnes) and Canada (1,900 metric tonnes). The reserves held by the United States (3,000 metric tonnes) during the period were nearly 2.14 times the reserves of Mexico (1,400 metric tonnes) and 7,000 metric tonnes short of the Australian reserves (10,000 metric tonnes). The gold reserves ratio for Mexico during the period was 1,256.73% ((1,400 metric tonnes ÷ 111.4metric tonnes) x 100% = 12.56733 x 100% = 1,256.7325 = 1,256.73%). The ratio is indicative of the country's ability to maintain annual gold production at 111.4 metric tonnes over the next 12.57 years, which is 2.42 years (12.57 years – 14.99 years) less than the estimated mining period for the United States (14.99 years); and 5.55 years (12.57 years – 7.02 years) more than the period determined for Ghana (7.02 years). Indonesia's total gold reserves at the end of 2019 (2,600 metric tonnes) were 400 metric tonnes short of the tonnage held in reserves as of January 2016 (3,000 metric tonnes), implying no new discovery and further depletion of existing reserves.

The combined total gold reserves of Australia (10,000 metric tonnes), Russia (5,300 metric tonnes), South Africa (3,200 metric tonnes) and the United States (3,000 metric tonnes) were 21,700 metric tonnes. These were equivalent to 40.19% of the world's total reserves and superior to the combined total reserves (8,600 metric tonnes) of Indonesia (2,600 metric tonnes), Peru (2,100 metric tonnes), China (2,000 metric tonnes) and Canada (1,900 metric tonnes). The combined total reserves for these latter economies constituted about 15.93% of the globe's total gold reserves, which was a far cry from the rate (40.19%) contributed by the afore-listed economies in 2019. The current dominance of Australia, Russia, and South Africa may be exemplified by their respective gold reserves capacities - 10,000 metric tonnes, 5,300 metric tonnes, and 3,200 metric tonnes. Their collective contribution (18,500 metric tonnes) to global gold stocks reserves (54,000 metric tonnes) in 2019 was equivalent to 34.26% ((18,500 metric tonnes ÷ 54,000 metric tonnes) x 100% = 0.3425926 x 100% = 34.25926 = 34.26%). That is, more than a third of the world's total gold reserves (34.26%) were held by Australia, Russia and South Africa during the period.

Uzbekistan had the ninth-largest gold reserves in 2019. These reserves (1,800 metric tonnes) were equivalent to 3.33% of the world's total reserves (54,000 metric tonnes) and 56.25% of the reserves held by South Africa (3,200 metric tonnes). The country had gold reserves ratio of 1,730.77% ((1,800 metric tonnes ÷ 104 metric tonnes) x 100% = 17.307692 x 100% = 1,730.7692 = 1,730.77%) in 2019. This suggests a constant production volume of 104 metric tonnes per annum. Uzbekistan could produce 17.31 times or ensure consistent production over the next 17.31 years before depleting the country's entire gold reserves. Similarly, the total gold reserves of Kazakhstan in 2019 were 1,400 metric tonnes, the tenth-largest reserves in the world during the period. These reserves translated into ratio of 1,822.92% ((1,400 metric tonnes ÷ 76.8 metric tonnes) x 100% = 18.229167 x 100% = 1,822.9167 = 1,822.92%), implying at constant production volume of 76.8 metric tonnes per year, Kazakhstan has the capacity to produce 18.23 times; or ensure consistent production over the next 18.23 years before the entire gold reserves are depleted.

The inference is controlling for new discoveries and variations in production capacity, gold mining in large commercial quantities in Kazakhstan may not travel beyond nineteen years. However, the estimated life for gold mining in Kazakhstan is about 2.60 times (18.26 years ÷ 7.02 years = 2.59687 = 2.60) the estimated life for Ghana (7.02 years); and 3.49 times (18.23 years ÷ 5.22 years = 3.49234 = 3.49) the estimated life for China (5.22 years). However, it could be argued that the "unpredictability" of China implies the country may have undeclared reserves that could extend gold mining in the country beyond the estimated 5.22 years.

While major gold-producing economies across the globe are striving to maintain large stocks of gold reserves to remain competitive, ensure higher gold revenues and significant contributions of same to GDP in the medium- and long-term, leading mining companies across the globe are also strategising and making frantic efforts to consolidate their stocks of gold reserves in mines across global economies. This is evidenced in some of the historic mergers and acquisitions witnessed in the global mining industry in recent years. Barrick Gold Corporation (as cited in George, 2012, pp. 31.1-31.2) catalogued a series of significant mergers and acquisitions in the global mining industry in 2010. Some of these include the merger of Kinross Gold Corporation in Toronto, Canada and Red Back Mining Incorporated in Vancouver, Canada. The latter owned the Tasiast Gold Mine in Mauritania and Chirano Gold Mine in Ghana prior to the merger. Noche Resources Corporation in Toronto, Canada, acquired Goldcorp's silver-gold mine at San Dimas in Mexico and was renamed Primero Mining Corporation, Toronto, Canada, after the acquisition. Andean Resources, located at Fremantle in Western Australia, Australia, and owner of the Cerro Negro gold-silver project in Argentina, was acquired by Goldcorp.

Prior to the foregoing acquisition, Goldcorp off-loaded its 21% interest in the Morelos project in Mexico to Gleichen Resources Limited, Toronto, Canada. The latter is now called Torex Gold Resources Incorporated, Toronto, Canada. Further, Lihir Gold Limited, located at Port Moresby in Papua New Guinea, was acquired by Newcrest Mining Limited, situated in Melbourne, Victoria, Australia. The former owned the Lihr Island Mine in Papua New Guinea prior to the purchase. In addition, Goldcorp divested its controlling interest in Terrane Metals Corporation, which owned the Mount Milligan copper-gold project in British Columbia, Canada. After the divestiture, Terrane Metals Corporation was acquired by Thompson Creek Metals Company Incorporated, Vancouver, Canada (Barrick Gold Corporation as cited in George, 2012, pp. 31.1-31.2).

Experts have noted difficulties in mining in recent times, owing largely to the fact that many older mines, such as those in South Africa and other large and low-cost mines, are nearing depletion. For instance, South Africa witnessed 46.67% decrease [((3,200 metric tonnes – 6,000 metric tonnes) ÷ 6,000 metric tonnes) x 100% = -2,800 metric tonnes ÷ 6,000 metric tonnes) x 100% = -0.466666 x 100% = -46.6666 = -45.57%] in total gold reserves between January 2016 and December 2019, while global gold reserves decreased by 4.76% [((54,000 metric tonnes – 56,700 metric tonnes) ÷ 56,700 metric tonnes) x 100% = -2,700 metric tonnes ÷ 56,700 metric tonnes) x 100% = -0.04761905 x 100% = -4.761905 = -4.76%] during the period. In a related development, Harper (2020) noted that the cost of mining in China remained relatively high due to predominantly smaller mine sizes. Indeed, not all global regions have been explored for gold mining;

there are a few regions that remain outstanding, as acknowledged by the World Gold Council (2020a). Harper (2020) believed the untapped regions for gold mining are mostly those ravaged by civil war and conflicts, as witnessed in some parts of West Africa. Though the news on unexplored regions is assuring, the rate of gold mining and usage calls for proactive interventions to avoid early depletion of the global gold reserves in the immediate- and medium-term.

4.5. Gold Production in Africa

Africa remains one of the global regions with strong exploration and mining potential for the precious metal called gold. The contribution of gold revenue to gross domestic product and socio-institutional infrastructure development of African economies and economies in other regions across the globe cannot be overemphasised. In 2019, fifteen of the fifty-five economies in Africa were included in forty-three economies with significant gold production volumes across the globe. The analysis suggests the rate of total African economies with gold production capacity in large commercial quantities in 2019 was equivalent to 27.27% ((15 African gold-producing economies ÷ 55 African economies) x 100% = 0.272727 x 100% = 27.2727 = 27.27%) of the total number of economies (55) on the continent.

However, Africa's representation on the global list of major gold-producing economies was equivalent to 34.88% ((15 African gold-producing economies ÷ 43 global gold-producing economies) x 100% = 0.348837 x 100% = 34.8837 = 34.88%) during the period. Table 4 and figure 4 present useful data on these fifteen African economies and their respective gold production volumes (in metric tonnes), gold revenues (in US dollars), and percentage contributions of gold revenue to GDP, and global and African rankings during the period. Values for gold revenues in column 5, table 4 were arrived at by first converting the metric tonnes into troy ounces (1 metric tonne = 32,150.75 troy ounces) and, finally, multiplying the derived troy ounces by the average closing price per ounce of gold for 2019 (US$1,393.34) (see Tables 5 and 6). Each gold revenue in column 5, table 4 was expressed as a percentage of the GDP recorded by the implied economy in 2019 to obtain the values in column 6, table 4. The GDP values for 2019 were accessed from the World Bank (2021a).

Data released by Metals Focus (as cited in World Gold Council, 2020a), presented in the table and figure, indicate Ghana remained the leading gold producer in Africa in 2019. Respective total gold production volumes by South Africa (118.20 metric tonnes), Sudan (76.60 metric tonnes), Burkina Faso (62 metric tonnes), and Mali (61.20 metric tonnes) affirmed their respective second, third, fourth and fifth rankings in Africa during the period. However, issues related to gold quality, accelerated depletion of reserves, realisation of marginal profits and incurring of losses have characterised operations of the mining industry in South Africa in recent years.

World Ranking	Africa Ranking	Country	Production Volume in Metric Tonnes	Gold Revenue in US$	% Cont. of Gold Revenue to GDP
7th	1st	Ghana	142.4	6.379Bill.	9.52%
8th	2nd	South Africa	118.2	5.295 Bill.	1.51%
14th	3rd	Sudan	76.6	3.432 Bill.	11.25%
16th	4th	Burkina Faso	62	2.777 Bill.	17.37%
17th	5th	Mali	61.2	2.742 Bill.	15.87%
19th	6th	Tanzania	48	2.150 Bill.	3.40%
21st	7th	Congo, D.R.	45.6	2.043 Bill.	4.05%
22nd	8th	Côte d'Ivoire	41.9	1.877 Bill.	3.21%
23rd	9th	Zimbabwe	38.7	1.734 Bill.	8.09%
30th	10th	Guinea	27.5	1.232Bill.	10.02%
33rd	11th	Senegal	16.8	752.588 Mill.	3.19%
35th	12th	Mauritania	15.1	676.434 Mill.	8.90%
36th	13th	Egypt	14.9	667.474 Mill.	0.22%
37th	14th	Madagascar	14.5	649.555 Mill.	4.60%
38th	15th	Nigeria	14	627.157 Mill.	0.14%

Table 4: Leading Gold Producing Countries in Africa – 2019
Data Source: Metals Focus (as cited in World Gold Council, 2020)

One of the key objectives of the current research was to measure earnings from gold mined above-ground levels by the major gold-producing economies across the globe, especially those on the African continent, and to analyse the economic usefulness and significance of the contribution of gold revenue to gross domestic product. Data in columns 5 and 6 in table 4 present essential statistics on the respective revenues derived from gold by the 15 major gold-producing economies in Africa and the percentage contribution of gold revenue to their respective GDPs in 2019. The data indicate the respective percentage contributions of gold revenue to GDP for seven of the fifteen major gold-producing economies in Africa during the period, including Burkina Faso, Mali, Sudan, Guinea, Ghana, Mauritania, and Zimbabwe, were above 8%, while the respective percentages contributed to GDP of the remaining eight economies were below 5%. Consistent with the largest-production volume, Ghana recorded the highest revenue from gold production (US$6.379 billion) in 2019; followed by the respective gold revenues of South Africa (US$5.295 billion) and Sudan (US$3.432 billion).

Total gold revenue derived by Burkina Faso in 2019 was equivalent to US$2.777 billion, the fourth-highest among the fifteen major gold-producing economies in Africa during the period. Quite remarkably, gold revenue derived by Burkina Faso in 2019 was equivalent to 17.37% of GDP, the highest rate in Africa, closely followed by Mali with a percentage contribution of 15.87%. Sudan's relatively impressive gold revenue (US$3.432 billion) was the third-highest and equivalent to 11.25% of GDP, the third-highest rate of contribution during the period. The statistics affirm the valuable contribution of gold revenue to the respective economies of the foregoing countries and the probability of these economies languishing in financial challenges should external and internal factors serve as impediments to the realisation of targeted gold revenue in any given financial year.

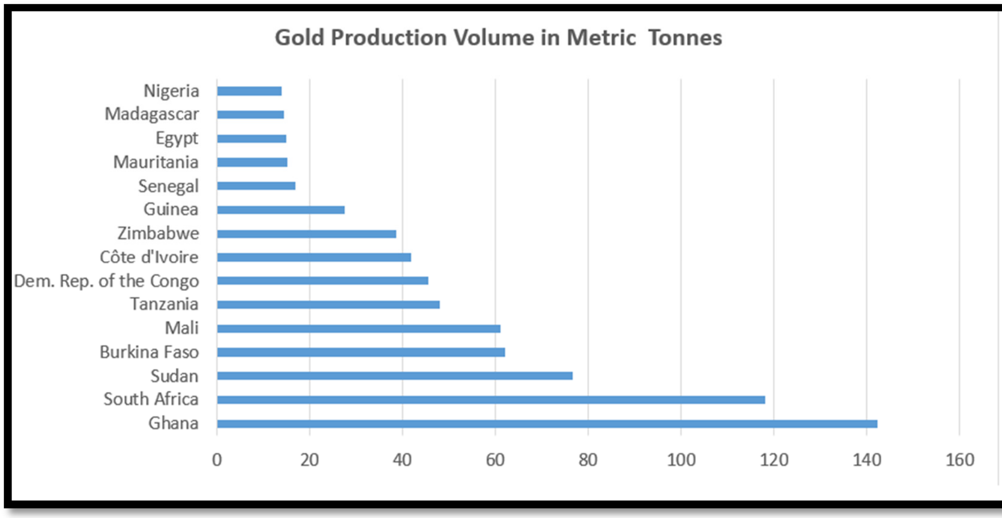

Figure 4: Leading Gold Producing Countries in Africa – 2019
Data Source: Metals Focus (as cited in World Gold Council, 2020)

Nigeria (US$448.120 billion), South Africa (US$351.432 billion) and Egypt (US$303.092 billion) remained the top-three leading economies in Africa during the 2019 financial year. Coincidentally, each of these three leading African economies produces gold in large commercial quantities, albeit the respective quantities produced by Egypt (14.9 metric tonnes) and Nigeria (14 metric tonnes) in 2019 were a pale shadow of South Africa's relatively strong production capacity (118.2 metric tonnes) during the period. Total gold revenue realised by South Africa in 2019 (US$5.295 billion) was about 7.93 times the revenue derived by Egypt (US$667.474 million) and 8.44 times the revenue earned by Nigeria (US$627.157 million). However, a common characteristic shared by these three economies was that the percentage contribution of gold revenue to their respective GDPs was below 2%; South Africa recorded 1.51%, while the respective rates for Egypt and Nigeria were 0.22% and 0.14%.

In 2019, the fifteen African economies produced 737.4 metric tonnes of gold, equivalent to 22.53% of the total volume produced by the forty-three global economies (3,272.7 metric tonnes). Ghana's total above-ground stocks of gold in 2019 were estimated at 142.40 metric tonnes. This was equivalent to 4.35% of the total above-ground stocks of gold globally (3,272.7 metric tonnes) and equivalent to 19.31% of total gold stocks produced (737.4 metric tonnes) in Africa during the period. Combined total gold stocks produced by Ghana (142.40 metric tonnes), South Africa (118.20 metric tonnes) and Sudan (76.60 metric tonnes) amounted to 337.20 metric tonnes. This was equivalent to 45.73% of the total gold produced by the fifteen African economies (737.4 metric tonnes) listed in table 4 and figure 4.

The study revealed that South Africa is home to 50% of the total gold ore mineral reserves discovered across the globe. Imperatively, the world's largest single body of gold ore is found in the Witwatersrand Basin in South Africa. Most part of the remaining 50% is divided among Australia, Russia, the United States, China, Canada and other economies (Hoffmann, n.d.; Market Research.Com, n.d.). The quality of gold mined and the profitability of gold operations in South Africa have come under scrutiny among some academics and investment analysts in recent years. These challenges notwithstanding, the South African economy continues to assert its influence in Africa and across the globe. The country's GDP in 2019 was valued at US$351.432 billion, the second-largest in Africa after Nigeria (US$448.120 billion) and followed by Egypt (US$303.092 billion) (World Bank, 2021c). The country's total volume of gold produced in 2019 (118.2 metric tonnes) was the eighth-largest in the world and second-largest in Africa after Ghana (142.4 metric tonnes).

Total gold revenue realised by South Africa during the period amounted to US$5,294,996,653.791 (US$1,393.34 x (118.2 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 3,800,218.65 troy ounces = US$5,294,996,653.791); equivalent to 3.66% of global gold revenue; and 1.51% ((US$5,294,996,653.791 ÷ US$351,432,000,000) x 100% = 0.0150669 x 100% = 1.50669 = 1.51%) of GDP (US$351.432 billion). The computations suggest gold revenue usually accounts for less than 2% of South Africa's total economic output values, implying other components make the bulkiest contribution to the country's GDP. We observe a common thread among the United States (0.04%), China (0.12), Canada (0.47%), Russia (0.87%) and South Africa (1.51%). That is, although these economies make a significant impact on gold in terms of volumes of production and stocks of reserves, the annual contribution of gold revenues to their respective GDPs is quite marginal.

Barrick Gold is noted for owning the majority of shares in Nevada Gold Mines. The latter is known for its role as the single largest gold mining complex in the world. It has an annual production capacity of 3.5 million ounces, equivalent to 108.86 metric tonnes (3.5 million ounces ÷ 32,150.75 troy ounces = 108.8622 metric tonnes). It is imperative to note new gold mines are still being discovered. However, the discovery of new large gold deposits is becoming increasingly difficult. To this end, older mines have continued to serve as a major source of gold production in recent years. Mining vast stretches below and on surface levels requires a lot of expertise and remains highly capital-intensive. Statistics indicate that surface mining constitutes approximately 60% of global mining operations, while underground mining accounts for the remaining 40% (Harper, 2020).

The Great Lakes region could boast of new gold refineries in recent years. These new refineries have installed a production capacity in excess of 330 tonnes or 10,609,747.5 troy ounces annually (Smith, 2020). Unfortunately, not all gold carts to the new refineries are passed through official channels. To wit, not all gold presented for the refinery is accounted for at the national level; some are sent by rebel fighters, dissidents and other illegal gold dealers. Though this phenomenon is pervasive in Eastern Africa, it was found to be more prevalent in the Democratic Republic of Congo during the research period (Smith, 2020).

One of the complex and murderous conflicts in Africa in prior and recent years is believed to have been recorded in the Democratic Republic of Congo, especially in the eastern part of the country. The battle for ethnic identity, political control, borders and natural resources such as gold by foreign-backed militias, national fighters and local fighters in the eastern part has had a dire effect on the streams of gold revenue derived by the country over the years. Generally, the gold industry in Eastern Africa, including the Democratic Republic of Congo, is believed to have been reshaped by frequent smuggling, local and national tax evasion through mislabelling of consignments, and attempts at the international level to block gold exports from war zones (Smith, 2020).

The inference here is that the official total gold production reported by the Democratic Republic of Congo (45.6 metric tonnes), as shown in tables 3 and 4 and figures 3 and 4, may not reflect the actual metric tonnes of gold exported from the country during the financial year under review (2019). It is likely quite significant metric tonnes of gold were exported and officially unaccounted for through smuggling and mislabelling of consignments, among other unapproved means and methods of exports. The new gold refineries in the Great Lakes region are believed to serve the purpose of warlords and other smugglers. For instance, the protracted civil conflict in the eastern part of the Democratic Republic of Congo occasioned the establishment of a supply chain which facilitates the smuggling of gold from the war zones in South Kivu and Ituri to regional refineries (UN Report as cited in Smith, 2020).

After the refinery in the Great Lakes region, the gold consignments are exported to Dubai in the United Arab Emirates (UAE) for re-refining. In Dubai, the cartel has the opportunity to blend the smuggled gold with those from other sources. These newly-packaged gold consignments, which include smuggled gold from the Democratic Republic of Congo and other Eastern African economies, are eventually sent to constitute an integral part of the gold bullion bars in Switzerland (UN Report as cited in Smith, 2020). One observes rebels and warlords in various conflict zones in Africa and elsewhere endowed with rich minerals such as gold, which have one thing in common. That is the insatiable taste for gold and its exploitation to finance their warring activities. Illegal artisanal miners latch on ineffective mining regulations and codes to feast on these mineral resources.

As noted earlier, the total gold production volume of the Democratic Republic of Congo in 2019 was estimated at 45.6 metric tonnes. This volume was high enough to ensure the country remained the seventh- and twenty-first-largest gold producer in Africa and throughout the world, respectively. During the period, the economy recorded a GDP of US$50.401 billion and total gold revenue of US$2,042,739,825.828 (US$1,393.34 x (45.6 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 1,466,074.2 troy ounces = US$2,042,739,825.828). The latter was equivalent to 4.05% ((US$2,042,739,825.828 ÷ US$50,401,000,000) x 100% = 0.0405298 x 100% = 4.05298 = 4.05%) of GDP (US$50.401 billion); and affirmed significant contribution of gold revenue to total economic output in the Democratic Republic of Congo. It is apparent that the official annual contribution of gold revenue to GDP recorded by the country would have been higher if the activities of illegal artisanal miners in the rebel-controlled and other mining areas were regularly accounted for and included in the estimates for total gold stocks mined above-ground level.

The implication of the refinery challenges in the Great Lakes region is that other member countries in the Eastern Bloc, including Tanzania and Sudan, are equally affected. In 2019, Tanzania recorded a GDP of US$63.177 billion, representing an increase of 8.93% over the US$58 billion recorded earlier in 2018. Data in tables 3 and 4 and figures 3 and 4 depict Tanzania's total gold production; and global and Africa rankings during the period under review. The country's total gold stocks above ground level in 2019 (48 metric tonnes) ranked sixth in Africa and nineteenth globally. The total gold stocks suggest total gold revenue of US$2,150,252,448.24 (US$1,393.34 x (48 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 1,543,236 troy ounces = US$2,150,252,448.24). Percentage-wise, total gold revenue was equivalent to 3.40% ((US$2,150,252,448.24 ÷ US$63,177,000,000) x 100% = 0.0340354 x 100% = 3.40354 = 3.40%) of GDP (63.177 billion) during the period. Though remarkable, compared with rates recorded by Nigeria (0.14%), South Africa (1.51%) and Côte d'Ivoire (3.21%), the evidence suggests the volume of gold officially reported could have exceeded 48 metric tonnes, and the contribution of gold revenue to GDP would have been superfluous, controlling for smuggling, corruption in political officialdom and mislabelling of gold consignments, among other pertinent impeding factors.

A UN Report (as cited in Smith, 2020) bemoaned challenges to the establishment of beneficial ownership of gold smuggled to the refineries in the Great Lakes region due to several factors, including the decision of some refineries to act as brokers, use of cash payment methods that are very difficult to trace; the decision to trade on refiner-to-refiner basis thereby concealing the origin of smuggled gold; and use of corporate networks in the transaction process. The UN Report (as cited in Smith, 2020) further noted the exclusion of banking networks in most gold trading activities in many Eastern African economies, thereby compounding the possibility of effective tracing and determination of the transactions' sources.

South Africa's total gold reserves in 2019 were 3,200 metric tonnes, the third largest globally, during the period. The gold reserves ratio recorded during the period was approximately 2,707.28% ((3,200 metric tonnes ÷ 118.2 metric tonnes) x 100% = 27.072758 x 100% = 2,707.2758 = 2,707.28%). The reserves ratio tells us the extent of the duration of South Africa's gold production capacity. The results imply that at a constant production volume of 118.2 metric tonnes per annum, the country could remain in operation over the next 27.07 years before exhausting the gold reserves entirely. Although South Africa maintained a relatively lower gold production volume (118.2 metric tonnes) than Ghana (142.4 metric tonnes) in 2019, the estimated gold mining life for the former is over three times (3.86 times) (27.07 years ÷ 7.02 years = 3.85613 = 3.86) the estimation for the latter (7.02 years). Thus, controlling for new discoveries, Ghana's dominance in gold production on the African continent could fizzle into thin air in the next few years.

One of the few African economies with strong prospects of gold discovery and production is Sudan. In 2019, the country maintained a total production capacity of 76.6 metric tonnes. Statistics in the tables and figures affirm that this tonnage was enough for Sudan to acclaim the respective third- and fourteenth-largest producer in Africa and globally. Sudan crowned her economic performance in 2019 with a GDP valued at US$30.514 billion and total gold revenue of US$3,431,444,531.983 (US$1,393.34 x (76.6 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 2,462,747.45 troy ounces = US$3,431,444,531.983). This revenue was equivalent to 11.25% ((US$3,431,444,531.983 ÷ US$30,514,000,000) x 100% = 0.1124548 x 100% = 11.24548 = 11.25%) of the country's GDP (US$30.514 billion) and affirmed higher contribution of gold revenue to GDP of Sudan than recorded by Ghana (9.52%), Uzbekistan (8.04%), Mongolia (5.22%), Côte d'Ivoire (3.21%), Kazakhstan (1.89%), South Africa (1.51%); and the advanced and emerging economies with significant volumes of gold production listed in table 3 and figure 3.

Management of Sudan's mineral resources under former President Omar al-Bashir was believed to be fraught with many challenges. Specifically, the management of gold production under the regime could best be described as largely decentralised, unstructured and not effectively regulated. This created management loopholes and room for increased manipulation, corruption and smuggling. Kumar (as cited in Smith, 2020) found that President al-Bashir's regime issued fifty mining licences in a day without due diligence. Further, corrupt practices in officialdom heightened to the level where artisanal miners dealt with warlords and corrupt officials instead of paying royalties and local taxes.

The official total volume of gold produced by Sudan in 2018 was 93 tonnes. This volume was enough to rank the country third in Africa after Ghana and South Africa, respectively. Further records revealed that the total value of gold officially exported by Sudan between 2014 and 2018 amounted to $8.6 billion. However, these official earnings from exports ($8.6 billion) were at variance with the total value of gold imports ($12.7 billion) recorded by Sudan's major trading partners during the period. The analysis suggests a substantial value gap of $4.1 billion ($12.7 billion - $8.6 billion = $4.1 billion) in gold trading in Sudan during the period. Kumar (as cited in Smith, 2020) attributed the variance ($4.1 billion) to smuggling, implying a loss of revenue in excess of $550 million to the State. Invariably, the foregoing gold management excesses were recorded under the leadership of former President al-Bashir.

Conversely, Kumar (as cited in Smith, 2020) witnessed improvements in the management of mineral resources, especially gold, following the overthrow of President al-Bashir's regime by the Military Junta in April 2019 and the assumption of governance during the period. The Military Junta implements the centralised system. That is, gold trading is regulated at the centre of political authority. Some analysts hailed this initiative and believed it has the potential to halt smuggling and other corrupt practices in the country. It is hoped that this novel approach to the management of precious metals in Sudan will reflect positively on the official total metric tonnes of gold mined and produced and the gold revenues reported at the end of the current and subsequent financial years.

Côte d'Ivoire ended the 2019 financial year with a GDP of US$58.539 billion, representing 0.07% of global GDP (US$87.735 trillion). The country remains a competing force with Ghana in global cocoa production and exports. However, Ghana affirms its superiority over Côte d'Ivoire in terms of global gold production and reserves. This notwithstanding, the total volume of gold produced by Côte d'Ivoire in 2019 (41.9 metric tonnes) was the eighth- and twenty-second-largest in Africa and globally after the Democratic Republic of Congo ended the financial year with a total gold production volume of 45.6 metric tonnes, the seventh- and twenty-first-largest gold stock above-ground level in Africa and across the globe. Côte d'Ivoire's total earnings from gold during the period were valued at US$1,876,991,199.6095 (US$1,393.34 x (41.9 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 1,347,116.425 troy ounces = US$1,876,991,199.6095); equivalent to 3.21% ((US$1,876,991,199.6095÷ US$58,539,000,000) x 100% = 0.0320639 x 100% = 3.20639 = 3.21%) of GDP (US$58.539 billion).

An important observation is the indispensable role of gold revenue in the determination of total economic output values for developing economies such as Burkina Faso (17.37%), Mali (15.87%), Sudan (11.25%), Ghana (9.52%), Uzbekistan (8.04%) and Mongolia (5.22%). It is worth noting that prolonged civil conflicts in key mining areas in Sudan, the Democratic Republic of Congo, and Mali and overt illegal artisanal mining activities in Ghana often deny these economies proper estimates for a total volume of gold mined above-ground level annually. The foregoing tends to affect the official total gold revenue derived from the operations and activities thereof by these implied economies.

Data in table 4 and figure 4 indicate Ghana and Nigeria were the respective highest (142.40 metric tonnes) and lowest (14 metric tonnes) contributors from the African continent to major global gold production in 2019 (see table 3 and figure 3). Nigeria's total gold production capacity of 14 metric tonnes in 2019 was enough to place thirty-eighth globally and fifteenth in Africa after Madagascar, the fourteenth- and thirty-seventh-largest producer in Africa and globally with a total production capacity of 14.5 metric tonnes. Nigeria's ranking in gold production may not be surprising to many analysts since the country is noted at the global level for significant production of crude oil rather than gold. Nigeria's ability to mine gold in large commercial quantities may be described as an economic addendum; it is indicative of alternative sources of foreign inflows (besides crude oil and other major commodities) in the Nigerian economy.

Senegal's total gold production capacity of 16.8 metric tonnes in 2019 was enough for it to be placed thirty-third globally and eleventh in Africa after Guinea (thirtieth-largest producer globally and tenth-largest producer in Africa with

27.5 metric tonnes). Senegal's GDP was valued at US$23.578 billion, while total gold revenue recorded during the period was US$752,588,356.884 (US$1,393.34 x (16.8 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 540,132.6 troy ounces = US$752,588,356.884). Total gold revenue (US$752,588,356.884) was equivalent to 3.19% ((US$752,588,356.884 ÷ US$23,578,000,000) x 100% = 0.0319191 x 100% = 3.19191 = 3.19%) of GDP (US$23,578,000,000) during the 2019 financial year.

Nigeria continues to assert its role as the leading economy in Africa, recording a total GDP of US$448.120 billion in 2019. Total revenue from gold mining activities to the Nigerian economy in 2019 was valued at US$627,156,964.07 (US$1,393.34 x (14 metric tonnes x 32,150.75 troy ounces) = US$1,393.34 x 450,110.5 troy ounces = US$627,156,964.07); equivalent to 0.14% ((US$627,156,964.07 ÷ US$448,120,000,000) x 100% = 0.00139953 x 100% = 0.139953 = 0.14%) of GDP (US$448,120,000,000). The relative strength of Nigeria in gold mining and production (14 metric tonnes) reflects the precious metal's percentage contribution (0.14%) to GDP (US$448.120 billion). Expectedly, the contribution of gold revenue in percentage terms to GDP during the period was non-significant.

Eight of the fifteen economies listed in table 4 and figure 4 is situated in West Africa. They include Ghana, Burkina Faso, Mali, Côte d'Ivoire, Guinea, Senegal, Mauritania and Nigeria. The rest are spread across Southern Africa (South Africa, Zimbabwe and Madagascar), Eastern Africa (Sudan, Tanzania and the Democratic Republic of Congo) and Northern Africa (Egypt). This suggests that gold production in commercial quantities was more pronounced in the West African sub-region than anywhere else on the continent during the period. The Numerical advantage of West Africa was corroborated by its quantitative contribution to Africa's total gold production during the period. Total gold stocks produced by the eight West African economies in the table and figure equalled 380.9 metric tonnes, equivalent to 51.66% of total gold production contributed by the African continent (737.4 metric tonnes) to global gold production (3,272.7 metric tonnes) in 2019. However, the total volume of gold produced by West Africa (380.9 metric tonnes) was less than the volume produced by China (383.2 metric tonnes) during the period.

It is apparent at this juncture that Africa's development challenges do not relate to the limited availability of natural and human capital resources. Rather, they rest on leadership and the inability of the same to ensure effective utilisation of the resources endowed with each sovereign state. Indeed, economic wastefulness, such as witnessed in Sudan and elsewhere, inflamed passions and increased the level of hesitance among Western economies in the past and recent years to continually provide financial support to accelerate development and growth among African economies. Leadership in Africa must be seen practically to be making significant improvements in the management of their respective economies through efficient and effective utilisation of natural and other resources to repose lost confidence in Western leaders and their citizens, so the requisite technical and financial assistance could be provided as and when necessary to accelerate the continent's development and competitiveness at the global level.

4.6. Demand for Gold

The global demand for gold for various purposes and activities could be categorised into four. These include the demand for gold for technology, investment, and jewellery, as well as the demand for gold by central banks. Innovations in *technology*, specifically in electronics, are believed to be nucleated around gold and *nanotechnology*. Scientists describe the latter as the branch of technology that focuses on dimensions and tolerances of less than a hundred nanometers when it comes to manipulating molecules and individual atoms. Gold and nanotechnology play a significant role in innovations introduced in areas such as environmental management, medicine and engineering. The latter could be expanded to include the manufacturing of jet aircraft engines, spacecraft, computers and communications equipment (U.S. Geological Survey, n.d.a). The precious metal plays a crucial role in dentistry and the development of medical equipment for effective drug transfusion into the human body. Stewart (2020) contended that human life, to some extent, depends on natural minerals. For instance, human necessities and luxuries such as mobile phones, houses and cars contain some mined elements.

Data shared by the U.S. Geological Survey (n.d.a) estimated total stocks of gold above-ground level at the end of 2019 at 197,576 metric tonnes, equivalent to 6,352,216,582 troy ounces. The use of this mined gold during the period was categorised into four parts: jewellery, private investments, official holdings and other uses. Since the technology was not specified, it could be inferred to have been categorised under other "uses" or "purposes," which accounted for 28,090 metric tonnes, equivalent to 14.22% ((28,090 metric tonnes ÷ 197,576 metric tonnes) x 100% = 0.1421731 x 100% = 14.21731 = 14.22%) of total gold mined and available for use during the period. The total volume of gold used for other purposes (28,090 metric tonnes) was the least quantity in the four categories.

Harper (2020) revealed that most electronic products, such as mobile phones that are enamoured with gold, are disposable. The value of enamoured gold in an average cell phone is estimated at a few dollars or pounds sterling. Fortunately, it is possible to extract the gold from disposed electronic products, and efforts to recycle the extracted gold are already ongoing. However, higher recycling rates are required to address a major phenomenon, that is, rapid exhaustion of the precious metal, which has the potential to negatively impact its availability for use in the near and distant future.

Precious metals such as gold play a critical role in civilisation and advances in the contemporary technological world by furnishing basic needs. This is evidenced in the total volume of gold (28,090 metric tonnes) accounted for by technology and other purposes and uses other than jewellery, private investment and official holdings in 2019. This value contribution notwithstanding, minerals such as gold could pose serious threats to human health and the environment through their mining processes (Stewart, 2020).

Gold has proven to be both counter-cyclical and pro-cyclical. Its performance becomes manifest in periods of uncertainty; it serves as a safe-haven for *investment* and investors in the periods of uncertainty. Gold prices in the short-and medium-term are strongly influenced by investment factors. Generally, an investment portfolio is enhanced and protected when modest allocations are made to the precious metal. Expected and unexpected market shocks could increase investment losses and volatilities and reduce purchasing power. However, the inclusion of gold in portfolios provides strong protection for investments during these periods. The acceptance of gold as a reliable investment source and store of value in the long term is beginning to gain currency among investors. This is evidenced by a more than 235% increase in annual investment in gold in the last three decades.

Despite the foregoing, the share of gold in global investment portfolios is less than 1% (World Gold Council, 2020a). The inference is that gold is often included in investment portfolios for strategic reasons but not as a dominant investment asset; it is included to provide the requisite protection for the investment portfolio against foreseen and unforeseen volatilities that could potentially result in losses to investors. However, the total volume of gold production allocated to private investment and official holdings in 2019, as released by the U.S. Geological Survey (n.d.a), was quite significant; the former accounted for 42,619 metric tonnes, while the latter's total allocation was 33,919 metric tonnes. The respective total gold productions allocated to private investment (42,619 metric tonnes) and official holdings (33,919 metric tonnes) constituted 21.6% and 17.2% of the total stocks of gold (197,576 metric tonnes) above-ground level during the period. When private investment and official holdings are lumped together, total gold allocation to investment increases to 76,538 metric tonnes (42,619 metric tonnes + 33,919 metric tonnes = 76,538 metric tonnes), equivalent to 38.74% ((76,528 metric tonnes ÷ 197,576 metric tonnes) x 100% = 0.387385 x 100% = 38.7385 = 38.74%) of total gold stocks (197,576 metric tonnes) at the end of 2019.

Demand for gold for the production of jewellery accounts for over 50% of global supply annually. By far, it is the sector with the largest demand for gold around the world. In 2019, the U.S. Geological Survey (n.d.a) estimated the total volume of gold used in the manufacture of jewellery at 92,947 metric tonnes, representing 47% of the total gold stocks mined above-ground levels; and available for use (197,576 metric tonnes). Generally, markets in the Middle East and Asia dominate the demand for high-caratage and purer gold. Indian and Chinese jewellery markets account for about 50% of the demand for gold across the globe. Thus, total gold demand is often impacted (negatively) when demand by either of these populous countries is low. To illustrate, Market Research.Com (n.d.) attributed the relatively lower gold consumption in 2015 to the economic downturn in China, which affected the demand for pure gold to manufacture more jewellery.

The financial crises of 2008 compelled many central banks to review their respective reserves and behaviour towards gold. Currently, central banks are a major source of demand for gold annually; central banks in emerging markets have increased their demand for gold while European banks are no longer selling. Central banks are increasingly appreciating gold as a long-term store of national value. The foregoing is in tandem with the first Central Bank Gold Agreement, which was agreed upon and signed in 1999, during which European banks affirmed their continuous commitment to ensuring gold constitutes an important part of their monetary reserves. To further demonstrate their commitment to the implementation of the Central Bank Gold Agreement, European Banks agreed to cap their annual gold sales at 400 metric tonnes over a five-year period (The Royal Mint, 2020). Statistics released by the World Gold Council (2020a) indicated that about 7,853 metric tonnes of gold were sold by central banks between 1987 and 2009, and they purchased about 3,297 metric tonnes between 2010 and 2016.

4.7. Factors Influencing the Price of Gold

During the 2020 financial year, some observers in the global financial market wondered why the price per ounce of gold continued to surge despite the headwinds from the COVID-19 pandemic. Several factors account for the sterling performance of precious metals during natural disasters such as the COVID-19 outbreak and during periods of global financial market crises such as those witnessed in the last decade. Notable among these factors are the following.

4.7.1. Demand and Hedge against Volatility

One of the basic but important requirements for investment is the need to hedge against expected and unexpected market volatilities to assure a significant reduction in losses, if not prevented entirely. In India, gold is perceived as a major source of ornamentation and investment. A study conducted by the World Gold Council in collaboration with the Federation of Indian Chambers of Commerce and Industry revealed that about 77% of the sampled respondents identified gold as a significant source of investment, while over 50% attributed their demand for gold to ornamentation. As noted earlier, gold has proven to be both counter-cyclical and pro-cyclical. That is, it serves as an attractive asset in challenging and normal economic times. Many investors would prefer to invest in gold during an economic boom or recession due to the provision of strong protection for investment portfolios against volatilities. Generally, gold prices are not significantly impacted by the external and internal economic factors that influence returns on investments in most asset classes.

4.7.2. Interest Rate Factor

In a global investment regime characterised by low-interest rates, many investors, including households, would prefer to hold their investments in gold, especially when other assets or securities are losing value. In Ghana, interest payments on 91-, 182-, and 364-day Treasury bills witnessed a significant decrease during the 2020 financial year. Generally, when the latter occurs, the returns on investment are adversely impacted. This influences investors' decision to seek "investment relief" and "greener pastures" in gold. The relative strength and performance of gold assure stability in investments. Thus, gold becomes a strong and effective portfolio diversifier when equities and other asset classes are underperforming in the global capital markets (Williams, 2018).

4.7.3. Protection against Inflation

The COVID-19 outbreak spiraled inflationary levels in individual economies and regions across the globe. For instance, the average inflation rate recorded in Africa in May 2020 was 15.2%, up from the 15.0% recorded earlier in April 2020. However, rising inflation tends to affect the stability and value of implied currencies. To illustrate, at the end of the second quarter of 2020, many foreign currencies suffered varying casualties (fell in value or depreciated) relative to the American dollar. Some of these included the Brazilian real, Zambian kwacha, Russian ruble, Mexican peso, South African rand, Turkish lira, and the Ghanaian cedi, among others. Generally, the exchange rates of the foregoing currencies relative to the American dollar do not have a direct effect on the global price of gold per troy ounce. However, a prolonged inflationary period encourages investors to purchase gold to hedge against conditions of uncertainty arising thereof. Thus, investors in the aforementioned economies would be interested in purchasing gold rather than keeping their respective local currencies during the inflationary period. As investors seek investment respite in gold during periods of inflation, demand for the precious metal increases. All else held constant, increased demand relative to supply would result in higher gold prices per ounce.

4.7.4. Favourable Weather Pattern

Favourable weather conditions allow farming activities to thrive and for farmers to increase yield and harvests. Dhawan (2019) estimated annual gold consumption in India to be between 800 and 850 tonnes, with rural India accounting for about 60%. Increased crop harvests allow farmers to earn more revenue and a substantial portion of the farmers' earnings is held in the form of gold to ensure wealth or asset creation. During lean farming seasons, portions of the gold are sold to generate funds. Thus, rural India perceives investments in gold as a viable source of hedging against volatilities in the relative strength and stability of the Indian rupee. The practical initiatives of the Indian farmers could be replicated within and across regions. That is, farmers in other developing and emerging economies could be encouraged through financial literacy and education to emulate the investment or hedging strategy of their counterparts in India. The financial literacy campaign could be facilitated by relevant bodies, including non-governmental organisations (NGOs) and appropriate government agencies. The success of this programme would assure improvements in the living standards of the farmers while minimising their excessive reliance on governments for assistance and financial headway.

4.7.5. Geopolitics and Pandemic Outbreak

Extant research has proven that precious metals perform creditably during periods of geopolitical and economic exchanges between and among nations and during prolonged periods of natural disaster occurrences. Consequently, the recent trade war between the United States and China and the COVID-19 pandemic outbreak heightened trade tensions and uncertainties. These unfortunate socio-economic situations adversely impacted prices and values for other asset classes but boosted the prospects and price per ounce of gold in the global market. In periods such as the foregoing, investors perceive gold as a safe haven for storing wealth. To this end, demand for and price per ounce of gold often witness significant increases.

4.7.6. Gold and the American Dollar

The overall impact of the COVID-19 outbreak on the United States and other advanced economies during the 2020 financial year cannot be overemphasised. China injected over US$344 billion into its economy to boost manufacturing and other related activities. After an initial US$2 trillion stimulus injection, there were considerations for an additional US$3 trillion stimulus injection into the United States economy. The devastating effect of COVID-19 on the economy of the United States rapidly affected the values of many asset classes, including investments in equities and the weakening of the American dollar. To stem the tide, most investors tended to seek investment "refuge" in gold. As noted in the preceding section, gold is denominated in the American dollar and often maintains an inverse relationship with the currency: demand for gold increases when the American dollar weakens, and investors seek alternative investment sources to strengthen their investment portfolios. Conversely, demand for gold decreases when investments in other asset classes become attractive through higher returns on investments and when the American dollar appreciates in value.

4.7.7. Demand by Central Banks

The menacing effect of COVID-19 prompted the ingenuity of many central banks across the globe during the 2020 financial year. Most governments and their respective finance ministries and central banks were compelled to roll out measures that would ease social and financial burdens while advancing national economic stimulation during the period. These included liquidity injection, policy and interest rate cuts, tax waivers and tax reductions, among others. According to the World Gold Council (2020a), these governments and central banks' initiatives increased gold prices by 17% at the end of the second quarter of 2020. The initiatives resulted in a total flow of 734 tonnes into *gold-backed exchange-traded funds (ETFs)*. The total demand for gold by central banks during the second quarter of 2020 was 233 metric tonnes. Central banks' total purchases slowed during the second quarter. However, the quantity (233 metric tonnes) was higher than total purchases in the second quarter of 2019.

Cumulatively, the balance sheets of the *G4 Central Banks* comprising the Bank of England (BOE), Bank of Japan (BOJ), United States' Federal Reserve (FED) and European Central Bank (ECB) were projected by Morgan Stanley to increase by US$7.2 trillion. Generally, as more assets are purchased with the American dollar, the currency weakens and creates room for further investments in gold. The total volume of gold purchased by various central banks in 2018 was estimated at 651.5 metric tonnes (Anderson, 2019), equivalent to 20,946,213.625 troy ounces. This translated into total central banks' investment of US$26,579,278,855.171(US$1,268.93 x 20,946,213.625 troy ounces = US$26,579,278,855.171) in gold bullions during the period.

4.8. Future Prospects for Gold

Globally, demand for gold at the end of June 2020 was estimated at 2,076 metric tonnes, representing a year-on-year decrease of 6%. Demand for gold for jewellery decreased to 572 metric tonnes, equivalent to a 46% decrease, while demand for gold for technological usage reduced to 140 metric tonnes, reflecting a 13% fall during the period. The fall in demand could be attributed to factors such as market lockdowns, a decrease in disposable incomes, an increase in the price of gold per ounce and a significant decrease in end-user demand for electronic gadgets and equipment during the period. Similarly, investments in gold bars and coins decreased to 396.7 metric tonnes. This represented a year-on-year decline of 17%. The response of investors in the Middle East and Asian markets to investments in gold during the period was low relative to their counterparts in the Western markets. Actual demand for gold during the second quarter of 2020 was 1,015.7 metric tonnes, reflecting a year-on-year decrease of 11% (World Gold Council, 2020a).

In 2020, the World Gold Council (2020a) attributed the poor performance of gold in terms of demand to the ravages of COVID-19. Although demand for gold was low, the precious metal provided strong support for investments. Gold production and recycling were impacted by lockdown restrictions. This resulted in the total gold supply of 2,192 metric tonnes, representing a 6% reduction, and 116 metric tonnes (2,192 metric tonnes – 2,076 metric tonnes = 116 metric tonnes) more than the total demand during the first half of 2020. Notwithstanding the excess supply-over-demand situation, gold prices continued to surge, as evidenced in the closing price per ounce of gold on 31st December 2020 (US$1,895.10), as displayed in table 1 and figure 1. Limited gold mining in recent years has necessitated an increased recycling rate of the precious metal. Available estimates pegged global demand for gold at 1,000 metric tonnes more than supply. This and other macro-economic factors such as inflation and lower interest rates affirm strong prospects for gold in the global financial markets.

Discussion in this section revealed that gold prices in the short- and medium-term are strongly influenced by investment factors. However, in the long term, central banks' demand, long-term savings decisions, supply dynamics, and consumer demand, among other pertinent factors, tend to influence the price per ounce of gold in the global market. The impact of COVID-19 on global economies, including Ghana, Nigeria, South Africa, China, the United States, Germany, and the United Kingdom, to mention a few, was ominous during the 2020 financial year. The COVID-19 pandemic marred most socio-economic initiatives and activities in over 213 countries, dependencies and territories across the globe. This notwithstanding, major gold-producing economies such as Australia, Russia, China, South Africa and the United States with significant gold stocks, both above-ground levels and in reserves underground, and Ghana, with sufficient gold stocks in reserves and above-ground levels, were predicted to end the 2020 financial year with improvements, if not tremendous improvements, in their respective financial inflows to douse the debilitating effect of the pandemic on total national expenditures.

4.9. Descriptive Statistics

This section presents a summary of annual gold production volumes by Ghana during the research period. Figure 5 presents a statistical summary of the total gold stocks mined in Ghana and available for use and exports annually from 1980 to 2020. The foregoing data formed the basis of analysis in this section. Annual gold values used in this section were measured in troy ounces. Analysis in the figure drew on data in Table 5, column 4. Data in figure 5 depict the respective skewness (0.435339189) and sample variance (2008500653598.3) for the distribution. The value for sample variance (2008500653598.3) tells us the expectation of squared deviation of the research random variable from its mean, whereas the Skewness value explains the distortion or asymmetry of the random variable around the mean in the distribution. The statistical data depict respective standard error and Kurtosis values of 221331.9245 and -0.793202258. The extent to which the coefficients are significantly different from zero is explained by the standard error value (221331.9245).

The Kurtosis value (-0.793202258) indicates the extent to which the tails of the distribution in figure 5 differ from the tails of a normal distribution. Stated in different words, Kurtosis helps determine whether or not some extreme values are contained in the tails of the distribution. The minimum and smallest value in figure 5 is 276,000 troy ounces. This represents the total volume of gold produced by Ghana in 1983, the year characterised by very limited rainfall, famine and economic hardships, which impelled the ingenuity of the economic management team of the political administration. Phase One of Ghana's Economic Recovery Programme (ERP) spanned from 1983 through 1986.

Mean	**2031439.585**
Standard Error	221331.9245
Median	2180417
Mode	287000
Standard Deviation	1417215.811
Sample Variance	2.0085E+12
Kurtosis	-0.793202258
Skewness	0.435339189
Range	4524000
Minimum	276000
Maximum	4800000

Mean	**2031439.585**
Sum	83289023
Count	41
Largest(1)	4800000
Smallest(1)	276000
Confidence Level (95.0%)	447328.5058

Figure 5: Statistics on Ghana's Annual Gold Production from 1980 – 2020

The maximum and largest value (4800000) is representative of total stocks of gold mined above-ground level and available for use in 2018 (4,800,000 metric tonnes). The range explains the difference between the largest and smallest values for the distribution. The value for the *range* (4524000) in figure 5 explains the substantial difference (4,524,000 metric tonnes) between the total volumes produced in 2018 (4,800,000 metric tonnes) and 1983 (276,000 metric tonnes). The value for sum (83289023) in the figure depicts the total stocks of gold produced during the period (83,289,023 troy ounces) and included in the analysis, whereas the standard deviation value (1417215.811) is indicative of the extent of tightness of the probability distribution.

At the end of the 2019 financial year, Ghana did not only emerge as the leading gold producer but also the highest earner from gold production in Africa. Despite the highest earnings from gold production in Africa (US$6.379 billion) during the period (as shown in column 5, Table 4), Ghana remained the African economy with the fifth-highest percentage contribution of gold revenue to GDP (9.52%); after Burkina Faso (17.37%), Mali (15.87%), Sudan (11.25%) and Guinea (10.02%). The statistics are indicative of the valuable role of gold revenue in the measurement of GDP in most developing economies endowed with precious metals in large commercial quantities.

4.10. Results

The objective of this research was to test two major underlying hypotheses. That is, measure the extent to which national gold revenues significantly influence national GDP values and how global gold revenues significantly influence global GDP values. Data in tables 5 and 6 and figures 6, 7 and 8 proved useful to the analysis in this section. Table 5 presents historical data on annual gold production volumes by Ghana from 1980 through 2020. Columns 5 and 6 in the table present useful data on Ghana's annual gold revenues and GDP values over the research period (1980 to 2020). Data on average closing price per ounce of gold and annual GDP values in the table were accessed from Macrotrends (2021a&b), whereas statistics on annual production volumes were accessed from the databases and archives of the United States Geological Survey (n.d.a).

Davis (2020) noted the availability of seven distinct forms of ounces. These include troy, avoirdupois, metric, tower, apothecary, Dutch and Spanish ounces. The measurements revealed one kilogram is equivalent to 35.273962 avoirdupois ounces, 34.782608695 Spanish ounces, 33.333 metric ounces, 32.150747 troy and apothecary ounces, 29.1595095 tower ounces, and 10 Dutch ounces. The conversions depict superior rates for avoirdupois ounces (35.273962), Spanish ounces (34.782608695) and metric ounces (33.333). However, conversion of kilogram into troy ounces (32.151) and conversion of metric tonne into troy ounces (32,150.75) were found to dominate the conversion rates in the global gold market during the research period. As a result, these rates formed the basis of measuring gold in ounces throughout the current research.

Statistics in column 5, table 5 and figure 6 depict Ghana's respective annual gold revenues computed and sampled for the research. Trend analysis of data in the table and figure depicts fluctuations in annual gold revenues from 1980 (US$210.245 million) to 1990 (US$207.760 million), increases steadily from 1991 (US$306.513 million) to 1995 (US$644.578 million) and declines in 1996 (US$613.460 million) and 1997 (US$581.712 million). Ghana witnessed further fluctuations in gold revenue between 1998 (US$685.966 million) and 2001 (US$598.997 million) and a steady increase from 2002 (US$694.936 million) to 2005 (US$956.443 million). The average annual gold revenue recorded by Ghana from 1980 to 1990 was US$144,512,551. This was 3.84 times or 73.93% less than the average recorded between 1991 and 2000 (US$554,336,542).

Further trend analysis of the data in figure 6 reveals that major peaks in Ghana's annual gold revenue were recorded in 2013 (US$6,075,217,850) and 2020 (US$7,983,807,052). The foregoing notwithstanding, the 2006 financial year is quite historic in the annals of Ghana's gold production and earnings. It is the year in which total gold revenue first exceeded US$1 billion; actual gold revenue was nearly US$1.357 billion, representing a 41.83% increase over the previous year. Available figures depict a steady increase in gold revenues from 2007 (US$1.732 billion) to 2013 (US$6.075 billion), a decrease in 2014 (5.580 billion), and a steady increase from 2015 (US 4.669 billion) to 2020 (US 7.984 billion), reflecting stable average closing prices during the period. The average closing price per ounce of gold (US$1,773.73) and total gold revenue (US$7.984 billion) recorded during the 2020 financial year remain the highest since 1969.

Year	Average Closing Price	Production in Metric Tonnes	Prod. Equiv. in Troy Ounces	Total Gold Revenue in US$	Ghana's GDP in US$
2020	$1,773.73	140	4,501,140	7,983,807,052	68,420,000,000
2019	$1,393.34	142	4,578,267	6,379,082,542	66,980,000,000
2018	$1,268.93	149	4,800,000	6,090,864,000	65,560,000,000
2017	$1,260.39	128	4,101,560	5,169,565,208	59,000,000,000
2016	$1,251.92	124	3,993,026	4,998,949,110	55,010,000,000
2015	$1,158.86	125	4,029,324	4,669,422,411	48,560,000,000
2014	$1,266.06	137	4,407,581	5,580,262,001	53,660,000,000
2013	$1,409.51	134	4,310,163	6,075,217,850	62,410,000,000
2012	$1,668.86	87	2,782,348	4,643,349,283	41,270,000,000
2011	$1,573.16	83	2,665,929	4,193,932,866	39,340,000,000
2010	$1,226.66	72	2,329,051	2,856,953,700	32,200,000,000
2009	$973.66	68	2,180,417	2,122,984,816	26,050,000,000
2008	$872.37	74	2,373,355	2,070,443,701	28,680,000,000
2007	$696.43	77	2,486,848	1,731,915,553	24,830,000,000
2006	$604.34	70	2,244,686	1,356,553,537	20,440,000,000
2005	$444.99	67	2,149,359	956,443,261	10,740,000,000
2004	$409.53	63	2,029,982	831,338,529	8,880,000,000
2003	$363.83	71	2,274,651	827,586,273	7,630,000,000
2002	$310.08	70	2,241,150	694,935,792	6,170,000,000
2001	$271.19	69	2,208,774	598,997,421	5,310,000,000
2000	$279.29	72	2,318,087	647,418,518	4,980,000,000
1999	$278.86	80	2,570,344	716,766,128	7,720,000,000
1998	$294.12	73	2,332,266	685,966,076	7,480,000,000
1997	$331.00	55	1,757,438	581,711,978	6,890,000,000
1996	$387.73	49	1,582,183	613,459,815	6,930,000,000
1995	$384.07	52	1,678,282	644,577,768	6,470,000,000
1994	$384.16	45	1,430,880	549,686,861	5,440,000,000
1993	$360.05	39	1,261,445	454,183,272	5,970,000,000
1992	$343.87	31	997,710	343,082,538	6,410,000,000
1991	$362.34	26	845,925	306,512,465	6,600,000,000
1990	$383.73	17	541,423	207,760,248	5,890,000,000
1989	$381.27	13	429,473	163,745,171	5,250,000,000
1988	$436.78	12	372,984	162,911,952	5,200,000,000
1987	$446.84	10	327,972	146,551,009	5,070,000,000
1986	$368.20	9	287,000	105,673,400	5,730,000,000
1985	$317.42	9	299,000	94,908,580	4,500,000,000
1984	$360.65	9	287,000	103,506,550	4,410,000,000
1983	$423.71	9	276,000	116,943,960	4,060,000,000
1982	$376.11	10	331,000	124,492,410	4,040,000,000
1981	$459.16	10	333,000	152,900,280	4,220,000,000
1980	$614.75	11	342,000	210,244,500	4,450,000,000

Table 5: Historical Data on Ghana's Annual Gold and GDP Values from 1980 – 2020
Sources: Macrotrends (2021a&B); US Geological Survey (N.D.); World Bank (2021a)
Standard Measurements: 1 Metric Tonne = 32,150.75 Troy Ounces; 1 Kilogram = 32.151 Troy Ounces

Historical data on annual global gold production from 1969 to 2020, in table 6 and figure 7, were accessed from the databases and archives of the United States Geological Survey (n.d.a). The raw data accessed were in either troy ounces, or metric tonnes or kilograms. The data in kilograms were first converted into troy ounces (1 kilogram = 32.151 troy ounces) and finally into metric tonnes (1 metric tonne = 32,150.75 troy ounces). Statistics in column 2, table 6 and figure 7 indicate that 2010 marked the beginning of financial years in which the average closing price per ounce of gold was quoted in thousands of American dollars. The average closing price at the end of December 2010 was US$1,226.66, equivalent to 25.98% [((US$1,226.66 - US$973.66) ÷ US$973.66) x 100% = (US$253 ÷ US$973.66) x 100% = 0.2598443 x 100% = 25.98443 = 25.98%)] increase over the average closing price in 2009 (US$973.66); and 28.25% [((US$1,573.16 - US$1,226.66) ÷ US$1,226.66) x 100% = (US$346.50 ÷ US$1,226.66) x 100% = 0.2824744 x 100% = 28.24744 = 28.25%)] decrease over the average closing price recorded in 2011 (US$1,573.16).

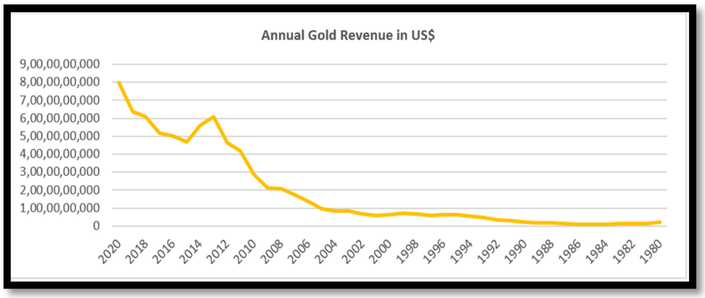

Figure 6: Historical Data on Ghana's Annual Gold Revenue from 1980 – 2020

Heightened financial and economic uncertainties in the global market in 2010 encouraged investors to perceive and accept gold as a viable and safe investment alternative. This affirmed the assertion that gold thrives in periods of abysmal performance of stocks and other investment assets and practically increased investments in gold in 2010. Total gold purchased for investment was estimated at 1,680 metric tonnes (George, 2012) or 54,013,260 troy ounces (1,680 metric tonnes x 32,150.75 troy ounces = 54,013,260 troy ounces) during the period. The major threat to gold as a viable investment alternative to investors in the global market is cryptocurrencies, especially bitcoin. The accelerated rate of performance and popularity of cryptocurrencies, including bitcoin, after their introduction to the global financial market a little over a decade ago, is unheralded.

In 2014, the Cortez mine, owned by Barrick Gold Corporation, was believed to have experienced a nearly 32.5% decrease in its production capacity. Some analysts argued that these operational setbacks adversely impacted total gold production at the global level during the period. An economic downturn in China in 2015 affected global demand for jewellery (Market Research.Com, n.d.). Given that over 50% of total gold demand in the global market is channelled into jewellery manufacturing, a decrease in demand for jewellery tends to have a negative effect on demand for pure gold.

Sometimes, it is difficult to effectively measure global demand, especially when gold exported from rebel-controlled areas and conflict zones is rarely accounted for and seldom forms an integral part of official gold production volumes estimated and declared by the affected economies. As noted earlier, Sudan is geographically situated in East Africa and remains one of the few African economies with significant gold finds. As one of Africa's economies located in the Eastern bloc, Sudan has not weaned off the challenges saddled with other neighbouring countries, such as the Democratic Republic of Congo, in the mining, production and estimation of official gold production volumes. Parts of Sudan, such as Darfur, Blue Nile and Kordofan, have been in various forms of conflict for several years. Smith (2020) revealed that artisanal miners in these conflict zones consistently produce and sell tonnes of gold to traders who, in turn, smuggle it to the Gulf States to trade, and this affects proper estimates and accounting for gold operations at the national level.

Year	Average Closing Price	Global Gold Production in Metric Tonnes	Global Gold Prod. Equivalent in Troy Ounces	Total Gold Value in US$	Global GDP in US$
2020	$1,773.73	3,200	102,882,400	182,485,599,352	83,844,990,000,000
2019	$1,393.34	3,300	106,097,475	147,829,855,817	87,735,000,000,000
2018	$1,268.93	3,300	106,097,475	134,630,268,952	86,439,000,000,000
2017	$1,260.39	3,230	103,846,923	130,887,622,650	81,306,000,000,000
2016	$1,251.92	3,180	102,240,180	125,178,019,183	76,103,531,034,285
2015	$1,158.86	3,120	100,310,340	115,500,476,250	75,218,000,000,000
2014	$1,266.06	3,050	98,060,550	121,707,287,850	79,296,761,326,307
2013	$1,409.51	2,960	95,166,960	126,887,050,171	77,189,953,892,237
2012	$1,668.86	2,690	86,485,518	144,332,220,735	75,162,000,000,000
2011	$1,573.16	2,700	86,807,025	136,561,339,449	73,460,000,000,000
2010	$1,226.66	2,560	82,305,920	100,961,379,827	66,126,000,000,000
2009	$973.66	2,460	79,090,845	77,007,592,143	60,410,000,000,000
2008	$872.37	2,280	73,303,710	63,947,957,493	63,690,000,000,000
2007	$696.43	2,380	76,518,785	53,289,977,438	58,044,000,000,000
2006	$604.34	2,460	79,090,845	47,797,761,267	51,512,000,000,000
2005	$444.99	2,470	79,412,353	35,337,702,739	47,527,000,000,000
2004	$409.53	2,430	78,126,323	31,995,072,853	43,875,000,000,000
2003	$363.83	2,590	83,270,443	30,296,285,277	38,948,000,000,000
2002	$310.08	2,550	81,985,050	25,421,924,304	34,712,000,000,000
2001	$271.19	2,600	83,591,950	22,669,300,921	33,431,000,000,000
2000	$279.29	2,590	83,271,090	23,256,782,726	33,581,572,220,367
1999	$278.86	2,570	82,627,428	23,041,484,572	32,563,000,000,000
1998	$294.12	2,500	80,376,875	23,640,446,475	31,394,000,000,000
1997	$331.00	2,410	77,483,308	25,646,974,948	31,458,000,000,000

Year	Average Closing Price	Global Gold Production in Metric Tonnes	Global Gold Prod. Equivalent in Troy Ounces	Total Gold Value in US$	Global GDP in US$
1996	$387.73	2,250	72,339,188	28,048,073,363	31,573,000,000,000
1995	$384.07	2,200	70,731,650	27,165,904,816	30,887,000,000,000
1994	$384.16	2,300	73,946,725	28,407,373,876	27,771,000,000,000
1993	$360.05	2,330	74,922,151	26,975,720,468	25,858,000,000,000
1992	$343.87	2,299	73,909,008	25,415,090,581	25,453,000,000,000
1991	$362.34	2,188	70,329,091	25,483,042,833	23,967,000,000,000
1990	$383.73	2,182	70,163,352	26,923,783,063	22,627,000,000,000
1989	$381.27	2,014	64,749,317	24,686,972,093	20,088,000,000,000
1988	$436.78	1,848	59,409,904	25,949,057,869	19,244,000,000,000
1987	$446.84	1,658	53,310,923	23,821,452,833	17,201,000,000,000
1986	$368.20	1,602	51,512,815	18,967,018,483	15,119,000,000,000
1985	$317.42	1,500	48,217,000	15,305,040,140	12,794,000,000,000
1984	$360.65	1,444	46,408,000	16,737,045,200	12,180,000,000,000
1983	$423.71	1,400	44,996,000	19,065,255,160	11,747,000,000,000
1982	$376.11	1,341	43,127,000	16,220,495,970	11,515,000,000,000
1981	$459.16	1,283	41,250,000	18,940,350,000	11,624,000,000,000
1980	$614.75	1,209	38,882,000	23,902,709,500	11,228,000,000,000
1979	$307.01	1,207	38,802,000	11,912,602,020	9,971,000,000,000
1978	$193.57	1,213	38,985,000	7,546,326,450	8,585,000,000,000
1977	$147.84	1,211	38,921,000	5,754,080,640	7,278,000,000,000
1976	$124.80	1,214	39,024,000	4,870,195,200	6,438,000,000,000
1975	$160.87	1,200	38,574,000	6,205,399,380	5,920,000,000,000
1974	$158.76	1,242	39,941,000	6,341,033,160	5,316,000,000,000
1973	$97.12	1,347	43,297,000	4,205,004,640	4,609,000,000,000
1972	$58.17	1,395	44,843,000	2,608,517,310	3,778,000,000,000
1971	$40.80	1,447	46,506,000	1,897,444,800	3,273,000,000,000
1970	$35.96	1,480	47,531,000	1,711,088,636	2,961,000,000,000
1969	$41.10	1,450	46,612,000	1,915,753,200	2,705,000,000,000

Table 6: Historical Data on Annual Global Gold and GDP Values from 1969 – 2020
Data Sources: Macrotrends (2021b); U.S. Geological Survey (N.D.); World Bank (2021a)
Standard Measurements: 1 Metric Tonne = 32,150.75 Troy Ounces; 1 Kilogram = 32.151 Troy Ounces

Total global gold production in 2010 was estimated at 2,560 metric tonnes or 82,305,920 troy ounces, which was 4.07% ((2,560 metric tonnes – 2,460 metric tonnes) ÷ 2,460 metric tonnes) x 100% = 100 metric tonnes ÷ 2,460 metric tonnes) x 100% = 0.0406504 x 100% = 4.06504 = 4.07%) more than the total volume produced in 2009 (2,460 metric tonnes or 79,090,845 troy ounces). However, total gold production in 2011 (2,700 metric tonnes or 86,807,025troy ounces) was about 5.47% ((2,700 metric tonnes – 2,560 metric tonnes) ÷ 2,560 metric tonnes) x 100% = 140 metric tonnes ÷ 2,560 metric tonnes) x 100% = 0.0546875 x 100% = 5.46875 = 5.47%) more than the total volume produced in 2010. Nearly 47% of the stocks of gold mined above-ground level during the period were produced by the world's top fifteen mining companies. The top five of the top fifteen mining companies in ascending order during the period were Goldcorp, Incorporated, located in Vancouver in British Columbia, Canada; Gold Fields Limited, Johannesburg, South Africa; AngloGold Ashanti Limited, Johannesburg, South Africa; Newmont Mining Corporation; and Barrick Gold Corporation located at Denver, Colorado in the United States. Total gold stocks of the top five producers accounted for about 33% of the world's total gold production in 2010 (Klapwijk et al., as cited in George, 2012).

Historically and more importantly, South Africa remains one of the leading gold mining economies across the globe. Official records revealed that gold was first discovered in the Witwatersrand Basin in June 1884, followed by another discovery in September of the same year. Despite the recent setbacks (as cited in Whitehouse, 2019), the socio-economic exploits of the mining industry in South Africa have been very phenomenal. The growth, expansion and competitiveness of the South African mining industry at the regional and global levels cannot be underestimated. Harper (2020) described the Witwatersrand Basin in South Africa as the largest single source of gold discovery in human history. He argued that nearly 30% of all the gold ever mined had come from Witwatersrand. This corroborates Hoffmann (n.d.), who noted that as of 1895, a quarter or 25% of the world's total gold was accounted for by Witwatersrand, and the latter's contribution to global gold production as of 1985 was about 40%. The extremely deep Mponeng mine is another major source of gold in South Africa. Other major gold sources around the world and not located in South Africa include AngloGold Ashanti Limited in Ghana, Grasberg Mine in Indonesia, Newmont Boddington and Super Pit in Australia; and the gold mines in the State of Nevada in the United States, among others. What is quite worrying and remains a pressing issue to key stakeholders in the global mining industry is how to curb the accelerated rate at which global gold reserves are being depleted.

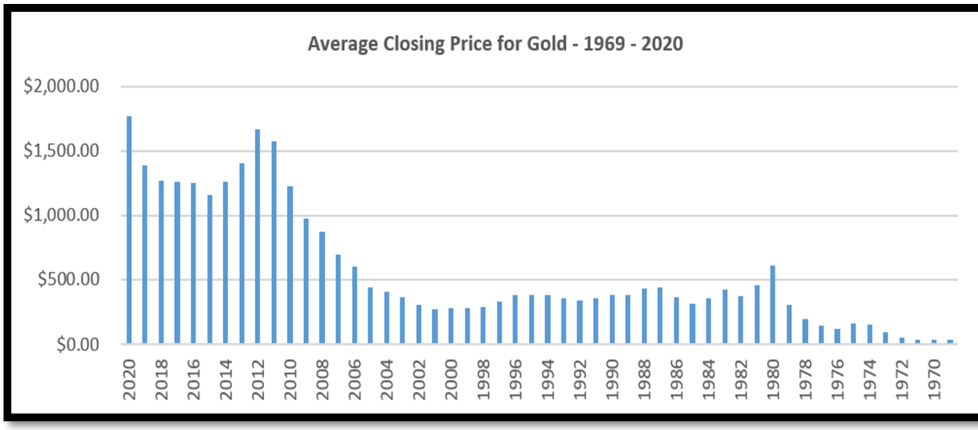

Figure 7: Historical Data on Annual Average Closing Price per Ounce of Gold 1969–2020
Data Sources: Macrotrends (2021a); US Geological Survey (n.d.)

OECD (2020) provided an apt definition for gross domestic product. It defined the concept as the standard measure of value-addition, which is created through the systematic production of goods and services in a given economy within a specified period. O'Neill (2021a) added that the aggregate value of all goods and services produced in an economy within a given financial year is denoted by GDP. Generally, a country's economic strength is contingent on the computed GDP value. The global economy is usually characterised by three major sectors. The inference is that the determination of gross domestic product for the global economy is dependent on the computation of economic activities in three distinct sectors, including agricultural, industrial and services sectors.

The foregoing also forms the basis for measuring total economic output values for individual economies. The sum of production activities in these key sectors or the total amount spent on final goods and services by governments, corporate bodies and individuals minus imports constitutes the total GDP for a given financial year. The CIA World Factbook (as cited in IndexMundi, 2020) defined production activities in the services sector as finance, communications, transportation, government activities, and other private economic activities that do not result in the production of material goods. The industrial sector has the following production activities: construction, mining, energy production and manufacturing, whereas the agricultural sector comprises forestry, farming and fishing.

Data in column 6, table 6 and figure 8 depict annual global GDP values at current prices for the financial years 1969 through 2020. The annual global GDP values presented in the table and figure were accessed from the World Bank's database (2021a). Analysis of annual global GDP values in the table using the incremental or year-on-year approach revealed a steady increase in annual global GDP values from 2010 (9.46%) to 2019 (1.50%), save 2015 (-5.14%) and a thump in 2020 (-4.43%). The annual global GDP value for 2020 (US$83,844,990,000,000) in the table was an estimate (O'Neill, 2021b). The projected global GDP value for 2020 (US$83,844,990,000,000) implied annual global GDP for the 2020 financial year was expected to fall short of the value for 2019 (US$87,735,000,000,000) by approximately US$3.890 trillion (US$83,844,990,000,000 - US$87,735,000,000,000 = -US$3,890,010,000,000). This suggests a decline in annual global GDP values between 2019 and 2020 by negative 4.43% ((US$83,844,990,000,000 - US$87,735,000,000,000) ÷ US$87,735,000,000,000) x 100% = -US$3,890,010,000,000 ÷ US$87,735,000,000,000) x 100% = -0.04433818 x 100% = -4.433818 = -4.43%). The average global GDP value from 2010 through 2020 was equivalent to US$78.353 trillion (US$861,881,236,252,829÷ 11 = US$78,352,839,659,348), whereas the average recorded from 1969 through 1979 was approximately US$5.530 trillion.

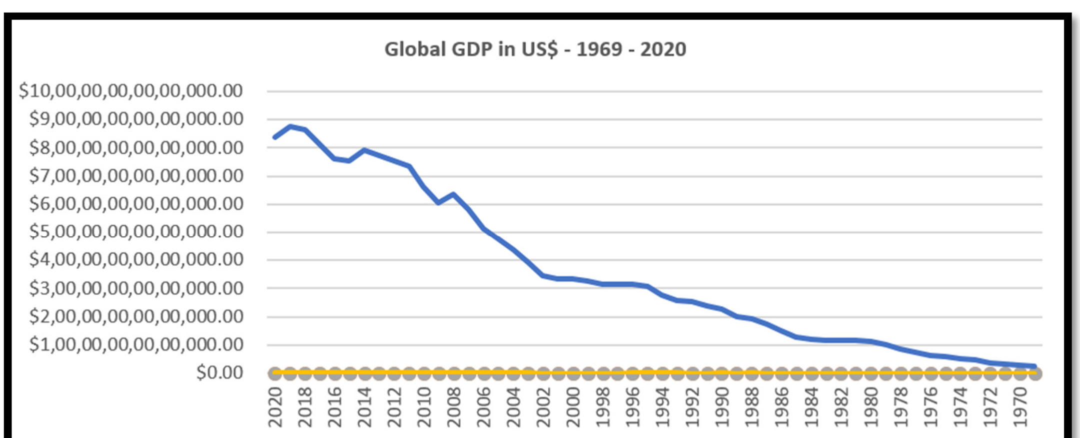

Figure 8: Historical Data on Global GDP Values from 1969 to 2020
Data Source: World Bank (2021a)

The average global GDP value recorded from 2010 through 2020 (US$78,352,839,659,348) was equivalent to 14.17 times the average recorded from 1969 through 1979 (US$5,530,363,636,363) [(US$60,834,000,000,000÷ 11 = US$5,530,363,636,363)]. The wider gap in the ratio (14.17 times) for average global GDP values between 2010 and 2020 and between 1969 and 1979 may be attributed to the variations and geometric increase in national and global populations and advances in global technologies over the years, which have accelerated demand for and supply of essential and luxurious goods and services in the global market. The data suggest that the closer the financial years, the lower the ratio. To illustrate, the average global GDP value recorded from 2010 through 2020 (US$78,352,839,659,348) was equivalent to 1.73 times the average recorded from 1999 through 2009 (US$45.299,415,656,397) [(US$498,293,572,220,367 ÷ 11 = US$45,299,415,656,397)]. The average global GDP value recorded for 1999 through 2009 (US$498,293,572,220,367) was US$72,822,476,022,985 less-; and US$492,763,208,584,004 more than the respective averages recorded for 2010 through 2020 (US$78,352,839,659,348); and 1969 through 1979 (US$5,530,363,636,363).

The general decline in the performance of the global economy in 2020 could be attributed mainly to the COVID-19 outbreak and its attendant effect on economic activities and output in individual countries and, by extension, on the global economy. In 2020, COVID-19 impacted negatively on production activities in over 213 countries, dependencies and territories across the globe (Worldometer, 2021). The lower GDP value recorded in 2020 (US$83,844,990,000,000) adds up to lower GDP values recorded in six additional financial years relative to their preceding financial years, from 1969 to 2020. These include 2015 (US$75.218 trillion); 2009 (US$60.410 trillion); 2001(US$33.431 trillion); 1998 (US$31.394 trillion); 1997 (US$3.458 trillion); and 1982 (US$11.515 trillion). Respective global GDP values recorded from 1969 through 1979 were less than US$10 trillion. The US$10 trillion threshold was surpassed in 1980 (US$11.228 trillion), and the global GDP value was nearly doubled in 1989 (US$20.088 trillion). For the first time, a record US$30.887 trillion was achieved in 1995. This performance was sustained till 2003 (US$38.948 trillion) and increased significantly thereafter. Respective percentage increases in annual global GDP values for the financial years 2011 through 2019 were computed as follows: 2011 (11.09%); 2012 (2.32%); 2013 (2.70%); 2014 (2.73%); 2015 (-5.14%); 2016 (1.18%); 2017 (6.84%); 2018 (6.31%); and 2019 (1.50%).

4.10.1. Test of Hypothesis One

Ghana was randomly selected among the 43 major gold-producing economies, and the country's historical data on annual gold revenues and GDP values from 1980 to 2020 were used to test the alternative hypothesis under the first set of hypotheses in section 3.4.1 which predicted that national gold revenue has a significant effect on national GDP (see data in Table 5 and Figure 6). Output from the statistical analysis of research hypothesis one is presented in the following section.

4.10.1.1. Model Summary

Tables 7 to 10 and figures 9 to 11 present regression analysis outputs on the first hypothesis. Summary is identified as an important constituent of a regression model. To this end, table 7 presents a summary or overall description of the regression model. Values for R, R^2 and adjusted R^2 are displayed in the table. Value for the multiple correlation coefficients between the independent variable (national gold revenue) and the dependent variable (national GDP) is presented in the R row (0.988107327). The table affirms that the number of observed values in the analysis is 41. The R^2 value (0.976356089) in table 7 is indicative of the extent to which variability in the dependent variable is accounted for by the independent variable. The R^2 value implies that gold revenue accounts for about 97.64% (0.976356089 x 100% = 97.6356% = 97.64%) of the variation in Ghana's annual GDP values. The results suggest that less than 3% (100% - 97.64% = 2.36%) of the outcome is explained by external random factors. That is, only about 2.36% of the variation in annual GDP is explained by other components included in the measurement of total national economic output values.

Regression Statistics	
Multiple R	0.988107327
R Square	0.976356089
Adjusted R Square	0.975749835
Standard Error	3425799150
Observations	41

Table 7: Summary Output

The activities of most unlicenced and unregulated small-scale or artisanal miners (commonly called "Galamsey operators" or "Galamseyers") in Ghana are usually not captured in the annual official estimates for total metric tonnes of gold produced. The foregoing implies that identified challenges inherent in gold production among East African economies such as Sudan, the Democratic Republic of Congo, Tanzania, and others are not peculiar; they extend to other regions on the continent, including West Africa and Ghana in particular. Efforts aimed at addressing the challenges of illegal small-scale mining are complicated by the indirect involvement of political forces and bigwigs, in some cases, top government officials who own some of these illegal mining businesses in "absentia." That is, they operate these businesses under the names of "lay" illegal artisanal miners, making it difficult to easily unearth their identity and true ownership. The extent of damage (in the form of pollution) caused to water bodies through the activities of illegal artisanal miners in Ghana and elsewhere is quantifiably very high.

The analysis suggests the existence of a direct relationship between gold revenue and GDP; as earnings from gold increase, total economic output value surges, and vice versa. The statistical outcomes confirm the valuable contribution of gold revenue to national GDP; confirm the clarion call for regulation and control of the activities of illegal artisanal miners to improve and actualise annual national estimates for total gold produced and revenues derived thereof; confirm the need for minerals and mining policy reforms; and expeditious implementation of same to control environmental pollution and hazards. This initiative has the potential to minimise national expenditure on the preservation and treatment of polluted water bodies, so a chunk of annual gold revenue could be channelled into key infrastructural development and social intervention programmes. All else held constant, the successful implementation of reformed policy and regulations has the potential to improve estimates for national gold reserves while minimising the portentous extent to which top government officials operate illegal mining businesses under pseudonyms.

The significant influence of gold revenue on Ghana's GDP implies external factors, including natural disasters such as tsunamis and pandemic outbreaks, that have the potential to affect the supply, price and demand for gold in the global market and can have dire financial implications for the economy. This explains why the current and previous Ghana governments have bemoaned the financial consequences of limited inflows from gold exports whenever demand and price are adversely impacted in the world market. One of the non-pharmaceutical interventions implemented by almost every economy on the globe during the recent outbreak of COVID-19 was border closure, including land, sea and air transportation border closures. This development halted many trading activities and affected demand for, shipment and price per troy ounce of gold during the first quarter of 2020.

However, the use of gold as a viable investment alternative manifested when COVID-19 impacted strongly on stock trading, and investors were compelled to seek refuge in other investment assets to consolidate and strengthen their investment portfolios. The indispensable role of gold revenue in the measurement of GDP is not restricted to Ghana; the study revealed a similar trend for other developing economies. The rate contributed by gold revenue to the respective GDPs of the following economies in 2019 was significant: Burkina Faso (17.37%), Mali (15.87%), Sudan (11.25%), Guinea (10.02%), Mauritania (8.90%), Zimbabwe (8.09%), Uzbekistan (8.04%), Mongolia (5.22%), among others.

The adjusted R^2 remains one of the measures that determine the generalisability of the regression model. Generally, an ideal adjusted R^2 value is closer to zero or the R^2 value. The adjusted R^2 value (0.975749835) in table 7 is not significantly different from the observed value for R^2 (0.976356089). This implies that the cross-validity of the regression model is good; the model may accurately predict the same dependent variable from the given independent variable in a different group of participants (Field, 2009). The R^2 significance was computed to cross-validate the value (1610.4733) in Table 8 using an F-ratio formula. The ideal F-ratio formula for measuring R^2 significance is:

$$F = \frac{(N - k - 1)\, R^2}{k\,(1 - R^2)}$$

Where:
R^2 = Unadjusted value
N = Number of cases or participants in the study
k = Number of independent variables in the regression model
Value for the F-ratio was determined as follows:

$$F = \frac{(41 - 1 - 1)\ 0.976356089}{1\ (1 - 0.976356089)}$$

$$= \frac{38.077887471}{0.023643911}$$

$$= 1{,}610.473304141603$$

Our computations revealed that the change in the variance that can be explained gives rise to an F-ratio of 1,610.4733, equivalent to the F-value (1,610.4733) in table 8. This F-ratio shows a significant value ($p = 0.000$, $p < 0.05$) as presented in table 9.

In Ghana, some experts have described the impact of illegal mining on water bodies, particularly on the environment, as very devastating. Unfortunately, wastes generated by illegal small-scale miners in the course of their operations are discharged directly into nearby water bodies without any treatment. This increases the level of pollution and contamination and reduces the quality of water bodies that drain or stream along mining communities and adjoining towns. The Water Resource Commission of Ghana (as cited in Business & Human Rights Resource Centre, 2017) affirmed the alarming rate at which water bodies in the country are being polluted. The Commission (as cited in Business & Human Rights Resource Centre, 2017) estimated the rate of pollution of Ghana's water bodies to be sixty percent (60%), with many of the affected water bodies in critical conditions. The Commission (as cited in Business & Human Rights Resource Centre, 2017) noted widespread illegal mining activities in the south-western parts of the country; and where most water bodies have been severely impacted through rampant pollution.

4.10.1.2 ANOVA

The analysis of variance (ANOVA) facilitates our ability to determine whether or not regression analysis provides a better and more significant prediction of the outcome than the mean. Data in table 8 show degree of freedom (between) of 1 (2 - 1 = 1); degrees of freedom (within) of 39 (41 - 2 = 39); total degrees of freedom (df) of 40 (41 - 1 = 40), and an F-value of 1610.4733.

	df	SS	MS	F	Significance F
Regression	1	1.89007E+22	1.89007E+22	1610.4733	2.48938E-33
Residual	39	4.57708E+20	1.17361E+19		
Total	40	1.93584E+22			

Table 8: ANOVA

Further, statistics in table 8 depict the model sum of squares (SSM) value, represented by *Regression*; the residual sum of squares (SSR) value, represented by *Residual*; the total sum of squares (SST) value, represented by *Total*; and the degrees of freedom (df) for each group of squares. The degree of freedom for the SSM is 1, comprising one independent variable (national gold revenue). The mean squares (MS) values in the table were derived from the division of the sum of squares by the degrees of freedom. That is, 1.89007E+22 (1.89006754584334E+22) ÷ 1 = 1.89007E+22; and 4.57708E+20 (457707892786142000000) ÷ 39 = 1.17361E+19.

4.10.1.3. Model Parameters

A normal probability plot on the relationship between national gold revenue (NGR) and national GDP (NGDP) is presented in figure 9. The figure depicts a flat distribution of comparative values over a twenty-six-year period and a steady rise in comparative gold revenues over the remaining fifteen-year period. A flat distribution of comparative values was recorded from the 1.22nd through 32.93rd to the 63.20th percentile, while a steep rise was observed from the 64.63rd through 81.71st to the 98.78th percentile for the normal probability.

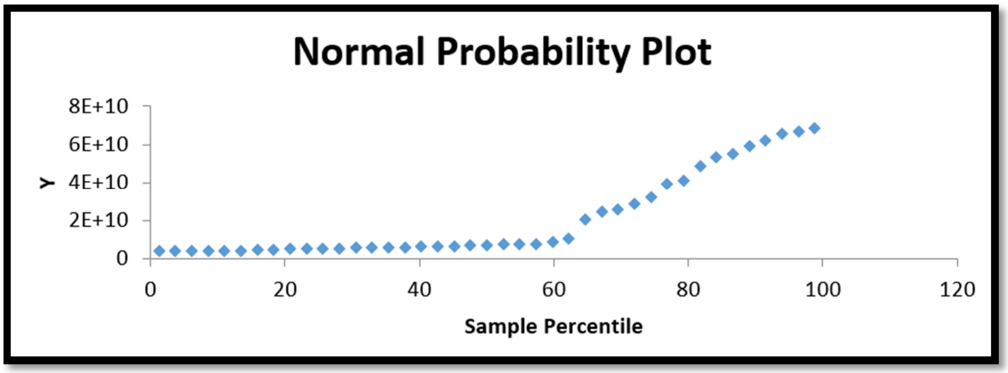

Figure 9: Normal Probability Plot for NGR and NGDP from 1980 – 2020

Table 9 presents the results on the parameters of the regression model. Data in the table show the coefficients, standard error, test statistic, significance, and confidence intervals for the coefficients. The coefficients in the table hint at the contribution of the independent variable (national gold revenue) to the regression model. Generally, a positive coefficient connotes a positive relationship between the independent variable and the dependent variable; a negative value is indicative of a negative relationship between the two variables. Results in table 9 show a positive coefficient value (9.574151593). This means a positive relationship exists between national gold revenue and national GDP.

Further, the relationship between the two variables is significant ($p = 0.000$, $p < 0.05$); the outcomes suggest that national gold revenue has a significant influence on national GDP. This validates, to a large extent, the valuable contribution of gold revenue to national GDP, especially among most developing mining economies; clarion call for regulation and control of the activities of illegal artisanal miners to improve and actualise annual national estimates for total gold production volumes and revenues; the need for minerals and mining policy reforms and expeditious implementation of same to control environmental pollution and hazards.

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	2730965801	697724497.8	3.91410336	0.0003537	1319684795	4142246807
X Variable 1	9.574151593	0.238574232	40.13070277	2.489E-33	9.091589661	10.0567135

Table 9: Model Parameters

The magnitude of the t-test in table 9 avers the independent variable (national gold revenue) has a strong impact on the dependent variable (national GDP). A standard error is identified with the coefficients in the table. The standard error shows the extent to which the coefficients would vary in different research samples (Field, 2009). The probability that a parameter would fall between a pair of values around the mean is measured by the confidence interval. As stated differently, confidence interval values affirm the extent or level of uncertainty or certainty in a method of sampling (Hayes, 2021). Data in table 9 depict the respective upper and lower 95% confidence interval values for the *Intercept* (4142246807.28756 and 1319684794.71328) and *X Variable 1* (10.0567135262328 and 9.09158966063825).

4.10.1.4. Test of Assumptions

Statistical tests were conducted to determine the linearity of the relationship between the independent variable (national gold revenue) and the dependent variable (national GDP) and to measure the variance in residual values. The statistical outputs are presented in figures 10 and 11 and table 10. The scatter plots in figure 10 are on a straight line. This affirms that the relationship between the independent and dependent variables is linear; it implies that the linear regression model fits the analysis.

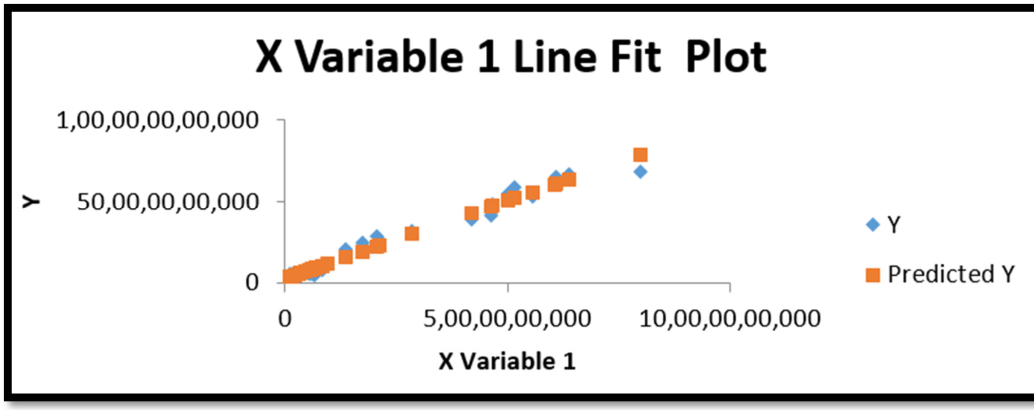

Figure 10: Linear Relationship between X and Y Variables

Moreover, the residual plot in figure 11 depicts the independent variable (national gold revenue) on the horizontal axis and the residuals on the vertical axis. The residual plot in the figure shows a random pattern. That is, the points are randomly dispersed around the horizontal axis, affirming the appropriateness of the linear model for the research data. Stated differently, the scatter plots in figures 10 and 11 affirm the fitness of the linear regression model for the current research.

The *residual* values in Table 10 allow us to test the *homoscedasticity* of the model. That is, whether or not the residual values at each level of the independent variable depict constant variance. Residuals in the table show constant variance values. This implies the assumption of homoscedasticity is met.

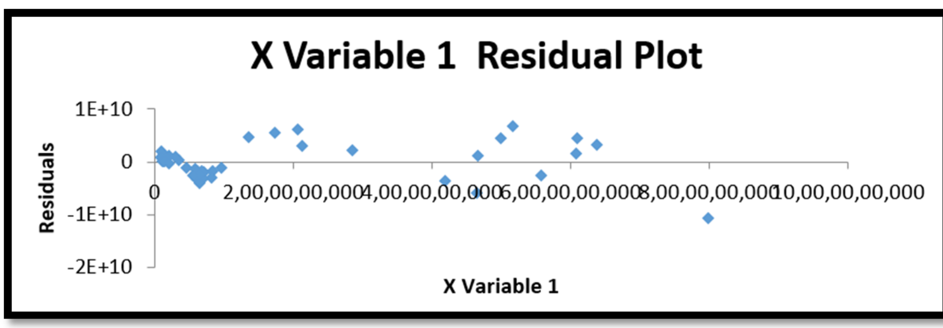

Figure 11: Linear Relationship between X (NGR) and Y (NGDP) Variables

Further, data in figures 10 and 11 indicate that a relationship between the X and Y variables was measured at the interval level and beyond, while the variability of the dependent variable (national GDP) was not constrained. The foregoing analysis indicates that most of the assumptions have been met; this renders the regression model fit and appropriate for the research.

Observation	Predicted Y	Residuals	Standard Residuals
1	79169144810	-10749144810	-3.17767669
2	63805269085	3174730915	0.938518237
3	61045821072	4514178928	1.334487666
4	52225166775	6774833225	2.002785339
5	50591662388	4418337612	1.306154926
6	47436723818	1123276182	0.332064421
7	56157240130	-2497240130	-0.7382375
8	60896022460	1513977540	0.447564083
9	47187095738	-5917095738	-1.74921983
10	42884314833	-3544314833	-1.04777513
11	30083873620	2116126380	0.625572136
12	23056744260	2993255740	0.884870301

Observation	Predicted Y	Residuals	Standard Residuals
13	22553707660	6126292340	1.811062808
14	19312587852	5517412148	1.631064824
15	15718815009	4721184991	1.395683077
16	11888098572	-1148098572	-0.33940245
17	10690326903	-1810326903	-0.53517128
18	10654402235	-3024402235	-0.89407787
19	9384386421	-3214386421	-0.95024125
20	8465857914	-3155857914	-0.93293897
21	8929448837	-3949448837	-1.16754139
22	9593393368	-1873393368	-0.55381508
23	9298509001	-1818509001	-0.53759008
24	8300364462	-1410364462	-0.41693385
25	8604323066	-1674323066	-0.49496564
26	8902251066	-2432251066	-0.71902534
27	7993751137	-2553751137	-0.75494336
28	7079385298	-1109385298	-0.32795798
29	6015690029	394309971.1	0.116566446
30	5665562606	934437393.8	0.276239643
31	4720093910	1169906090	0.345849217
32	4298686891	951313109.2	0.281228465
33	4290709526	909290474.2	0.268805677
34	4134067377	935932622.7	0.276681665
35	3742698952	1987301048	0.587488617
36	3639634933	860365066.6	0.254342282
37	3721953202	688046798.4	0.203401323
38	3850605002	209394998	0.061901632
39	3922875007	117124993.4	0.034624649
40	4194856260	25143739.6	0.007433026
41	4743878516	-293878515.7	-0.08687676

Table 10: Predicted Y Values and Residual Values for Variable X

4.10.1.5. Report on P -Value and Confidence Interval

Table 9 depicts a respective *P*-value of 0.000 and a positive coefficient value of 9.574151593. These values are significant at Alpha level α = 0.05. The table further shows a confidence interval of 9.091589661 and 10.0567135. The Alpha level, a priori, for this study is α = 0.05. This implies there is a 5% probability that we would be wrong; there is a 5% likelihood that the population mean would not fall within the interval (Ashley et al.; Bowerman & O'Connell, 2004; Frankfort-Nachmias & Nachmias, 2008). However, we are 95% (100% - 5%) certain that our conclusions would be right. Again, the Microsoft Excel output in Table 8 shows the degree of freedom (between) of 1 (2 - 1 = 1), degrees of freedom (within) of 39 (41 - 2 = 39), total degrees of freedom (df) of 40 (41 - 1 = 40) and F-ratio of 1610.4733. These values could be interpreted as:

F (1, 39) = 1610.4733, p < 0.05, two-tailed

4.10.1.6. Interpretation and Rejection of Null Hypothesis

Results from the preceding analysis indicate that national gold revenue has a strong influence on national GDP. Therefore, we reject the null hypothesis (Ho: μ1 =μ2), which states that national gold revenue has no significant effect on national GDP, and accept the alternative hypothesis (H1: μ1 ≠ μ2), which states that national gold revenue has a significant effect on national GDP.

4.10.2. Test of Hypothesis Two

The alternative hypothesis under the second set of hypotheses in section 3.4.2 predicted that global gold revenue has a strong effect on global GDP. To test this hypothesis, the researcher drew on data in columns 5 and 6 in table 6 and figure 8. Results from the statistical analysis of research hypothesis two are presented in the following section.

4.10.2.1. Model Summary

Outputs from the regression analysis on the research hypothesis are presented in tables 11 to 14 and in figures 12 to 14. To reiterate, summary constitutes an important aspect of a regression model. As a result, an overall description of the regression model is presented in table 11. The data in the table indicates that 52 values were observed during the analysis. Values for R (0.938942882), R^2 (0.881613736), and adjusted R^2 (0.879246011) are displayed in the table. Value for the multiple correlation coefficients between the independent variable (global gold revenue) and the dependent variable (global GDP) is presented in the R row (0.938942882). The extent to which variability in the dependent variable is accounted for by the independent variable is explained by the R^2 value (0.881613736). Thus, the R^2 value in table 11 implies that global gold revenue accounts for about 88.16% (0.881613736 x 100% = 88.161374% = 88.16%) of the variation in annual global GDP values. The results suggest that less than 12% (100% - 88.16% = 11.84 %) of the outcome is explained by external random factors. That is, less than 12% of the variation in annual global GDP values is explained by other components essential to the effective measurement of global economic output or GDP values.

Regression Statistics	
Multiple R	**0.938942882**
R Square	0.881613736
Adjusted R Square	0.879246011
Standard Error	9.50626E+12
Observations	52

Table 11: Summary Output

It could be inferred from the analysis that holistic measures taken to address challenges related to the mining of precious metals could positively impact its financial contribution to global economic output and performance. However, generally, it is quite challenging, if not impossible, to effectively account for gold mined in rebel-controlled areas, in areas mired by prolonged civil conflicts, and in areas dominated by illegal artisanal miners. This explains the observed discrepancy between the total value of gold exports announced by the Sudanese government and the total import value declared by the country's two major importers from 2014 to 2018. For most developing economies, gold revenue constitutes a significant component of GDP. However, the reverse holds true for many advanced and emerging economies across the globe. To illustrate, the respective percentage contributions of gold revenue to the Ghanaian economy (9.52%) and to the economies of Burkina Faso (17.37%), Mali (15.87%), Sudan (11.25%), Guinea (10.02%), Uzbekistan (8.04%) and Mongolia (5.22%) in 2019 were significant. Conversely, the percentage contribution of gold revenue to the American (0.04%), Chinese (0.12%), Canadian (0.47%), Australian (0.86%) and Russian (0.87%) as well as Mexican (0.40%), Indonesian (0.33) and Turkish (0.22%) economies was marginal during the period.

The extent of influence of global gold revenue on global GDP (88.16%) is indicative of the precious metal's active and relatively extensive use in industrial and economic activities across the globe. As of the end of 2019, a total of 251,576 metric tonnes of gold had been discovered. The total stocks of gold comprised 197,576 metric tonnes (78.54% of total discoveries) that had been mined above-ground level and available for human consumption and industrial use. The total stocks in reserves underground were 54,000 metric tonnes, representing 21.46% of total discoveries (251,576 metric tonnes) during the period. Nonetheless, total gold stocks in reserves (54,000 metric tonnes) were less than a third (27.33%) of the total stocks available for use (197,576 metric tonnes). This implies that mining and the use of gold for various activities occur at a geometric rate relative to new discoveries and stocks of reserves.

The difference between the rate at which gold is mined and used and the rate at which new discoveries are made could be described as *mining lag*. The current gold-in-use and gold-in-reserves ratio of 3.66:1 is indicative of the existing wider gap between the two variables (mined gold for use and stocks of gold in reserves). The gap could be closed through the invention of new recycling technologies to accelerate the rates of recycling gold and gold-plated products. This initiative would ease pressures on the reserves to ensure the availability of the precious metal over several years and decades. The wider gap between mined and used gold on one hand and gold stocks in reserves on the other could be filled through two cardinal processes: acceleration of gold recycling rates and new discoveries.

The use of gold for various purposes – jewellery, private investments, official holdings, electronic equipment, medical technologies, and many more – calls for the introduction of alternative measures to ensure constant availability of the precious and critical metal (gold) in the medium- and long-term. The foregoing exigency accentuates the clarion call for the rapid introduction of novel recycling technologies to ensure increases in recycling rates for gold so the precious metal does not disappear through rapid depletion or exhaustion. As of 1985, South Africa produced nearly 40% of the world's total gold stocks mined and dominated gold production on the African continent for several decades until 2018, when Ghana's total gold production of 4.8 million ounces exceeded the country's total production (4.2 million ounces) by 600,000 ounces. Ghana's dominance on the African continent was reaffirmed in 2019 when the country ended the financial year with a total gold production volume of 142.4 metric tonnes, which was 24.2 metric tonnes more than the total volume produced by South Africa (118.2 metric tonnes) during the period. Further analysis in the following section would help determine and accentuate, or otherwise, the significance of the independent variable's (global gold revenue's) influence on the dependent variable (global GDP).

One of the significant measures that enhance our ability to determine the generalisability of the regression model is the adjusted R^2. Generally, an ideal adjusted R^2 value is closer to zero or the R^2 value. The adjusted R^2 value (0.879246011) in Table 11 is not significantly different from the observed value for R^2 (0.881613736). This implies that the cross-validity of the regression model is good; the model may accurately predict the same dependent variable from the given independent variable in a different group of participants (Field, 2009, p. 221). The R^2 significance was computed to cross-validate the value (372.3463) in table 12 using an F-ratio formula. Again, the ideal F-ratio formula for measuring R^2 significance is:

$$F = \frac{(N - k - 1)\, R^2}{k\,(1 - R^2)}$$

Where:

R^2 = Unadjusted value

N = Number of cases, participants or observations in the study
k = Number of independent variables in the regression model
Value for the F-ratio was determined as follows:

$$F = \frac{(52 - 1 - 1)\ 0.881613736}{1\ (1 - 0.881613736)}$$

$$= \frac{44.0806868}{0.118386264}$$

$$= 372.34629517492$$

Our computations revealed that the change in the amount of variance that can be explained gives rise to an F-ratio of 372.3463, which is equivalent to the F-value (372.3463) in table 12. This F-ratio shows a non-significant value ($p = 8.111$, $p > 0.05$), as presented in tables 12 and 13.

Historically, the Witwatersrand Basin in South Africa remains the single largest gold discovery in human history. However, the quantity and quality of gold mined from the Witwatersrand Basin in recent years have been a source of concern to key stakeholders in the mining industry in South Africa and elsewhere. Academics at the University of Witwatersrand (as cited in Whitehouse, 2019) expressed worries about the gradual reduction in the quality of gold mined at the Witwatersrand Basin over the past eighty (80) years and the impact on operations and earnings. A report on mining operations released by Whitehouse (2019) revealed that about 71% of mining firms in South Africa either reported marginal profits or losses from their operations. The overt decline in the quality of gold mined and operating profits affirms the urgent need for alternative measures that would assure the preservation of gold volumes in reserves while adding value to the stocks in circulation and use.

4.10.2.2. ANOVA

Generally, our ability to determine whether or not regression analysis provides better and significant prediction for the outcome than the mean is facilitated by the analysis of variance. Data in table 12 show degree of freedom (between) of 1 (2 - 1 = 1); degrees of freedom (within) of 50 (52 - 2 = 50); total degrees of freedom (df) of 51 (52 - 1 = 51); and F-value of 372.3463.

	df	SS	MS	F	Significance F
Regression	1	3.36486E+28	3.36486E+28	372.3463	8.11078E-25
Residual	50	4.51845E+27	9.0369E+25		
Total	51	3.8167E+28			

Table 12: ANOVA

Moreover, data outlined in table 12 depict the model sum of squares (SSM) value, represented by *Regression*; the residual sum of squares (SSR) value, represented by *Residual*; the total sum of squares (SST) value, represented by *Total*; and the degrees of freedom (df) for each group of squares. The degree of freedom for the SSM is 1, comprising the one independent variable (global gold revenue). The sum of squares divided by the degrees of freedom gives us the mean squares (MS). That is, 3.36486E+28 (3.36485627080218E+28) ÷ 1 = 3.36486E+28; and 4.51845E+27 (4.51845002926262E+27) ÷ 50 = 9.0369E+25.

4.10.2.3. Model Parameters

A normal probability plot on the relationship between global gold revenue (GGR) and global GDP (GGDP) is presented in figure 12. The figure depicts a flat distribution of comparative values over a seven-year period (0.96th through 12.50th percentile) and a steady rise in comparative values from the 14.42nd through 68.27th to the 99.04th percentile over the research period. Table 13 presents results on the parameters of the regression model. Statistics in the table show the coefficients, standard error, test statistic, significance, and confidence intervals for the coefficients.

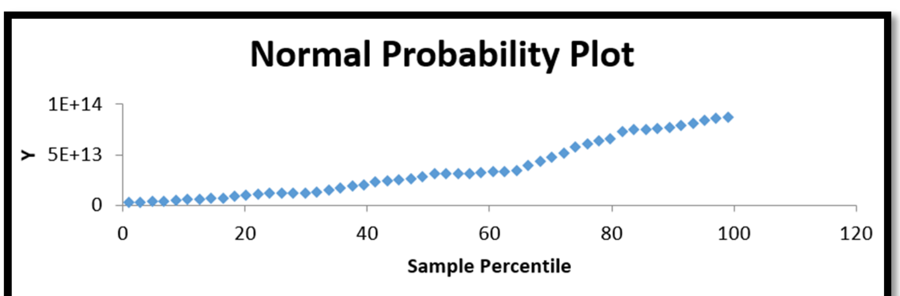

Figure 12: Normal Probability Plot for GGR and GGDP from 1969 – 2020

The coefficients announce the contribution of the independent variable (global gold revenue) to the regression model. Generally, a positive coefficient value connotes a positive relationship between the independent and dependent variables. Conversely, a negative value affirms a negative relationship between the two variables. Results in Table 13 show a positive coefficient value (527.3364872). This means there is a positive relationship between global gold revenue and global GDP. However, the relationship between the two variables, independent and dependent variables, is not significant (p = 8.111, p > 0.05); the results suggest that global gold revenue has no significant influence on global GDP. Thus, global gold revenue does not suffice to determine global GDP, controlling for contributions of other components pivotal to the measurement of the world's total economic output values.

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	1.05876E+13	1.82351E+12	5.806190513	4.372E-07	6.92501E+12	1.425E+13
X Variable 1	527.3364872	27.32840608	19.29627676	8.111E-25	472.4457681	582.227206

Table 13: Model Parameters

The magnitude of the t-test (p = 4.372, p > 0.05) in Table 13 tells us that the independent variable (global gold revenue) has minimal influence on the dependent variable (global GDP). A standard error is identified with the coefficients in the table. The standard error affirms the extent to which the coefficients would vary in different research samples (Field, 2009). As affirmed earlier, the probability that a parameter would fall between a pair of values around the mean is measured by the confidence interval. Available data in Table 13 depict respective upper and lower 95% confidence interval values for the *Intercept* (14250262105122.9 and 6925013012205.11) and *X Variable 1* (582.227206231785 and 472.44576811197).

4.10.2.4. Test of Assumptions

Statistical tests were conducted to determine the linearity of the relationship between the independent variable (global gold revenue) and the dependent variable (global GDP) and to measure the variance in residual values. The statistical outputs are presented in figures 13 and 14 and table 14. The scatter plots in figure 13 are on a straight line. This implies that the relationship between the independent variable and dependent variable is linear; it infers that the model fits the analysis.

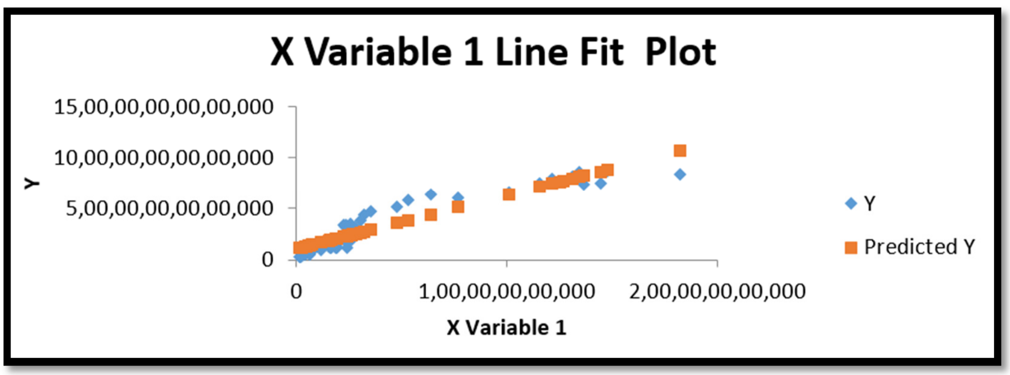

Figure 13: Linear Relationship between X and Y Variables

The residual plot in figure 14 depicts the independent variable (global gold revenue) on the horizontal axis and the residuals on the vertical axis. The residual plot in the figure shows a random pattern. That is, the points are randomly dispersed around the horizontal axis, affirming the linear model's appropriateness for the research data. Stated in different terms, the scatter plots in figures 13 and 14 indicate fitness of the linear regression model for the study.

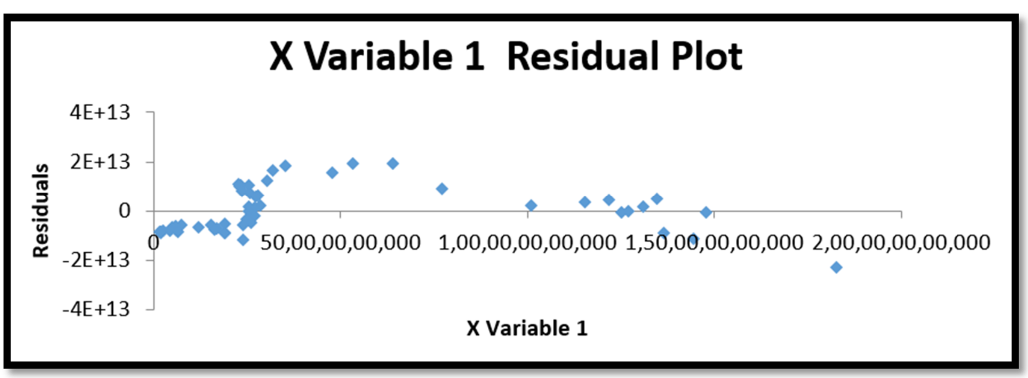

Figure 14: Linear Relationship between X (GGR) and Y (GGDP) Variables

The *residual* values in table 14 allow us to test the *homoscedasticity* of the model. That is, to test whether or not the residual values at each level of the independent variable depict constant variance. Residuals in Table 14 show constant variance values. This implies that the assumption of homoscedasticity is met. Further, data in figures 13 and 14 indicate that the relationship between the X and Y variables was measured at the interval level and beyond while the variability of the dependent variable (global GDP) was not constrained. The foregoing analysis indicates that most of the assumptions have been met. This renders the regression model fit and appropriate for the research.

Observation	Predicted Y	Residuals	Standard Residuals
1	1.06819E+14	-2.2974E+13	-2.44076661
2	8.85437E+13	-8.08714E+11	-0.08591827
3	8.15831E+13	4.85591E+12	0.515894522
4	7.96095E+13	1.69654E+12	0.180241708
5	7.65986E+13	-4.95043E+11	-0.05259369
6	7.14953E+13	3.72275E+12	0.395506725
7	7.47683E+13	4.52843E+12	0.481102947
8	7.74998E+13	-3.09855E+11	-0.03291917
9	8.66993E+13	-1.15373E+13	-1.22572748
10	8.26014E+13	-9.14141E+12	-0.97118899
11	6.38283E+13	2.29774E+12	0.244113507
12	5.11966E+13	9.21345E+12	0.978842003
13	4.43097E+13	1.93803E+13	2.058970839
14	3.86894E+13	1.93546E+13	2.056244893
15	3.57931E+13	1.57189E+13	1.669980355
16	2.92225E+13	1.83045E+13	1.944680565
17	2.74598E+13	1.64152E+13	1.743959289
18	2.6564E+13	1.2384E+13	1.31568582
19	2.39935E+13	1.07185E+13	1.138734561
20	2.2542E+13	1.0889E+13	1.156854818
21	2.28518E+13	1.07298E+13	1.139938307
22	2.27383E+13	9.82475E+12	1.043786601
23	2.30541E+13	8.33989E+12	0.886034833
24	2.41122E+13	7.34578E+12	0.780419428
25	2.53784E+13	6.19459E+12	0.658116699
26	2.49132E+13	5.97379E+12	0.634658748
27	2.55679E+13	2.20312E+12	0.234060455
28	2.48129E+13	1.04508E+12	0.111029965
29	2.39899E+13	1.46306E+12	0.155436084
30	2.40258E+13	-58775848669	-0.00624438
31	2.47855E+13	-2.15853E+12	-0.22932351
32	2.3606E+13	-3.51798E+12	-0.37375202
33	2.42715E+13	-5.02752E+12	-0.53412681
34	2.31496E+13	-5.94856E+12	-0.63197821
35	2.05896E+13	-5.47064E+12	-0.58120369
36	1.86585E+13	-5.86454E+12	-0.6230524
37	1.94137E+13	-7.23369E+12	-0.7685115
38	2.06414E+13	-8.89444E+12	-0.94495051
39	1.91413E+13	-7.6263E+12	-0.81022205
40	2.05756E+13	-8.95158E+12	-0.95102035
41	2.31924E+13	-1.19644E+13	-1.27110544
42	1.68696E+13	-6.89859E+12	-0.73290977
43	1.45671E+13	-5.98209E+12	-0.63554067
44	1.3622E+13	-6.34397E+12	-0.67398737
45	1.31559E+13	-6.71787E+12	-0.71371018
46	1.386E+13	-7.93997E+12	-0.84354696
47	1.39315E+13	-8.6155E+12	-0.91531508
48	1.28051E+13	-8.19609E+12	-0.87075717
49	1.19632E+13	-8.1852E+12	-0.86960064
50	1.15882E+13	-8.31523E+12	-0.88341462
51	1.149E+13	-8.52896E+12	-0.90612116
52	1.15979E+13	-8.89288E+12	-0.94478498

Table 14: Predicted Y Values and Residual Values for Variable X

4.10.2.5. Report on P-Value and Confidence Interval

Table 13 depicts a respective *P*-value of 8.111 and a positive coefficient value of 527.3364872. These values are not significant at Alpha level α = 0.05. The table further shows confidence intervals of 472.4457681 and 582.227206. The

Alpha level, a priori, for this study is $\alpha = 0.05$. The inference is that there is a 5% probability that we would be wrong, and there is a 5% likelihood that the population mean would not fall within the interval (Ashley et al.; Bowerman & O'Connell, 1990; Frankfort-Nachmias & Nachmias, 2008). However, we are 95% (100% - 5%) certain our conclusions would be right. Again, the Microsoft Excel output in Table 12 shows the degree of freedom (between) of 1 (2 - 1 = 1), degrees of freedom (within) of 50 (52 - 2 = 50) and total degrees of freedom (df) of 51 (52 - 1 = 51); and F-ratio of 372.3463. These values could be interpreted as:

$F(1, 50) = 372.3463$, $p > 0.05$, two-tailed.

4.10.2.6. Interpretation and Rejection of Alternative Hypothesis

Outcomes of the foregoing analysis indicate that global gold revenue has minimal effect on global GDP. Therefore, we reject the alternative hypothesis (H1: $\mu 1 \neq \mu 2$), which states that global gold revenue has a strong effect on global GDP, and accept the null hypothesis (Ho: $\mu 1 = \mu 2$), which states global gold revenue has no strong effect on global GDP.

5. Recommendations

Discussions throughout the preceding sections revealed a major common thread. That is the universal acceptance of gold and its major role in the creation of social satisfaction among members of society. The discussions revealed the valuable contribution of gold revenue to the measurement of total economic output values at the national, sub-regional, regional and global levels and some teething challenges that militate against the effective and significant financial contribution of the precious metal to national and global development and growth. In view of the foregoing, the following recommendations are proffered.

- The research revealed very harmful effects of mining activities on the health of mine workers and inhabitants of mining communities and the suburbs. Some of the health challenges encountered by mine workers are believed to be hereditary, implying they could be passed on to the children and other descendants of affected mine workers. Further, we observed minimal attention from mining companies to the health needs of mine workers; the zeal for profit maximisation far outweighs the attention paid to the health needs of mine workers. It may be most unfortunate for mine workers to develop recurring diseases or health challenges that may have the potential to be inherited by subsequent generations, especially when these diseases could be cured or prevented. *To reverse the unfortunate development and trend, mining companies are called upon to prioritise the health needs of their workers to minimise the harmful effects of mining activities on current and future generations of mine workers and their respective families*. Further, *compliance with the use and application of chemicals to the exploration process and the entire mining activities is paramount to tame the adverse effects on the lives of people residing in mining communities and the suburbs and tame the potentially harmful impact on the environment in general*.
- To ensure effective implementation, various governments of mining economies should ensure the health needs of key stakeholders in the mining sector are incorporated into the mining codes and regulations and prioritised. Where the clause is already captured in the codes and regulations, the relevant regulatory bodies must ensure strict adherence and application to save human lives and to reduce the financial burden on governments in regards to the obligation to expend to address challenges emanating from the activities of legal and illegal artisanal miners; and operations of large scale mining firms. As stated differently, *it would be both socially and economically beneficial for various governments to prevent the occurrence of hazardous situations and challenges during mining through effective implementation and application of mining codes and regulations rather than lax monitoring and control and "cure" the "malaise" at exorbitant costs*.
- Management of Sudan's mineral resources under former President Omar al-Bashir was believed to be fraught with many challenges. Kumar (as cited in Smith, 2020) found that President al-Bashir's regime issued fifty mining licences in a day without due diligence. Further, the level of corrupt practices in officialdom heightened to the extent that artisanal miners dealt with warlords and corrupt officials instead of paying royalties and local taxes. It is apparent at this juncture that Africa's development challenges do not relate to the limited availability of natural and human capital resources. Rather, they rest on leadership and the inability of the same to ensure effective utilisation of the resources endowed with each sovereign state. Indeed, economic wastefulness such as this inflamed passions and increased the level of hesitance among Western economies in recent years to continually provide financial support to accelerate development and growth among African economies. *Various leaders in Africa must be seen to practically be making significant improvements in the management of their respective economies through efficient and effective utilisation of available natural, human capital and other resources to repose lost confidence in Western leaders and their citizens; so the requisite technical and financial assistance could be provided as and when necessary; to accelerate the continent's development and competitiveness at the global level*. *The quest for assistance notwithstanding, the choice of an independent development path through diligent use of available natural and other resources holds the key to shared prosperity, freedom and accelerated growth of developing economies, including Ghana*.
- Generally, implied mining economies are expected to develop codes and regulations to ensure the overall effect of mining on the environment is minimised while human lives are protected and preserved through improved health standards. Codes and regulations developed by economies for mining companies in their respective jurisdictions stress the need for the mining firms to comply with laid down processes, including the development of management plans for the environment, effective planning on how to close the mine, monitoring of the mining environment and adjoining suburbs during periods of operations and after closures. Environmental impact

assessment and strategies adapted to ensure effective closure at the end of the mining period are expected to be executed prior to the commencement of mining operations. *Mining activities, especially those carried out by large- and small-scale mining companies, require strict compliance with these environmental and rehabilitation codes and regulations*.

- Ore mining results in the generation of a significant volume of waste known as tailings. For instance, for every tonne of copper mined, ninety-nine tonnes of waste are believed to be generated. However, the ratio is even higher for gold mining (Lumen, n.d.). The generated waste contributes to environmental hazards and human health challenges. As part of the environmental impact assessment and mitigation measures, mining companies create ponds in valleys which exist naturally to dispose of the tailings therein. Available statistics indicated the existence of three thousand and five hundred tailings impoundments at the end of the 2000 financial year and the estimated occurrence of two to five major failures and thirty-five minor failures each year (Lumen, n.d.). Evidently, these failures, be they major or minor, have immediate repercussions for the environment and human health; the impacts are not remote or deferred. Experts described subaqueous tailings disposal (STD) as the ideal since it ensures tailings are disposed of in the sea rather than in ponds created in natural valleys. *Subaqueous tailings disposal is strongly recommended for implementation since it provides some respite for the immediate or surface environment and humans therein. It is argued that when the lives of humans are protected through the application of STD, they could conduct much research to emerge with alternative measures to save, protect and preserve our aquatic lives in the near and distant future*.
- Nonetheless, these environmental preservation and health protection processes are often enshrined in the mining codes and regulations. What is deficient is strong enforcement through effective implementation. Therefore, it is envisaged that mining companies would strive to walk the talk by ensuring the implementation of the codes and regulations to the letter. *Voluntary enforcement of mining codes and regulations through the various mining companies via effective application is pivotal to addressing some of the identified perennial issues that negate the overall social and economic usefulness of precious metals such as gold to communities, mining companies, mine workers, gold-producing economies, sub-regional and regional economies and the global economy as a whole*.
- Except for a few advanced and emerging economies such as China, United States, Russia, Canada, Australia, Mexico and Indonesia, gold discoveries and mining in large commercial quantities occur in developing economies including Ghana, Burkina Faso, Mali, Guinea, Senegal, South Africa, Zimbabwe, Peru, Guyana, Uzbekistan, Mongolia, and Kazakhstan, among others. However, the study revealed a lack of stringent enforcement of codes and regulations related to mining in most of these developing economies. This corroborated Stewart (2020), who noted that countries endowed with that precious metal excessively focus on gold revenue and neglect environmental preservation and protection of human lives. To reverse the trend, *leaders of mining economies, especially those in the developing regions, are entreated to ensure strict enforcement of mining codes and regulations so the eventual effect of mining does not degenerate into a "curse" but remains a perpetual socio-economic blessing to all and sundry*.
- Consistent with Lumen (n.d.), we recommend stringent enforcement of the mining code and regulation that stress and require the application of civil engineering parameters to the design of mining waste dumps and the application of special conditions to mining areas characterised by volcanic eruptions, earthquakes and torrential rainfall. To wit, *authorities in mining economies must ensure that designs for waste dumps meet all regulatory requirements to assure the safety of the environment and the health of all humans*.
- One of the significant lessons gleaned from the current research was a tremendous increase in the use and application of various metals, including gold, by society from the twilight of the twentieth century to the contemporary period. Demand for precious metals such as gold has witnessed a tremendous surge due to the accelerated development of notable economies such as China and India, with very large distinct populations; and strong taste, preference and demand for gold jewellery. As of the end of 2019, total stocks of gold mined and available for use above ground level were about 3.66 times (197,576 metric tonnes ÷ 54,000 metric tonnes = 3.6588 = 3.66) the stocks in reserves underground. This indicates the rapid depletion of the world's total gold reserves and the urgent need to develop novel recycling techniques to arrest the phenomenon. Thus, *the world requires dramatic transformation, an increase in recycling technologies, and an increase in recycling rates of critical metals such as gold to ensure their availability for use and application in the medium- and long-term. All else held constant. Improved recycling technologies and rates would ensure the revolution of already-mined gold and ease any perceived pressures on the reserves over extended periods*.
- As of May 2018, the Republic of Ghana's carried interest in mining companies was estimated at 10%, implying the country's strong stake in the payment of declared dividends. However, between 2012 and May 2018, the country's share of dividends was consistently zero. The financial implication was the economy's denial of a significant amount of domestic revenue. Thus, *in 2018, it became necessary for the elected government to review the existing regulatory measures in the mining sector, especially measures related to exemptions and carried interest. Further, it was necessary to reassess the country's Natural Resource Control and Governance Strategy amidst other pertinent mining reforms. A practical manifestation of these proactive measures was exemplified in Ghana's dominance in African gold production and revenues between 2018 and 2019. Consistent with inter-governmental exchanges and practices, other developing economies are encouraged to imitate Ghana's practical example to increase total revenue derived from gold operations and revenues accruing directly to their respective economies*.

- Notable gold-producing economies in the West African sub-region could contribute tremendously to and assure a significant increase in the global value chain for gold through the formation of a body called *Regional Strategy for Mineral Resource Development*. *The mandate of this sub-regional body would extend beyond the increased value chain for gold to include effective development and value-addition for other natural resources such as diamond, bauxite, manganese, iron and others*. *Existing mining codes and regulations at the regional and global levels could serve as a guide to the formulation of new codes and regulations for the Regional Strategy for Mineral Resource Development*. *The establishment of this body and its intended mandate could be replicated, when necessary, in other sub-region regions across Africa and other global regions*.
- Further, leaders of developing economies are implored to strive to ensure a paradigm shift from excessive reliance on the exportation of gold in its pure or raw form to the exportation of semi-processed and fully-processed refined gold. The foregoing underscores the need for the establishment of gold refineries in individual developing economies; it affirms the growing need for the decision to establish gold refineries to move beyond mere rhetoric to real practice. Therefore, *it is incumbent on leaders of developing economies to walk the talk and practically demonstrate their commitment to investing in the establishment of gold refineries to assure value-addition while shoring up total earnings from the precious metal to facilitate development, enhance job creation and accelerate economic growth*.
- The study revealed that the Great Lakes region, with relatively fewer African economies endowed with gold in large commercial quantities, could boast of gold refinery. However, the narrative is the complete opposite for the West African sub-region, home to the largest number of gold-producing economies in Africa. *Quite conspicuously, any decision to establish a refinery to serve the West African sub-region, replicating what prevails in the Great Lakes region, would be economically beneficial to all African and global economies*. *However, it is worth stressing that if the pendulum of the eventual cost-benefit analysis swings in favour of patronage of refineries in the Great Lakes region, then gold-producing economies in West Africa could opt for the same as a substitute for the establishment of new refineries in the sub-region, vice versa*.
- Steps taken by the membership of the Organisation of Petroleum Exporting Countries (OPEC) to regulate the daily, weekly and monthly supply of crude oil to the world market have succeeded in closing the initial "yawning" gap between supply and demand, which affected price per barrel of the commodity in prior years. The eventual effect is our witness to some price stability and steady increase in the price per barrel in recent periods. All things held a constant and stable supply of crude oil with a corresponding increase in demand in excess of supply would imply an upward adjustment in the price per barrel and an increase in revenues derived from the sale of the same. In the same vein, *the few global economies endowed with gold extraction and production capacity in large commercial quantities could collaborate with or through the World Gold Council to regulate the total volume of gold supplied or made available to consumers in the global market within certain time frame, say weekly, monthly, quarterly, and so forth*. *This initiative, which would mimic the OPEC strategy, would facilitate the regulation of supply to ensure steady appreciation of the price per ounce of the commodity during the financial year, not only during periods of downturn in the stock markets. Undoubtedly, strategic adaption and implementation of the OPEC model, that is, regulation of gold supply at regular intervals, would be economically rewarding to mining firms and beneficial to economies in which these mining companies operate*.
- In most cases, the significance of the government's share of profit from mining operations is contingent on the striking difference between total gold revenue and total expenses incurred. Therefore, *it is imperative for the major gold-producing economies to take proactive steps towards creating economic parsimony in supply to positively affect the price per ounce of gold in the global market*. The intensive education on birth control in most advanced economies, including China, Japan, the United States, the United Kingdom, and many others, has increased the ageing population and decreased the population of young people, including new births. The implication is a significant reduction in dependency rate and availability of more funds for spending. China and India remain some of the global economies with significant demand for gold for jewellery, albeit birth control in the latter is not as stringent as in the former. Thus, *the creation of an economic shortage in supply relative to demand may be rewarding to traders, including firms in the mining industry and gold-producing economies*.
- Further, in the United States, demand for 14-carat gold jewellery is commonplace among middle-income earners and among other consumers of the commodity. All else held constant, with an increase in excess funds for spending, any artificial shortage created in the supply of gold is more likely than not to result in an upward review of the price per ounce in the world market. Arguably, *the creation of economic parsimony in the quantity supplied of gold comparative to the quantity demanded would be more revenue-assuring to mining firms and economies than excessive reliance on the "traditional" contingent factors such as negative real rates of return on other investments, poor performance of the global equity markets, increase in central banks' demand and weakening of base or underlying currency such as the American dollar. The foregoing lends strong credence to the urgent need for the adaption and implementation of the OPEC model by global gold-producing economies*.
- Extant literature revealed very limited traces of illegal mining activities, if any, in advanced economies endowed with gold in small and large commercial quantities. However, the narrative was reversed entirely for most developing economies, including Ghana, Sudan, Democratic Republic of Congo, Mali, Burkina Faso, and others, endowed with gold in large commercial quantities, and where revenues derived from the precious metal are required for key development projects, including the provision of critical, soft and hard infrastructure. Some artisanal miners engaged in illegal mining activities in developing economies, including Ghana, attributed their

unapproved occupational practices to leadership's inability to account effectively for their stewardship to the people. These illegal artisanal miners argued that the only way to ensure their modest share of the national "cake" is accessed is by engaging in illegal mining. To wit, *illegal artisanal mining, in some cases, is a protest against perceived ineffective or poor governance in most developing economies. The onus, therefore, lies on various governments of developing economies to strive to nib the activities of illegal miners in the bud.*

- *The foregoing could be achieved through improved governance, including the increased provision of transportation, water, power, energy, education and health facilities to mining areas and communities to enhance education standards, create more job opportunities, and improve living standards. These measures are presumed to provide practical alternatives in regard to job opportunities for illegal artisanal miners and to discourage the same from continuous engagement in unapproved mining activities, which could prove injurious to their health and the environment.*
- In addition, the research revealed that illegal artisanal mining in most developing economies, including Ghana, is encouraged by political stalwarts who mask their true identity and operate through pseudonyms. *Evidently, these unapproved practices contribute strongly to the record of gold revenue lag. That is the variance between official national gold revenue and the total value of gold imports declared by the country's gold-import partners. The nefarious practices add more to national expenditure than revenue; they have the tendency to derail positive causes of development through unproductive and uneconomic expenditure on the reclamation of depleted lands and treatment of polluted water bodies. However, bold steps taken by elected governments to ensure the regularisation of activities of illegal artisanal miners through formal registration and licencing, effective co-ordination, monitoring and integration would be socio-economically beneficial to their respective economies.*
- Deployment of law enforcement personnel to illegal mining communities remains a very strong option when illegal artisanal miners are adamant and penchant to continue with their illegal mining activities. The foregoing lends strong credence to the formation of a joint task force christened *Operation Vanguard* by the current political administration of Ghana to end the alarming rate of illegal artisanal mining and the effect of same on water bodies, the environment, and national economic output. *Operation Vanguard, which was formed in recent years, is comprised of a team of military and police personnel trained and deployed to mining communities to assist in the national fight against illegal mining and its concomitant effect on water bodies, human lives, and the environment in general. The formation of such a preventive security team could be replicated in other developing economies saddled with illegal artisanal mining and other mining challenges.*
- The respective initiatives of developing economies to halt illegal mining with all their might are very likely to be socio-economically productive. That is, the initiatives have the potential to increase the government's control over the mining of the precious metal and to improve annual accountability for gold revenue, in addition to the positive social effects enumerated earlier, including the protection of water bodies, human lives and the environment. *Indeed, finding lasting solutions to challenges confronting the respective mining industries in individual mining economies and globally must be the prime and shared responsibility of all and sundry and not restricted to a few stakeholders, including elected governments or otherwise, firms in the mining sector, academia and affected mining communities.*
- As noted by the Water Resource Commission of Ghana (as cited in Business & Human Rights Resource Centre, 2017), nearly 60% of Ghana's water bodies were severely impacted by the activities of illegal artisanal miners and, in some cases, by the activities of large scale mining companies who do not comply fully with standards of the Environmental Protection Agency; and standard application of chemicals during the mining processes. Many of the affected water bodies in Ghana were found by the Water Resource Commission (as cited in Business & Human Rights Resource Centre, 2017) to be in critical condition. As a result, *the quantitative and qualitative impact of Operation Vanguard on the collective fight against illegal mining in Ghana would manifest in the respective rates of contamination of water bodies before and after its formation*. Thus, a *reduction in the rate of contaminated or polluted water bodies from 60% to a lower rate, relative to the length of the period of its operations in deployed mining areas, would affirm a positive impact, and vice versa*.

More importantly, it is imperative for the team of personnel and its command structure constituting the mining task force to ensure the resources committed by the country to the fight against illegal mining become economically productive and beneficial through the delivery of both qualitative and measurable results. *Effective implementation of mining codes and regulations by relevant authorities in global mining economies to assure stability in the ecosystem is non-negotiable.*

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