THE IMPACT OF MINING ON ECONOMIC GROWTH Case Study: Lofa, Bong, Nimba and Gbarpolu counties

Prepared by

Liberia Macroeconomic Policy Analysis Center (LIMPAC)

Abstract

Gold mining has been the bedrock of the Liberian economy, contributing significantly to domestic government revenue, employment, merchandise exports, foreign exchange earnings and Foreign Direct Investment. However, its long-term impact on sustainable economic growth remains contested, particularly in resource-rich regions like Gbarpolu, Bong, Lofa, and Nimba Counties. This study examines the relationship between gold mining and economic growth in Liberia, focusing on three critical dimensions: efficiency and productivity, strategies for optimization, and labor force dynamics. Employing a mixed-method approach, the research integrates quantitative data from government and mining companies' reports, and qualitative insights from respondents during the survey conducted.

The findings reveal that optimized strategies have a positive impact on the economic growth of Liberia, with strong correlation between labor efficiency and productivity, strategies for optimizing economic growth, and economic growth. The paper also addresses the environmental impact of mining, including deforestation, water pollution, and soil degradation. It emphasizes the importance of implementing environmental regulations and responsible mining practices to mitigate these adverse effects and ensure long-term sustainability. Based on the findings, the paper concludes that while mining has brought significant economic benefit to Liberia, there is a need to formalize the sector, improve regulatory frameworks, enhance access to finance, and promote sustainable practices. The study recommends effective and transparent regulatory frameworks, governance and public participation, and enhanced revenue management to address the negative social impacts and promote sustainable development.

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List of Acronyms

ASM	Artisanal and Small-Scale Mining
FDI	Foreign Direct Investment
FGD	Focus Group Discussions
GAC	General Auditing Commission
GDP	Gross Domestic Product
ICMM	International Council on Mining and Metals
MCI	Mining Contribution Index
MNC	Multinational Corporations
WGI	Worldwide Governance Indicator

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Chapter One

Introduction

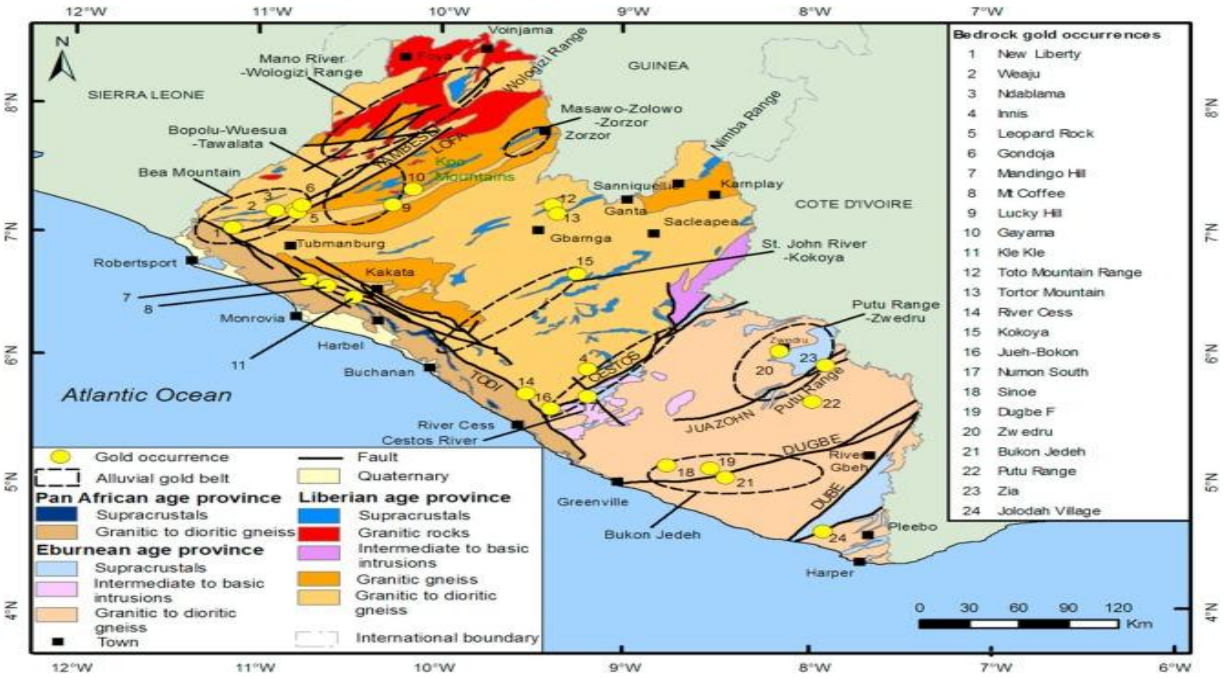
Liberia, one of the least developed nations, has recorded over 500 gold discoveries in various areas such as Bea Mountain, Bopolu-Wuesa-Tawalata, Masawo-Zolowo-Zorzor, Mano River-Wologizi Range, St. John River-Kokoya, Cestos River, Putu Range-Zwedru and Bukon Jedeh (LEITI, 2021). Currently, the artisanal and small-scale mining (ASM) sub-sector employs over 100,000 miners and 500,000 diggers, supporting the livelihoods of 787,500 to 1.575 million people (LEITI, 2021) and when managed effectively, holds the potential to addressing the unemployment situation and reduce poverty in Liberia (Minerals Yearbook, 2019).

The sector indirectly employs almost 1.575 million people and provides livelihood to 0.5 percent of the labor force (LEITI, 2024).The gold reserve is estimated at three million ounces (Wilson, Xuejiao, & Qi , 2017). Globally, Liberia ranks 30th in terms of mining impact on economic growth (ICMM Report, 2020). However, the mining sector contribution to growth has decreased over the years from 60 percent of export income and 25 percent of GDP for the period 1960 to 1980 (Wilson, Xuejiao, & Qi , 2017) to about 81 percent of export income and 18 percent of GDP between July 2021 to December 2022 (The Liberia Chambers of Mines, 2023).

Alluvial gold has long been exploited in Liberia at more than 30,000 oz per annum, initially in Zwedru, since the 1940s. But the surge in exploitation has been a far more recent phenomenon that took off in the aftermath of the 2008 financial crisis (Verbrugge, Cuvelier, & Bockstael, 2015). Liberia's total gold reserves are estimated at 3m. Troy Oz but the prevalence of illicit production renders output estimates highly uncertain. In November 2013, UN Panel of Experts reported that 'industrial sources' estimated that actual annual production was about 3,000 kg, suggesting that illegal exports accounted for 80 percent of output.

While reserves of alluvial gold are distributed throughout the country, the most significant occurrences are in Western Liberia between the Lofa and Mano rivers, in Bong and Nimba counties along the St John River and Ya Creek, and in the south-east of the country. Most of the available information on the nature and origin of gold reserves comes from mining companies reports which provide little scientific information.

Figure 1: The Distribution of the Principal Bedrock Gold Occurrences and Gold 'Belts' in Liberia



LEITI, 2022

Many other gold occurrences occur along a structural corridor extending north-east from New Liberty, a shear zone-hosted gold deposit owned by Avesoro Resources Inc. (Avesoro Resources, 2018a). Prominent examples include Weaju and Ndablama where Avesoro Resources continues to explore and has announced significant gold resources (Avesoro Resources, 2018b). Exploration in the Kpo Range area of Gbarpolu County has identified gold-bearing quartz veins (Whiteaker, 2007). Mineralization is thought to be related to shear zones at the margin of an Archaean greenstone belt consisting of banded iron formation, schist and amphibolite.

Despite the huge gold availability, ensuring that mineral resource wealth contributes to sustainable economic development has been a perennial topic concerning many African countries. It is an especially pressing issue in countries that are rich in resources, but perform poorly on a host of development indicators. Too many countries export resources, often through multinational firms, while the citizens enjoy little of the resource endowment. This occurs

mainly due to unfair concession agreements and/or the mismanagement of the resources revenues.

In Liberia, although notable investments have been made in the sector, the sector still faces substantial challenges, including the lack of modern technology, poor infrastructure, ineffective regulations, skilled labor shortage, and environmental degradation. A recent report by the General Auditing Commission (GAC) in 2021 reveals that 69 percent of field staff (i.e. 78 percent of 250 inspectors, 72 percent of 200 patrolmen, and 32 percent of mining agents) are not employed by the Ministry of Mines & Energy due to lack of funds from the government. This has the unintended consequence of forcing field agents to rely on the communities they are to monitor thereby providing them a strong incentive to charge miners for their services during the licensing process (Maconachie & Conteh, 2021). Some of the underlying factors include governance issues that range from the lack of capacity, coordination, transparency, as well as conflict of interest among members of Parliament directly involved in mining activities. The lack of robust monitoring means the government's Large Taxpayer Unit relies on the self-assessments of mining companies (including for production figures, as Customs do not have the facility and capacity to verify the weight and quality of gold independently) which compromises checks and balances.

Mining and natural resources such as iron ore, gold, and diamond, which are abundant in Liberia, can serve as another potential source for structural transformation. While the sector is important, it currently employs the least and its contribution to growth is the least. This sector can however unleash its potential if supported with strategic investments in responsible mining practices, infrastructure, and value addition, which can help stimulate growth in the mining sector. In addition, ensuring transparency, good governance, and community engagement are essential for sustainable resource extraction.

The 2020 Mining Contribution Index (MCI) confirms that many of the world's mining-dependent countries continue to rely on their natural resources as the primary driver of economic growth. However, sources including the Natural Resource Governance Index and the World Bank's Worldwide Governance Indicator (WGI), indicate that the governance of natural resources in many of these countries is weak, poor, or failing, thereby minimizing its impact on

growth. This paper examines the impact of the mining sector on Liberia's economic growth, identifying key factors that affect productivity and efficiency, and proposes strategies and policies to optimize production in the mining sector. The artisanal gold sector can address socio-economic challenges in countries like Liberia, contributing significantly to annual revenues, employment, income equality, and GDP. But the loosely-regulated nature of the sector raises concerns of economic leakages, exploitation, and social and environmental implications, which challenge artisanal miners, mining communities, and government's sustainable development drive (Gavin, Abigail, Roy, James, & Halima, 2017), (Shefa & Veiga, 2009).

Chapter Two

Literature Review

Introduction

A literature review is a systematic evaluation of academic work on a specific topic, organized by research objectives or issues. It is the scholarly core of a dissertation, analyzing and synthesizing source materials, and reporting on original research to the scholarly world.

(Best & Kahn, 2014) suggest that reviewing related literature helps researchers understand existing knowledge and unknowns, eliminates duplication, and provides useful hypotheses. Citing studies with substantial agreement or conflicting conclusions sharpens understanding, provides a background for the research, and informs the reader about the issue's status.

As such, this study included only those studies that are relevant, competently executed, and clearly reported – studies on mining and economic growth, studies on mining and environmental degradation, and studies on mining and governance.

Theoretical Literature Review

One of the main drivers of economic growth in the endogenous growth theory is the abundance of natural resources. The literature on the "natural resource curse" is just an extension of this theory. The resource curse refers to the negative development outcomes resulting from the abundance of minerals and fuels, including state intervention, rent-seeking, and corruption in less developed countries.

The resource curse theory suggests that countries abundant in natural resources, such as minerals, often face negative economic and social consequences (Auty, 1993); (Sachs & Warner, 1997). This implies that the larger the natural-resource sector gets, the less the positive externalities from the manufacturing sector become owing to its decline, leading to a negative impact on overall economic growth. In other words, overdependence on resource extraction can hinder economic diversification, lead to governance challenges, and result in environmental degradation (Ross, 1999). The other popular justification about the existence of the resource

curse relates to the political and institutional explanation. The literature suggests several channels through which the functioning of a political system could be affected by natural resources. Rent seeking is one of the channels. (Torvik, 2002), for example, suggests that greater amount of natural resources increases the number of entrepreneurs engaged in rent-seeking and reduces the number of entrepreneurs running productive firms. With a demand externality, it is shown that the resulting drop in income is higher than the increase in income from the natural resource. Applying the resource curse theory to the Liberian mining sector enables an examination of potential risks and the development of strategies to mitigate them.

The export base theory explains the diversification of mono-product commodity-exporting regions in terms of a five-stage sequence (Watkins, 1963), which in the case of mining begins when a mining company identifies a mineral with potential comparative advantage and begins to export it. The second stage sees mineral production expand, yielding both internal economies of scale and external economies (such as improved shipping facilities) that lower average production costs and further boost the mineral's competitiveness. In this stage, investment remains mostly within the mineral export, but in the third stage productive linkages are triggered in the form of investment in local input supplies to the mine that replace hitherto imported inputs of machinery and spare parts (backward link), and/or to undertake processing (forward linkage) prior to export, as a refinery, smelter or fabricating plant. In the fourth stage, capital overflows from the mineral sector into the non-export sector of the economy to supply growing household demand as well as the needs of firms supplying inputs to the mine. Examples include brewing, furniture production and business services in addition to mine inputs, any of which may eventually enter export markets. Meanwhile, fiscal linkage takes the form of government spending on economy-wide physical infrastructure and human capital and, perhaps, finances policies designed to speed economic diversification. The region reaches its fifth and final stage when the economy has become sufficiently diversified into additional commodity exports, services and/or manufacturing that the mineral export is no longer dominant.

Empirical Literature Review

Few studies and research have been done to assess the impact of mining on the Liberian economy. Much of the available research is in the form of consultants' technical reports and the grey literature. While many consultants' reports are very well done, it is difficult to draw generalities from them because their funding sources (mining companies and/or environmental advocacy groups) challenge their objectivity.

However, generally, several empirical studies have investigated the relationship between mining and economic growth. The association between resource dependence/abundance and economic growth was empirically analyzed by (Sachs & Warner, 1997) who developed a model using data for a large number of countries (varying from 40 to 95 depending on the specific regression) to explain the potential resource curse in resource-rich countries. They studied the impact of natural resources on economic growth using primary product exports as a percentage of GDP or GNP as a proxy for resource abundance which they term the share of exports in primary products They found that natural resources negatively affect economic growth, primarily due to the likely effects of the Dutch Disease on the manufacturing sector. Their work led to more subsequent research in this area. (Papyrakis & Gerlagh, 2004); (Leite & Weidmann, 1999), for example, also confirmed the existence of a resource curse.

The resource curse, a phenomenon attributed to economic and political factors, is primarily explained by the "Dutch disease," which suggests that increased prices or resource discoveries lead to resource sector expansion. (Neary & Wijnbergen, 1985), in their related theses on the Dutch Disease confirmed that natural resource booms delay the industrial sector, presumed as the main driving force of the economy, through either real exchange rate appreciation or the absorption of production factors. (Amankwah & Anim-Sackey, 2003) also examined the contribution of mining to Ghana's GDP growth using econometric analysis. They found that mining activities had a positive impact on economic growth, highlighting the sector's role as a significant driver of economic development. Conversely, (Bridge, 2008) noted that the majority of the resource curse literature finds robust economic growth associated with development from resource extraction to be a rarity as opposed to a general rule (Ross, 1999); (Sachs & Warner, 1997); (Watts, 2005); (Rosser, 2006). Much of the research that examines mining within developing nations concludes that very little of the economic benefits are retained in the local

economy because of the ownership structure of mining firms and lax environmental or labor safety standards.

By contrast, (Leite & Weidmann, 1999); (Sala-i-Martin & Subramanian, 2003), the empirical evidence does not lend credence for the Dutch Disease as an explanation of the resource curse. (Auty, 1993) case study does not also support this thesis by showing the complexity and diversity of cases among natural resource abundant countries, including several exceptions to the curse such as Norway, which has seized its oil abundance to become a rich country. Additionally, (Bulte, Damania, & Deacon, 2005) argue that natural resources abundance/dependence only negatively impact growth in some countries.

By using different measures of natural resources, (Boschini, Pettersson, & Roine, 2007), analyzed the impact of natural resources on economic growth in 80 countries from 1975 to 1998. They found that gold, silver, and diamonds had the most significant negative impact on economic growth. Other studies by (Sala-i-Martin & Subramanian, 2003) and (Isham, Woolcock, & Busby, 2005) dismiss the negative impact of geographically concentrated resources with export shares as confirmed by Lederman and Maloney (2008). For example, (Stijns, 2005) found no correlation between fuel and mineral reserves on growth during 1970-1989, while Davis (1995) found countries with a high share of minerals in exports and GDP performed relatively well in the same period.

Past studies have used macroeconomic and institutional factors to analyze the relationships between mining and economic growth in many developing economies (Mahonye & Mandishara, 2015) (Mahonye & Mandishara, 2015); (Butler, 2013); (Kahn, 2013). According to these studies, macroeconomic theory attempts to explain economic growth in relation to macroeconomic variables like real growth of mining, mining export to GDP, institutional variables, and FDI (Butler, 2013); (Agrebesola, 2014). In addition, interactions among government policies and institutions, organizations, and macro-economic variables also influence the degree of beneficiation, foreign exchange, balance of payment, and environmental factors in many developing economies (Agrebesola, 2014). Consequently, most multinational corporations (MNCs) often consider wider influences from sources such as government policies, institutions, macroeconomic and environmental factors in terms of their decision to invest in other countries

(Butler, 2013); (Kahn, 2013). Specifically, the efficiency of the political institutions in developing economies to formulate the desired investment-related fiscal and monetary policies influences the growth benefits from mineral exploitations in many African economies (Asheghian, 2004). Consequently, many Southern African economies that compete for a larger share of global FDI flows in the mining sector have started liberalizing their institutional environments (through various reforms), to create favorable investment opportunities for MNEs (Butler, 2013). This is on the premise that institutional quality, sound macroeconomics, educational levels (human capital), and natural resources are the major determinants of foreign investments inflows into the mining sector of many African economies (Asiedu & Lien, 2004). However, the inadequate functioning of institutions in Africa has been identified as creating high political risk, corruption, poor governance, bureaucracy, and rule-of law failures (Anyanwu, 2012). In addition, most African countries are characterized by less structural interaction between political and economic institutions, which inhibits the growth potentials of mineral exploitations in the region (Agrebesola, 2014); (Wyk & Lal, 2008).

In terms of employment, studies have explored the direct and indirect job creation effects of mining. (Akabzaa & Darimani, 2001) researched the employment impacts of large-scale mining in Ghana. They found that mining activities generated employment opportunities not only in the mining sector itself but also in related support industries. Similarly, (Ghose & Roy, 2007) examined the positive impact that the sector has in India on economic dimensions such as employment and income generation. This has contributed to poverty reduction and improved livelihoods in mining communities. In the sub-Saharan African context (Mwaipopo & et al, 2004) examined the relationship between Artisanal Mining (ASM) and livelihoods in Tanzania, with (Hilson & Baidoo, 2011) analyzing the role that micro-credit plays in overcoming the capital constraint that is often present in the sector. In Latin America (Seccatore, Marin, De-Tomi, & Viega, 2015) examined the role that efficiency in the sector could play in Brazil, finding a key role between efficiency in production and an index of human development at a global level. The study highlights the need for improvements in productivity to help boost the positive impacts of the sector.

Chapter Three

Research Methodology

Introduction

This Chapter explains the research methodology used. It discusses the research design and approaches, characteristics of respondents, data collection methods, data analysis methods, quality assurance, critiques of sources and concludes by ethical considerations.

Research Design and Approaches

In a research environment where the nuances of human and societal experiences cannot be fully captured by quantitative metrics alone, the value of qualitative insights cannot be understated. Noteworthy examples include the importance and return on value of qualitative research in planning (Gaber, 1993), understanding negative cases (Woodliffe, 2004), reasoning causality (Maxwell, 2012), and (re)imagining interventions or solutions (Duggleby, Peacock, Ploeg, & Swindle, 2020).

Hence, this study on the impact of mining on gold resources has been qualitative as far as sources of data are concerned. The population, target population and sampling was part of the design of this study.

Characteristics of Respondents

The interviewees about this study comprised of people from the following categories:

1. Respondents from Salayea, Zorzor, Zoweinta, Sacleapeah, Kpein, Belle Yalla, in Lofa, Bong, Nimba, and Gbarpolu Counties. 300 including miners, Supervisors.
2. Management and staff of Mining Companies in Bong and Nimba. 12 including both male and female from MNG Gold Liberia Incorporated in Bong, Altus Strategies in Lofa, Hamak Gold Ltd in Nimba, and the Randall and Oretha Doe Multi-Purpose Company in Gbarpolu
3. Management and staff of Ministry of Mines and Energy. Five including both male and female from the Planning and Operation Departments of the Ministry.

Study Area

The study covered Bong, Lofa, and Nimba due to the high mining potential of these counties. These counties are accessible and possess the greatest potential for attracting investment in the mining sector.

Sampling

The researcher used the purposive sampling technique to select the sample size for the study. Using this sampling modus operandi, the researcher intentionally or deliberately draws a sample from the population (Khan, 2014). The sample size of 300 was selected purposively to represent the population of the study. However, results from such sampling technique cannot be generalized (Nworgu, 2006).

Data Collection Methods

The research employed the mixed method which was suitable for the data collection process of the research area.

a. Structured Questionnaires

The questionnaire was useful in this study because it helped in answering the 3 research questions-i) What are the impact of mining on economic growth in Liberia? ii) What are the key factors affecting the efficiency and productivity of the mining sector? iii) What are the policies and strategies available to optimize economic growth in the mining sector? The close-ended questionnaire mainly targeted the key actors in the field including miners and supervisors as well as management and staff of the Ministry of Mines and Energy and Mining Companies operating in the targeted counties of Bong, Lofa, and Nimba.

b. Focus Group Discussions (FGDs)

The FGD was composed of thirty persons in each county who were purposely selected to provide the right information about the mining sector's performance in their county. The FGD helped in understanding and fine-tuning the data collected.

Chapter Four

Data Presentation and Analysis

Correlation

The Correlation test is a standardized routine statistical method used to appraise the relationship of the variables with each other in the model. There are different methods that are frequently applied to determine the correlation test outcome, which include but not limited to, the Kendall's correlation, Spearman's correlation (Lemenkova, 2018) and generally the Pearson's correlation. Therefore, Pearson's correlation test was considered to evaluate the relationship among variables based on the data provided.

Mostly, three components are assessed with the correlation analysis beginning with the significance, strength, and level. Firstly, the significance is measured based on the p-value, which in this case must be less than 0.05 (95% confidence interval). In accordance with the result of the correlation test, the Pearson's test result shows that p-value is less than 0.05($0.000 < 0.05$) indicating a statistically significant connection with the variables.

The level regulates the positive or negative interrelation among variables in the economic model. The existence of the '- 'symbol in the coefficient indicates a negative relation between variables, while the lack of the symbol defines a positive connection between the variables. In conclusion, the strength is showed based on the value of coefficient, ranging from 0 to 1 values indicates a strong level of interconnection. While, Values ranging between 0.1 – 0.4 illustrate a weak level of interconnection, and 0.5 – 0.7 values indicates a moderate level of the association. In distinction, values above 0.7 illustrate a more vital interrelation among data used in the model.

Table 1: Correlations

		L_E	IMP_M	E_PM	S_ECO
L_E	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	300			
IMP_M	Pearson Correlation	.434**	1		
	Sig. (2-tailed)	.000			
	N	300	300		
E_PM	Pearson Correlation	.507**	.844**	1	
	Sig. (2-tailed)	.000	.000		
	N	300	300	300	
S_ECO	Pearson Correlation	.480**	.955**	.864**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	300	300	300	300
**. Correlation is significant at the 0.01 level (2-tailed).					
*. Correlation is significant at the 0.05 level (2-tailed)					

Source: LIMPAC's Computation

*Signifies 1% significant level

Mining: Efficiency and Productivity, Strategies for optimizing growth, and Labor

Relationship between Impact of Mining on optimizing economic growth and Labor force in the Mining sector

Testing for the correlation relationships among the two variable, the result in the above table evidently shows that the Pearson Correlation Coefficient between **Impact of Mining on economic growth and Labor force in the Mining sector** is r=0.434**, which suggests that the relationship between the two variables are weak but correlate positively among the two variables in the model. Moreover, this value demonstrates a positive and significant correlation more dynamic interrelationship among data used in the model between **Impact of Mining on economic growth and Labor force in the Mining sector**. The correlation is significant at a 1% level of significance as the p-value is less than alpha, i.e., 0.000 < 0.01.

Relationship between Efficiency and Productivity and Impact of mining on economic growth

The correlation analysis results offered in the above table shows that Pearson Correlation Coefficient **between Efficiency and Productivity and Impact of mining on economic growth** is r = 0.844**, indicating that the two variables are positively and very strongly significant correlation relationship between **Efficiency and Productivity and Impact of mining on economic growth**. The correlation is significant at a 1% significance level as the p-value is less than alpha, i.e., 0.000 < 0.01.

Relationship between Strategies for optimizing Economic growth and Impact of Mining on Economic growth

The correlation analysis results presented in the above table show that Pearson Correlation Coefficient between **Strategies for optimizing Economic growth and Impact of Mining on Economic growth** is r =0.955**, which suggests that the two variables are positively and intensely correlated. Additionally, this value specifies a positive and significant correlation between **Strategies for optimizing Economic growth and Impact of Mining on Economic growth**. The correlation is statistical significant at a 1% significance level as the p-value is less than alpha, that is, 0.000 < 0.01.

Relationship between Strategies for optimizing Economic growth and Efficiency and Productivity The correlation analysis results presented in the above table show that Pearson Correlation Coefficient between **Strategies for optimizing Economic growth and Efficiency and Productivity** is r =0.864**, which recommends that the two variables are positively and strongly correlated with each other in the model. Moreover, this value of the Pearson coefficient specifies a positive and significant correlation between **Strategies for optimizing Economic**

growth and Efficiency and Productivity. The correlation is statistical significant at a 1% significance level as the p-value is less than alpha, that is, 0.000 < 0.01.

Summary of the Model

The model summary consider the six major components of the regression and they are R, R-square, Adjusted R-square, Std. Error of the Estimate and Durbin Watson.

In regards to the importance of the regression; the R: is the Pearson's correlation coefficient (r) which describes the strength and direction of linear relationship between two or more variables.

The R-value in below table is stated as 0.956^{a} shows that there is a strong and positive correlation among the dependent variable and the three independent variables used in the LIMPAC's model of the impact of Mining on Economic Growth, R-square (R^2) provides the coefficient determination (R-Squared) is used to measure the goodness of fit or the explanatory/dependent power of a model wherein, R^2 gives the proportion or percentage of the total variation in the dependent variable that is explained by the independent variables. Consequently, the result of the R-square (R^2) in the table 4.3 shows the value of 0.915 that is 91.5% of changes in the Impact of mining on Economic growth is explained by **Efficiency and Productivity, Strategies for optimizing growth, and Labor** while the (lesser part about) 8.5% is explained in the error which implies that the term of the model has a strong fit.

Moreover, the adjusted R-squared is the modified version of the R-squared that has been adjusted according to the number of independent variables in the model. The adjusted R-squared disciplines the R^2 for the addition of variables which do not contribute to the explanatory power of the model. The model convoys adjusted R-squared value of 0.914 which indicates about 91.4% changes in Imp_M (Impact of Mining sector), the is explained by E_PM (Efficiency and Productivities in the mining sector), L_E (Labor efficiency), and S_ECO (Strategies Of

optimizing economic Growth) equally, while the (less significant position about) 8.6% is explained in the error term of the model of Mining-economic Growth also has a strong fit.

The Durbin-Watson test tests the null hypothesis that linear regression residuals of time series data are uncorrelated, against the alternative hypothesis that autocorrelation exists.

Finally, the Durbin Watson (DW) statistics measures the evidence of autocorrelation in the residuals. The acceptance of the DW null hypothesis range of uncorrelated is between 1.45 and 2.44. Thus, the fitted regression line showed that there no evidence of autocorrelation judging from DW statistics value of 1.176, therefore, we failed to reject the null hypothesis that which states that linear regression residuals of the time series data are uncorrelated.

OLS Model

Table 2: Model Summary

Model	R	R Square	Adjusted R Square	Change Statistics				Durbin Watson
				F Change	df1	df2	Sig. F Change	
1	.956[a]	.915	.914	1053.032	3	294	.000	1.176
a. Predictors: (Constant), E_PM, L_E, S_ECO								
b. Dependent Variable: IMP_M								

Source: LIMPAC's Computation

Table 2 reveals the ANOVA table, the ANOVA (or F-statistic) evaluate the overall significance of the model, entails of calculations that provide information about levels of variability within a regression model and to form the basis test of significance.

The ANOVA table objective is to determine whether the results are significant and are not generated due to the statistical errors. The significance value, which must be less than 0.05, determines this level of significance. As per the results captured by the ANOVA (F-statistic)

value of 2368.118 and its associated probability value of 0.000 (F=1053.032, $p < .05$), the significance value is computed as 0.000, which is below 0.05; therefore, the result reveals that the regression model is significant and is not generated based on statistical errors.

Table 3: ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	204.199	3	68.066	1053.032	.000[b]
	Residual	19.004	294	.065		
	Total	223.202	297			
a. Dependent Variable: IMP_M						
b. Predictors: (Constant), E_PM, L_E, S_ECO						

Source: LIMPAC's Computation

Coefficient table for Impact of Mining on Optimizing Economic Growth in Liberia

The table below demonstrates coefficients of the regression coefficients column labeled "Unstandardized Coefficient" define the estimated coefficients (β). The coefficient estimates (β) shows the sign and size or magnitude of change on the dependent variable while the standardized Coefficient column is highly consider in the presentence of the Unstandardized Coefficient. The Standardized coefficient measures the statistical consistency of the coefficient and the directions of the independent variables on the dependent variable in the parameter estimates. The coefficients output in the table below with statistical figures describing how mining sector forecast the Impact on optimizing economic growth performance in Liberia.

In an art of providing clear interpretation of the empirical findings table below, the researcher concerned with the standardized output of Beta Coefficient of L_E (Labor efficiency) on mining sector has a standardized Beta coefficient of -0.04 and with an associated p-value of 0.035

suggesting that the p-value< 0.001 and statistical significant at 5% level. This suggest that for every one-unit increase in the Labor efficiency leads to 4.2% decreased on the impact mining on optimizing economic growth in Liberia.

This displays a negative relationship among the two variables, also suggests that Labor Efficiency has a significant impact on Economic growth such as reduction in income generation, incentive received by workers, investment in the sector. The negative relationship is highly driven by informal mining activities practiced and local tools usage is high in the sector, thus, causing the impact of labor to be disadvantageous to optimizing economic growth which in returns undermines economic growth in Liberian.

According to the variable, Strategies for optimizing economic growth constituted a coefficient of 0.894 with an associated p-value of 0.00 (given that the p-value <0.05). This coefficient shows that with every one unit increase of one standard deviation in Strategies for optimizing economic growth and income of Liberia's mineral reserves will leads to an increase in sustainable economic growth by 89.4% and statistically significant at 1% level of significance.

The output of the variable Strategies for optimizing economic growth has a high positive impact on economic growth, through developing new strategies in generating revenue through a more improved revenue sharing agreement by creating a commercial structure of sector to positively contribute to economic growth and improve the revenue generation from the sector.

The formulation of a more robust strategies for growth and not following the same trends for growth without development in Liberia that were observed for years in the history of Liberia but the sector are highly encouraged to establish strategies that will be forward looking by creating National Investment vehicle (says, National Mining Company of Liberia) that would be

responsible to enter into investment agreements or purchasing of shares that require a 21st century mining technology. This strategy will hugely promote economic growth in two key ways, through a new stream of revenue line creation called the revenue sharing from mining and increase in the income tax revenue charged to employees in the sector.

Additionally, the establishments of Liberians own cooperatives in the mining sector for the sole purpose of sourcing resources, such as equipment, financial and human resources will help the boost the revenue generation in the sector, promote both infrastructures development and increase savings and improve legal mining activities in the Country.

Furthermore, efficiency and productivities on local miners has a standardized Beta coefficient of 0.194 and with an associated a p-value of 0.007 suggesting that the p-value< 0.001 and significant at 1% level. Suggest that for every one-unit increase in the support to Efficiency and productivity leads to 19.4% increase in gold productivity in Liberia due to use of local tools for mining operations by Liberians.

This result shows that, support to the mining sector has a positive impact on the efficiency and productivity in the sector, it indicates that the mining sector is marked with potential investment by introducing the usage of modern equipment to the local miners through a cooperative structure instead of the usage of local tools for mining operation thus leading to low productivity and productivity will eventually increase if the support to the sector actives are highly encouraged and creating National Investment vehicle (says, National Mining Company of Liberia) that will be responsible to enter into investments agreements or purchasing of shares that require a 21st century mining technology.

Table 4: Coefficient

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		β	Std. error	Beta		
1	(Constant)	.587	.040		14.628	.000
	L_E	-.018	.009	-.042	-2.114	.035
	S_ECO	.891	.034	.894	26.404	.000
	E_PM	.054	.020	.194	2.715	.007
a. Dependent Variable: IMP_M (Impact of Mining)						

Source: LIMPAC's Computation

Chapter Five

Conclusion

This study has examined the impact of the mining sector on the Liberian economy, focusing on its effects, including optimization strategies and labor productivity and efficiency, on economic growth. The study has highlighted key findings and insights regarding the contributions of mining to the Liberian economy, the challenges and opportunities associated with the sector, and the implications for sustainable development.

By testing the impact of gold mining on economic growth in Liberia, this study established that optimized strategies have a positive impact on the economic growth of Liberia, with strong correlation between labor efficiency and productivity, strategies for optimizing economic growth, and economic growth. However, the strength of the effect of labor efficiency is moderated somewhat due to its negative relationship on economic growth. This suggests that, while informality of the mining sector does impact economic growth, the local economies are empowered from the income generated by artisanal mining. For labor efficiency in the mining sector to positively impact economic growth in Liberia, there is a need to formalize the sector, improve regulatory frameworks, enhance access to finance, and promote sustainable practices.

Recommendations

Reform Concessions
Review and renegotiate existing agreements to ensure fair fiscal terms, eliminating loopholes that lead to revenue losses from bad deals. Mandate transparent bidding, community development requirements, and streamlined permitting aligned with international standards like EITI. Include clauses for economic diversification, such as local processing hubs, to boost GDP multipliers beyond raw exports

Strengthen Oversight
Establish a Mining Sector Working Group for cross-cutting policy guidance, environmental monitoring, and compliance enforcement. Deploy resources like motorbikes, GPS, diamond testing machines, and digital licensing to enable regular inspections and reduce illegal operations. Amend the 2000 Minerals and Mining Law to resolve conflicts with environmental and procurement acts, incorporating anti-corruption measures and dispute resolution.

Implement pit-to-port tracking systems for accurate revenue reporting and suspicious transaction filings to combat illicit flows. Build capacity in the Ministry of Mines with trained staff, vehicles, and electronic systems for real-time data on production and exports. Foster community participation via development agreements and local content policies prioritizing Liberian employment and procurement.

Require environmental impact assessments, biodiversity offsets, and waste management in all operations to mitigate river damage and deforestation seen in gold mining areas. Integrate renewable energy and infrastructure like grid expansions to support mining while benefiting communities.

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