The Impact of Mineral Production on Zimbabwe Economic Growth and Development.

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Abstract:
The study sought to assess the impact of mineral production on Zimbabwe economic growth and development. The Zimbabwean government has put mineral production and exportation as an important key to fight against poverty, create more wealth increasing employment and productivity in the mining industries/Sector. The mining sector requires a large amount of capital to attain the required 90% production capacity to effectively increase mineral output. However, the mining sector has been experiencing the production constraints owing to the liquidity challenges affecting the economy, lack of credit lines, lack of confidence in the banking sector which affects savings, high rate of corruption and misallocation of resources in the mining sector.

The study used Ordinal least square method (OLS) to come up with the regression model and results. The Cobb Douglas model was also used to come with a specified model. The results from the study show that only mineral exports contribute meaningfully to mineral output growth, the other variables in the model are insignificant.

The main conclusion was that the mining sector relies on retrained earnings from exports for investment. The research recommended that government creates a conductive environment for investment and an exporting framework so as to increase the growth potential of the mining sector. Creating value addition and beneficiation method policy to the mineral products and creating confidence in the banking sector to increase savings. A stable macroeconomic environment is critical for the mining sector to achieve its targets. Reduce or eliminate corruption, invest in exploration, research and development of new mine and focus on linkages.

Key words: Mineral production, Mining sector, Economic growth and development, Zimbabwe.

Introduction
Mineral production has been viewed as the major driver of the economy since the advent of dollarization in Zimbabwe. However, the total impact of investment on mineral output has been debated at various level on whether it accounts for most of the recorded growth.

The research is to focus on the impact of mineral production on Zimbabwe economic growth and development for the period 1980 to 2015. Approximately 60% of Zimbabwe’s land surface comprises of ancient rocks renowned worldwide for containing rich varieties of mineral resources. The country’s diversified mineral resource base is dominated by two prominent geological features namely the Great Dyke and the ancient Greenstone Belts. The major known minerals include gold, coal, PGMs, and diamonds, more than 40 different minerals plus 800 operating mines, ranging from artisanal, and small scale mines. World bank projects the value of minerals to increase from about $2.1 Billion in 2012 to an average of around $8 Billion by 2018. The mining sector is constituting: 15% of nominal GDP, 58% of the nation’s total exports, 13% of fiscal revenue, more than 50% of foreign direct investment ZIMSTAT and COMZ (2014). These making the mining the cornerstone of economic growth and development. Zimbabwe’s diverse mineral output included about 9% of the World’s diamond (by volume), an estimated 7% of the world’s platinum production, and about 5% of the world’s palladium output IMF and Kimberley process certification scheme (2014) and Zimbabwe National Statistics Agency (2014). The United States had imposed economic sanctions on certain entities and individuals in Zimbabwe in 2003 (which were updated in 2005 and 2008) owning to human rights abuses, political violence, and the undermining of democratic institutions or processes in Zimbabwe Mobbs (2013). The provision of funds, goods, or services was prohibited to several state-owned entities, such as industrial Development corporation of Zimbabwe Ltd, MMCZ, Zimbabwe iron and steel company (private) Ltd, Zimbabwe Mining Development Corp. (ZMDC), and their Subsidiaries, Including Marange Resources (Private) Ltd, Mbada Diamonds (Private) Ltd, and Sino-Zim Development (Private) Ltd. Mobbs (2013).
According to Mobbs (2013) the production of coal, cobalt, copper, graphite, nickel, and PGMs, and estimated production of limestone and sulfuric acid increased notably in 2013 compared with that of 2012. Production volumes of Chromite, diamond, and phosphate rock and the estimated production volume of coke decreased significantly in 2013 compared with those of 2012. It is against this background that this study seeks to examine the impact of mineral production on Zimbabwe economic growth and development.

**Research Objective**
The main purpose of this study was to assess the impact of mineral production on Zimbabwe economic growth and development.

**Theoretical Literature**

**Harrod Domar Growth Model**
The Harrod Domar model is used in development economics to explain an economy’s growth rate in terms of the level of savings and productivity of capital. It suggests that there is no natural reason for an economy to have balanced growth. The model was developed independently by Sir Roy F. Harrod in 1939 and Evsey Domar in 1946. The Harrod-Domar model was the precursor to the exogenous growth model.

According to the Harrod Domar model there are three kinds of growth viz. warranted growth, actual growth and natural rate of growth.

*Warranted growth rate* is the rate of growth at which the economy does not expand indefinitely or go into recession.

According to Gujarati (2005), the Harrod Domar growth model follows the Keynesian framework that highlights the factors that are responsible for growth. According to the model, mineral output is based upon government influencing economic variables to create mineral output. the model specifies that capital stock (K), investment (I) and the marginal propensity to save (MPS) are significant in in the model.

The Harrod and Domar identifies the financing gap $M-X$ and the savings gap $S-I$ that hinder mineral output. It also states that it was the government’s responsibility to find sources of finance to cover those gaps.

However, it does fully explain the counterparts approach that is a phenomena in growth and overstates the effects of government intervention hence the continued use of Keynesian approach to growth.

**The Keynesian Growth Model**
The model attempts to reconcile the role of government in the economy presenting into aggregate demand function as $G$ so as to create mineral output. Keynes (1936) postulated that this will allow taxes (T) to be included in the model.

The model has both endogenous variable ( determined in the model) which are income (Y), consumption (C), tax (T), and disposable income (Yd) and exogenous variables ( not determined in the model) which are investment (I), government expenditure (G), autonomous consumption ($\alpha$), the marginal propensity to consume ($\beta$) and aggregate demand (AD).

The model specification it given below

$Y = C + I + G + (X - M)$

Consumption can be decomposed to

$C = \alpha + \beta Y$

According to Gujarati (2005), the Keynesian growth model is linear and cannot deal with data which relates to output which is none linear. Non linear are best dealt with by using log-linear models such as the Cobb-Douglas model.

**Cobb-Douglas Model**

Cobb-Douglas (1947) was developed from the neo-classical model $Q = f(K, L)$ a model that introduced the technological changes. The Cobb-Douglas model assumes that capital stock (K) and labour (L) are a fixed fraction of output

The model specification is given below

$Q = \lambda L^{\alpha}K^{\beta}$

Where $\lambda$ is the total factor productivity

L= percentage changes in labour force
K= percentage changes in Gross Fixed Capital Formation
Q= quantity
α and β are the output elasticity of labour and capital respectively. These values are constants determined by available technology.

According to Gujarati (2005), the model is used non-linear functions and its use of logarithms helps in smoothening data distribution and reduces the chances of encountering heteroskedasticity. The study adopted the Cobb-Douglas model as it best dealt with the secondary data for this study which was non-linear. It enables the provision of logarithmic data to obtain the best results of regression model according to Gujarati (2005), log-linear models ena critical in analysis of data by various researchers on the impact of investment on mineral output by identifying the total impact of variables with the aid of economic models.

Evidence from past studies
Mineral output growth and government expenditure
According to a study by the Australian Bureau of Resource and Energy Economics (BREE) (2012) it was determined that government expenditure has a significant impact on growth in the mining sector of Australia. It determined that the government expenditure variable explains 18% of the growth in the mining sector of Australia. According to the study, demand for minerals is also driven by government expenditure in infrastructure and skills development giving the industry a platform to increase output. Burrell (2011) studied the effects of government expenditure in the natural resources sector of Brazil and Australia. His study found out that over the period 1985 to 2010 the government expenditure variable determined mineral output by 12 percentage points and 16 percentage points in Brazil and Australia respectively. The study determined the base capital needed to kickstart operations in both countries came from the government in the form of tenders for exploration and prospecting. However, a study by Drysdale (2012) on the effects of economic interventions in the Australian mining sector between 1980 to 2008 showed that government expenditure was ambiguous and in the models estimated in the iron ore, gold and natural gas industries it was only responsible for only 1.5% of the growth recorded. He opined that due to the demand for minerals from China and emerging economies has led to less government involvement and more private investment. He also questioned studies notably done by the BREE (2012) and Burrell (2011) that pointed to government expenditure having a significant impact on growth in Australia. It is clear that government expenditure has an impact on growth in the mining sector hence its inclusion in our analysis based on the studies assessed.

Mineral output and exports
According to Mills (2012), exports are critical in providing a source of earnings that will be used to as retained earnings. Esnouf (2012) pointed out that it is necessary to have a source that provides earnings to be used in recapitalizing a company, industry or an economy. Most mining concerns are notable exporters and most of their earnings are derived from this source (BREE, 2012). A study by Mills (2012) on the effects of trade on growth patterns in international mining operations between 1980 to 2010 provided an analysis on the effects of exports on growth in the mining sector. According to the study which was conducted in nine countries notably Australia, South Africa, Zambia and Brazil determined that exports account for 16% of growth in the international sector. The study concluded that the nature of mining and availability of mineral resources have made it possible for comparative advantage to take root in making most countries net exporters of minerals. The BREE (2012) study on the determinants of growth in the resource and energy sector (1987 – 2013) provided an insight into the role of exports in causing mineral output. It found out that the exports variable determined 7% of growth in the sector. It concluded that the effect is lower than expected because of the volatility of commodity prices that affect the level of profits. In this regard it is highly difficult to retain earnings needed to be used for reinvestment.
Another study by Esnouf (2012) on the effects of trade in the Australian mining sector (1985-2010) determined that exports contribute 12% to the recorded increase in output. According to the study, the ability to trade has made it possible for the acquisition of skills and technology so as to increase output. These studies have shown that there is positive relationship between exports and growth in the mining sector but the significance varies between studies.

**Mineral output growth and investment**
Investment is critical in ensuring that there is the requisite capital to finance operations in the mining sector. Esnouf, (2012). It is the capital stock (K) required to initiate production and increase total factor productivity. Buckley (2007) carried out a study on the impact of investment and capital stock in the international mining sector (1985-2010). His study was carried out in South Africa, Papua New Guinea, Indonesia, Australia and Brazil. He found out that investment has a positive relationship with growth in the mining sector. It accounted for 40%, 34%, 33%, 26% and 30% of growth in the mining sectors of South Africa, Papua New Guinea, Indonesia, Australia and Brazil. This shows that investment has a significant impact on mineral output.

A study by Siddique (2011) also carried out a study on the determinants of growth in the Australian iron ore mining sector. He found out that investment had the highest significance in causing growth in the sector. According to his study, investment contributed 30% to the growth in iron ore production. Another study by Drysdale (2012) on the effects of interventions in the Australian mining sector (1980-2008), also established a positive relationship between investment and mineral output. In his study, investment contributed 24% in the growth of output in the sector.

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An investigation by the Australian Bureau of Statistics (ABS, 2012), found out that during the period from 1985 to 2012 investment had the highest contribution of 31% to output growth. It intimated that this was due to the high demand of minerals by emerging economies who were now investing in new mining projects that increased output.

It is quite clear that there is a positive relationship between investment and growth in the mining sector. However, its contribution may vary according to the studies used to assess its impact.

**Mineral output growth and labour force**
Labour is critical in converting capital into output hence impacting on growth. Nicholson, (2007). The skills have been viewed by Esnouf (2012) as important to achieve the profit making for any mining firm.

Esnouf (2012) concluded in his study on the effects of trade in the Australian mining sector (1985-2010) that labour contributed 5% of the total output growth of exports. Burrell (2011) in his study on the skills retention to capital ratio, concluded that labour productivity was responsible for 10% of growth in the mining sector of Australia.

The study however, concluded that labour only contributed positively to output growth if the prices of commodities were high. If the commodity prices fell it was found out that labour productivity decreased rapidly leading to retrenchments or in some cases mine closures.

The studies, taken into account by the researcher show conflicting conclusions to the contribution of labour in increasing output.

**METHODOLOGY**

**Theoretical model**
According to Lau (1978), several macroeconomic models have generally concentrated on estimating the impact of aggregate output or employment on mineral output in developing countries. Most studies have shown that
macro economic variables such as employment and aggregate output have a significant impact on mineral output. Behrman (1990) postulated that it is important to have a transmission mechanism, which is the distribution of income and relative prices for investment to have the desired effect on mineral output.

**Model specification**

The basic methodological approach and model is adapted from Cobb and Douglas (1947). Studies have specified the model as a transcendental logarithmic model (translog) since it is difficult to regress a Cobb-Douglas function.

\[ MO = f(L, K) \]  
\[ MO = \lambda L^\alpha K^\beta \]  

Where \( \lambda \) is the total factor productivity  
\( L \) = percentage changes in labour force  
\( K \) = percentage changes in Gross Fixed Capital Formation  
\( MO \) = Mineral Output

\( \alpha \) and \( \beta \) are the output elasticity of labour and capital respectively. These values are constants determined by available technology.

\( \lambda \) the total factor productivity is defined as the total productivity of labour plus the total productivity of capital is denoted as follows

\[ \lambda = L^\alpha K^\beta \]  

Government expenditure (G) and exports (X) affect mineral output through capital

\[ K = f(G, X) \]  

Substituting equation 4 into 3, the total factor productivity will be

\[ \lambda = f(G, X, A^1) \]  

\( A^1 \) represents factors that affect total factor productivity that are not \( G, X \) and \( M \)

Thus the substitution of equation 5 into equation 1 yields

\[ MO = f(G, X, A^1, L, K) \]  

By introducing parameter coefficients to be estimated in the equation yields and can be best portrayed in the form of changes in the variables

\[ \Delta MO = A^1, \Delta G^\theta, \Delta X^\epsilon, \Delta K^\alpha, \Delta L^\beta + \mu \]  

The linear form of equation 7

\[ \Delta MO = A^1 + \theta \Delta GE + \epsilon \Delta GX + \alpha \Delta K + \beta \Delta L + \mu \]  

\( \Delta MO \) is the natural logarithm of mineral output  
\( A^1 \) is the constant term  
\( \Delta GE \) is the natural logarithm of government expenditure  
\( \Delta GX \) is the natural logarithm of exports  
\( \Delta K \) is the natural logarithm of Gross Fixed Capital Formation  
\( \Delta L \) is the natural logarithm of the labour force  
\( \mu \) is the error term  
\( \theta, \epsilon, \alpha \) and \( \beta \) are elasticities of the variables \( G, X, K \) and \( L \)

**JUSTIFICATION OF VARIABLES**

**Mineral output**

Mineral output growth is used as a proxy for mineral output. According to Esnouf (2012), mineral output is the complete measurement of economic performance of an economy over a specified period of time. He went on to term mineral output as the absolute measurement of the well being of an economy. In this study mineral output is measured as a percentage change in GDP. The rise of output in the mining sector will lead to higher revenues accruing to the sector thus making it an investable economic sector.

**Government expenditure**

Keynes (1936) intimated that government expenditure can increase mineral output due to its impact on aggregate demand and altering of the aggregate supply. This is due to the fact that any government intervention
in the economy leads to a reaction of economic agents adjusting to the spending habits of government. The percentage change in government expenditure is used to exhibit its effect on mineral output

**Exports**
According to Drysdale (2012), exports are critical in providing a source of earnings that will be used to as retained earnings. These will be used to re-invest in the sector so as to increase output hence growth in the sector. The percentage change in exports is used to exhibit their effect on mineral output

**Gross fixed capital formation**
Investment is one of the key to achieving mineral output as it is a major determinant of mineral output growth as it enables the usage of economic agents to increase output Badawi, (2009). It enables long term prospects of the economy to be set so as to achieve increased output. According to the Chamber of Mines (2010), a fixed capital base less depreciation is used and investment flows annually are added to the base. This approach is used as a proxy for gross fixed capital formation. This variable is used to analyse its impact on mineral output in the mining sector. In this regard, investment is postulated to be positively related to mineral output growth. The percentage change in gross fixed capital formation is used to exhibit its effect on mineral output growth.

**Labour force**
According to Mills (2012), labour is one of the major determinants of mineral output since a highly productive workforce is more than likely to increase output. In this regard, labour is postulated to be positively related to mineral output. The percentage change in labour force participation is used to exhibit its effect on mineral output.

**Estimation method**
The study will use the Ordinary Least Squares (OLS) estimation technique. Most studies on mineral output have utilized it due to its ease of use. The Cobb-Douglas model has been selected because of its appropriateness in non-linear regression. Gujarati (2005) intimated that most studies analyzing production trends. Diagnostic tools have been used to check for the adequacy of the model estimated to make it useful for forecasting.

**Diagnostic checking**
It is critical to use diagnostic tests so as to ascertain the adequacy of the model to be evaluated before it can be used for forecasting purposes. The diagnostic tests include

1. Unit Root Test (Augmented Dickey Fuller)
2. Autocorrelation
3. Multicollinearity

**Unit root tests**
In order to avoid the problem of spurious regression when non-stationary series are estimated in their levels in stochastic models a unit root test is conducted Badawi (2003). It is used to determine the time series properties of all variables. The Augmented Dickey Fuller tests that take into account the possibility of structural breaks in the time series are used to analyse the time series properties of these series. The study is going to utilize the Augmented Dickey Fuller test so as to test the integration of variables.

**Autocorrelation**
Autocorrelation refers to the correlation of a series with its own past and future values. It complicates the application of statistical tests by reducing the number of independent observations and the identification of significant covariance between time series. However, it can be exploited for predictions thus an autocorrelated time series is predictable and probabilistic because future values depend on current and past values. The Durbin Watson statistic will be utilized to test for autocorrelation. According to Gujarati (2005), the statistic fills the important role as a general test of model misspecification. It is designed to detect errors that follow a first order autoregressive process.

**Multicollinearity**
It is the presence of a linear relationship among the explanatory variables. According to Gujarati and Porter (2009), the stochastic nature of most regressors correlation and inter-relationships are bound to exist among them making multicollinearity inherent in most explanatory variables. The study will utilize the covariance statistic to test for this.
The research is going to utilize the “F value” and “Prob(F)” which tests the overall significance of the regression model. The F value is the ratio of the mean regression sum of squares divided by the mean sum of squares Gujarati (2005). Its value will range from zero to an arbitrarily large number. It specifically tests the null hypothesis that all of the regression co-efficient are equal to zero by comparing the full model against a model with no variables and with the estimate of the dependent variable being the mean of the values of the dependent variable.

The Prob(F) value is the probability that the null hypothesis for the model is true. Using an example of a Prob(F) value of 0.0100 then there is 1 chance in 100 that all of the parameters are zero, thus the exceptionally low value will imply that at least some of the parameters are non zero and in that regard the regression equation does has some validity in fitting the data.

**Data sources and problems**

The study uses annual time series data covering the period from 2007 to 2015. The mining output data is secondary having being obtained from existing publications. The period chosen was adequate to enable an analysis of the impact of output on the growth prospects of the mining sector. Data was obtained from ZIMSTAT, Zimbabwe Investment Authority and The Ministry of Economic Planning and Investment Promotion (MoEPiP). Due to the inadequate monitoring of the economy validity of the data in terms of quality, consistency, accuracy and reliability may result in the reduction of precision of the parameters hence the use of diagnostic tools.

**Data population and sampling**

Once a population has been defined, according to Horn (2012) a sample frame of the population can be produced and usually necessary to research only a proportion of this population. In this present study the population is the mining sector and investment officials from the public and private sector in Zimbabwe. The research used random sampling as it commonly used as stated by Horn (2012) in inductive based methodology. A random sample of the formal mining sector was used to represent the whole mining sector. All members of the study population were given an equal chance of selection.

**RESULTS AND DISCUSSION**

**Descriptive Statistics for a Common Sample**

Before the estimation is carried out, interpretation and time series correction procedures looks at the measures on central tendency and the descriptive statistics. The summary of descriptive statistics using log transformed figures is shown overleaf.

### Table 1: Descriptive Statistics

<table>
<thead>
<tr>
<th></th>
<th>LnMO</th>
<th>LnGE</th>
<th>LnX</th>
<th>LnK</th>
<th>LnL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4.00</td>
<td>7.450</td>
<td>3.784</td>
<td>7.486</td>
<td>2.724</td>
</tr>
<tr>
<td>Median</td>
<td>4.034</td>
<td>7.505</td>
<td>3.861</td>
<td>7.593</td>
<td>2.810</td>
</tr>
<tr>
<td>Maximum</td>
<td>4.399</td>
<td>7.806</td>
<td>4.172</td>
<td>8.219</td>
<td>2.991</td>
</tr>
<tr>
<td>Minimum</td>
<td>3.032</td>
<td>6.832</td>
<td>2.250</td>
<td>6.602</td>
<td>1.991</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.283</td>
<td>0.235</td>
<td>0.372</td>
<td>0.368</td>
<td>0.250</td>
</tr>
<tr>
<td>Skewness</td>
<td>-1.437</td>
<td>-0.962</td>
<td>-2.758</td>
<td>-0.750</td>
<td>-1.62</td>
</tr>
<tr>
<td>Jarque-Bera</td>
<td>1.831</td>
<td>4.259</td>
<td>1.84</td>
<td>3.255</td>
<td>1.1349</td>
</tr>
<tr>
<td>Probability</td>
<td>0.0250</td>
<td>0.118</td>
<td>0.01</td>
<td>0.196</td>
<td>0.01</td>
</tr>
<tr>
<td>Observations</td>
<td>26</td>
<td>26</td>
<td>26</td>
<td>26</td>
<td>26</td>
</tr>
</tbody>
</table>

Source: OLS Regression Results
Few variables showed that there are some outliers which are represented by the disparities of the minimum and maximum values. Four variables (LnMO, LnGE, LnX and LnK) are positively skewed but LnL is negatively skewed. The mean, median, standard deviations of the variables were shown. The Jarque Bera results and its probabilities show that all transformed data (dependent and independent variables) is normally distributed.

Correlation Matrix
Table 3 shows what is known as the correlation matrix. Referring to the table, entries on the main diagonal (those running from the upper left-hand corner to the lower right-hand corner) give the correlation of one variable with itself, which is always 1, and the entries off the main diagonal are the pair-wise correlations among the independent variables. Taking the first row of this table, this gives the correlation of LGE with the other explanatory variables. For example, 0.512 is the correlation between LGE and LX, 0.381 is the correlation between LGE and LK, and so on. The evidence of multicollinearity is low as shown in the Intercorrelations between explanatory variables as shown.

Table 2: Intercorrelations

<table>
<thead>
<tr>
<th></th>
<th>LnGE</th>
<th>LnX</th>
<th>LnK</th>
<th>LnL</th>
</tr>
</thead>
<tbody>
<tr>
<td>LnGE</td>
<td>1</td>
<td>0.512</td>
<td>-0.381</td>
<td>0.248</td>
</tr>
<tr>
<td>LnX</td>
<td>0.512</td>
<td>1</td>
<td>-0.317</td>
<td>0.516</td>
</tr>
<tr>
<td>LnK</td>
<td>-0.381</td>
<td>0.317</td>
<td>1</td>
<td>-0.493</td>
</tr>
<tr>
<td>LnL</td>
<td>0.248</td>
<td>0.516</td>
<td>-0.493</td>
<td>1</td>
</tr>
</tbody>
</table>

Diagnostic Tests
In order to test for stationarity, ADF (Augmented Dickey-Fuller) tau statistics and the critical values are compared. The hypotheses for the test are: \( H_0 = \) the series is non stationary. \( H_1 = \) the series is stationary. When the ADF statistic is greater than the critical values, we reject \( H_0 \) and conclude that the series is stationary. Otherwise, accept the null hypothesis. Stationarity tests are done to reduce impressive-seemingly regression results, which are wholly spurious (Mukherjee et al., 1998).

The ADF test shows that variables are non stationary at first difference level. This means that we cannot reject the hypothesis that the series is non-stationary. At first difference, LnGE, LnX and LK variables were stationary at 1% whilst LnMO and LnL are stationary at 5% level of significance. This means we reject the null hypothesis that the series is non-stationary.

Table 3: ADF unit root test in second difference I (1)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Lags</th>
<th>Stationarity Process</th>
<th>ADF Test Statistic</th>
<th>DECISION</th>
</tr>
</thead>
<tbody>
<tr>
<td>LnM</td>
<td>1</td>
<td>Intercept</td>
<td>-3.459***</td>
<td>-3.749</td>
</tr>
<tr>
<td>LnGE</td>
<td>1</td>
<td>Intercept</td>
<td>-4.430**</td>
<td>-3.749</td>
</tr>
<tr>
<td>LnX</td>
<td>1</td>
<td>Intercept</td>
<td>-4.058**</td>
<td>-3.749</td>
</tr>
<tr>
<td>LnK</td>
<td>1</td>
<td>Intercept</td>
<td>-4.992**</td>
<td>-3.749</td>
</tr>
<tr>
<td>LnL</td>
<td>1</td>
<td>Intercept</td>
<td>-3.476***</td>
<td>-3.749</td>
</tr>
</tbody>
</table>

** denotes 1% level of significance
***denotes 5% level of significance

Durbin Watson Statistic
Since the estimated regression (see appendix 2) has a DW statistic which is approximately equal to 2 but lies in the region of indecision where it is difficult to determine whether there is perfect positive or negative autocorrelation. We therefore use the rule of thumb that states that if the DW statistic is close to 2 we assume that there is no autocorrelation. The best way to solve this problem of autocorrelation is to model using the...
Cochraine-Orcutt method. However, this method is not going to be used because it is beyond the scope of the study.

Presentation of Results
The results of the OLS regression with LnMO being the dependant variable and LnGE, LnX, LnK, and, LnL being the exogenous variable are indicated in table 5 below.

Table 4: Results from OLS

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std error</th>
<th>T- statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.24</td>
<td>07.8102</td>
<td>-0.089</td>
<td>0.771</td>
</tr>
<tr>
<td>LnGE</td>
<td>0.136</td>
<td>0.009</td>
<td>2.939</td>
<td>0.113</td>
</tr>
<tr>
<td>LnX</td>
<td>0.655</td>
<td>0.049</td>
<td>23.79</td>
<td>0.001***</td>
</tr>
<tr>
<td>LnK</td>
<td>0.001</td>
<td>0.001</td>
<td>1.214</td>
<td>0.981</td>
</tr>
<tr>
<td>LnL</td>
<td>0.085</td>
<td>0.023</td>
<td>3.688</td>
<td>0.290</td>
</tr>
</tbody>
</table>

The study will determined the statistical significance of the parameters of the equation using the t-test and the F-statistic. ***denotes significance at 1% level.

R² = 0.933   Adjusted R² = 0.921   Durbin Watson statistic = 1.713

The linear model of an estimated

LnMO = 0.24 + 0.136LnGE + 0.655LnX + 0.001LnK + 0.085LnL + μ

Interpretation of Results

The emphasis here is that it is the geometric mean instead of the arithmetic mean. OLS regression of the original data is used to estimate the expected arithmetic mean and the OLS regression of the log transformed outcome variable is used to estimate the geometric mean of the original variable.

Net exports have a positive significant impact on output growth at 1% level of significance. This implies that holding all other variables constant, 1% increase in net exports would result in 0.65% increase in mineral output conforming to previous literature which suggests that net exports is growth enhancing (Esnouf, 2012) The variables that are not significant have no significant impact on mineral output. The variables include government expenditure, gross fixed capital formation and labour. Therefore we reject the null hypothesis that states that investment has a positive impact on mineral output. Therefore, the alternative hypothesis that states that investment has no impact on mineral output is true. This conforms to the study by Mills (2012)

Explanatory Power of the Model

Using the model above, R² value of 0.933 shows that the variation in the explanatory variable accounted for over 93% in the variation of the dependent variable-mineral output model. This means that the sample points along the regression line are not diverse. This shows that the model has a very high explanatory power. The model is reliable in estimating the economic performance in Zimbabwe. The adjusted R² of 0.921 of means that after taking into account the degrees of freedom associated with the variables, the model still explains the same amount of variations.

Spurious Tests

According to Granger and Newbold (1995), an R² > DW statistic is a good rule of thumb to suspect that the estimated regression is spurious. If the DW statistic is greater than R² then the regression will not be spurious. In this research study, the R² < DW (0.933<1.713) therefore the regression is not spurious.

The above results are attempted to show the effects of mineral output, government expenditure, mineral exports, gross capital formation and labour productivity on mineral output in Zimbabwe. The results have shown that net exports have a positive significant impact on mineral output. The Adjusted R² value of 0.92 shows that the variation in the explanatory variable accounted for 92% in the variation of the dependent variable-mineral output model. Therefore we reject the null hypothesis that investment has a positive impact on mineral output.
Conclusion and policy recommendation

The study has shown the effect of gross fixed capital formation, labour, government expenditure and net exports on mineral output in Zimbabwe using the Cobb-Douglas model. The results show that net exports have a positive significant impact on mineral output whilst gross fixed capital formation, government expenditure and labour are statistically insignificant. Gross fixed capital formation which has been used in this study to measure investment and other insignificant variables show that they do not affect mineral output. Therefore, we reject the null hypothesis that states that investment has a positive impact on mineral output.

Since the advent of independence the Zimbabwe mining sector has not recorded significant growth. Using 1980 as a base year the sector has only grown by 25% taking into account the years (1998-2009) of retarded growth brought about by the economic challenges facing Zimbabwe. This is in comparison to South Africa’s mining growth rate in the same comparable period of 68.4% brought about by high levels of investment and exports. Results obtained show that only exports have a positive significant impact on mineral output in Zimbabwe. This shows that the mining sector relies on retained earnings realized from net revenue from exports as an arbiter for investment when the required amount of it is low.

The low levels of investment might be attributed to the hyper-inflationary and economic instability period between 1998 and 2009 that resulted in investor apathy hence the mining sector had to rely on export revenue as a source of investment.

The mining sector being highly capital intensive requires large amounts of investment to generate significant production output. However, the lead time between initial investment and initial mineral production is 13.5 years in Zimbabwe. In this regard, the lead time to the actualisation of an increase in output levels cannot be realised in the short term. Comparable lead times of Australia, Brazil and South Africa are 4.5, 7 and 8.9 years respectively. Mining requires investment that is approximately equal to its contribution to the Gross Domestic Product (GDP) annually. The mining sector contributed 27% to GDP amounting to approximately US$2.5 Billion. The highest figure of total investment into the mining sector was recorded in 2010 amounting to US$165 million. This proves that the investment levels in the mining sector are insufficient to trigger growth and secure an increase in output.

Since the mining sector of Zimbabwe relies on exports for revenue generation, the retained earnings are used for investment purposes in the interim. This explains why export variable is significant in the regression model. The latitude presented by an export driven output expansion is small compared to that of investment driven expansion because it depends on the price of exports, profit margins and type of mineral exported. The price of exports are volatile hence the export revenue fluctuates in times of boom and lows. Profit margins are notoriously low in some minerals especially those for industrial use such as cooper, chrome and iron and large for precious metals such as gold and diamonds. Some minerals may be exported in large quantities yet generate low export revenue, this is true of industrial minerals. However, precious minerals generate high export revenue from relatively small quantities.

This explains the relatively low output growth rates of industrial mineral output and high growth rates in precious mineral output. Firms involved in industrial mineral production cannot increase output because their retained earnings are low hence low investment funds. The reverse is true for precious mineral firms.

However, the mining sector is dominated by industrial minerals hence there is a low growth potential due to the reasons mentioned above thus giving validity to the results of regression model.

This study found a positive significant impact of exports and mineral output and rejected the null hypothesis that investment has a positive impact on mineral output. This positive relationship between exports and mineral output has been brought about by the low savings rate in Zimbabwe that has reduced domestic investment,
investor apathy due to the prevailing unstable macroeconomic environment, the non availability of foreign lines of credit and sanctions imposed on the country.

The study recommended that government should institute measures that create a conducive investment environment so as to close capital deficiency gap. This is critical because of the importance of investment in capital projects. The government need to invest in exploration and new mining development. Government should focus on value addition and beneficiation. Government should create linkages with other sectors especially the manufacturing sectors.

Instead of increasing corporate tax, mining rents and royalties on mineral revenue, the government should institute a favourable tax regime that takes into account the structure of the mining sector which according to the study relies on retained earnings (working capital) for growth

Macroeconomic stability is critical in achieving a conducive operating environment that allows optimum returns. Government should provide good condition for foreign direct investment, and ensures stable macroeconomic for proper planning and attract investors.

It is recommended that government engages with labour, the investment community and mining houses so as to come up with policies that tackle the deficiency identified in the study the current structure of the mining sector where only exports contribute to output growth is unsustainable since exports are subject to internationally arbitrated prices hence a fall in prices will lead to a decrease in revenue, retained earnings and consequently working capital.

It is also recommended that the mining sector establish a mining fund that is contributed to by the mining firms in the form of a percentage of surplus from export revenue, especially in the times of price booms. This fund will be used for investment purposes in the mining sector such as in capital projects, output expansion projects and exploration projects.

In order to get access to lines of credit it is critical that government maintains or improves relations with the international community. This will provide the mining sector with the required capital investment for future expansion projects. Government should also reduce or eliminate the corruption that is killing the mining sector.

Zimbabwe is endowed with abundant mineral resources, indeed mining can become the cornerstone of an economic turnaround and lead to economic growth and sustainable development in Zimbabwe.

REFERENCES


