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Economic Appraisal of Zambia's Mineral Taxation Regimes

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Abstract

There has been a lot of outcry from the public that Zambia's mineral tax reforms with an aim to optimize revenue benefits from the mines have not yielded the desired results. This has mainly been attributed to the weak design of its legislated mineral fiscal systems. Due to this underlying reason, this research aims at undertaking an economic appraisal of Zambia's mineral taxation regimes with an objective of assessing their robustness so as to ultimately determine that which is sturdiest in design. This research brings forward a well compiled methodology of evaluating mineral fiscal regimes. It also possess the potential of acting as a future reference of optimizing Zambia's mineral taxation where the most robust tax structure can act as a starting point in the optimization process. The appraisal used Lumwana Mine as case study and encapsulated five evaluation criterions. These include neutrality, progressivity, revenue raising potential, government risk and investor perception of risk. These measures have been selected as a criteria for evaluation because they best capture and explain the revenue generating objective of a taxation regime. The economic appraisal framework employs spreadsheet modeling techniques and was anchored on two state of affairs which include the status quo and worst case scenario. Overall results indicate that Zambia's mineral taxation systems except the 2008 regime are relatively robust in capturing mining revenue. It can be concluded that it is not a single tax that affects a mineral fiscal regime but the lump sum of all taxes and how they harmonize with each other. The study recommends that the government should review and optimize the current mineral taxation system as it is the most robust in design. Additionally, the government must increase the institutional capacity of Zambia Revenue Authority (ZRA).

Keywords: Economic Appraisal; Zambia; Lumwana Mine; Mineral Taxation; Robustness.

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1. Introduction

Zambia has a high level of macroeconomic dependence on mining. This makes it prone to financial risk emanating from the stochastic behavior of copper prices on the international market. The mining sector in Zambia is the mainstay of the economy and accounts for over 11% of Gross Domestic Product (GDP), 80% of foreign exchange earnings and over 60,000 direct jobs. Despite these positive externalities the public still claims that mining benefits have not trickled down to the common citizen. This has incited the public to mount pressure on the Zambian Government claiming that the country is not extracting the maximum revenue benefits from the mines. This has been attributed to the weak design of its legislated mineral fiscal regimes [1]. Due to this underlying reason, the research paper aims at undertaking an economic appraisal of Zambia's mineral taxation regimes with an objective of assessing their robustness so as to ultimately determine that which is sturdiest in design. The appraisal used Lumwana Mine as case study and was based on five criterions which include neutrality, government risk, investor perception of risk, revenue raising potential and progressivity.

Zambia has undergone a transition of six mineral tax reforms since the privatization of its mines in 1997 and 2000. These include (Amended from Manley [2]):

- **The Development Agreements (DA):** These were agreements signed with individual mines at privatization (i.e. 1997 to 2000);
- **The 2008 tax regime:** Tax regime used from April 2008 to March 2009;
- **The 2009 tax regime:** Tax regime used from April 2009 to March 2012;
- **The 2012 tax regime:** Tax regime used from April 2012 to December 2014;
- **The 2015 tax regime:** Tax regime used from January 2015 to June 2015; and
- **The Post-2015 tax regime:** Tax regime used since July 2015 till date.

The key features of Zambia's mining taxation regimes have been depicted in Table 1.

1.1. Limitations of the Research

This research focuses on the evaluation of five mineral taxation regimes (i.e. 2008, 2009, 2012, 2015 and Post-2015 tax system). It does not undertake an evaluation of the DA tax system. This is because in the DA era different mines were provided with different mining fiscal regimes by the Zambian Government and the structure of these regimes have not been made available to the public for scrutiny due to confidentiality reasons. This means that the individualized Lumwana mining tax agreement signed at privatization with the government has not been disseminated to the public for evaluation purposes. Additionally, the research study encapsulates direct taxes only. This is because indirect taxes are difficult to analyze due to their multiple exemptions and rates provided to the mines by the Zambia Revenue Authority (ZRA). Lastly, this research solely focuses on the

copper mining sector.

Table 1: Key features of Zambia's mining fiscal regimes

Type of Tax		DA	2008	2009	2012	2015	POST-2015
Profit based tax							
Company income tax (% of profit base)							
Mineral processing and tolling (%)		35	35	35	35	30	35
Mining operations (%)		25	30	30	30	0	30
Variable Profit Tax (VPT) in effect?		No	Yes	Yes	Yes	Yes Industrial minerals	Yes
Profit tax base details							
Capital depreciation allowance		100	25	100	25	25	25
Loss carry forward (maximum years)		5-10	10	10	10	10	10
Allowed debt to equity ratio		2:1	3:1	2:1	2:1	3:1	3:1
Revenue tax types							
Mineral royalty [ad valorem] (%)	Underground Mining	0.6	3	3	6	8	6
	Open cast Mining	0.6	3	3	6	20	9
Windfall tax in effect?		No	Yes	No	No	No	No
Other tax types							
Customs duty		**Exempted in most cases**					
Export duty (on copper anodes)		No	**15% but with some waivers**				

1.2. Background Theory

Most of the literature on mineral tax evaluation revolves around six evaluation measures. These include neutrality, progressivity, revenue raising potential, risk, administrative efficiency and economic allocative efficiency.

a) Neutrality

Several authors including Baunsgaard [3], Nakhle [4], and Daniel et al. [5] have described a neutral tax as one that leaves the pre-tax ranking of a project equal to its post-tax ranking. If project X is more attractive than project Y before tax is legislated, it should remain so after tax is implemented [6]. Guj [7] describes neutrality of a tax in terms of economic allocative efficiency as one that promotes the reallocation of resources to their most optimal use for the continued production of goods and services. In the mining sector, a neutral tax is defined as that which does not change an investor's decision relating to production and development of projects. Taxes offer a tradeoff between neutrality and other standard measures of taxation. For example, a tax that is neutral on one hand may not necessary be administrative efficient on the other e.g. Corporate Income Tax (CIT).

b) Progressivity

A progressive tax regime can be defined as one that maximizes government take in a company's pre-tax cash flows at higher profitability and at the same time minimizes this take at lower profitability. Similarly, Mohammed [8] describes a tax regime that is progressive as one that increases government take when the rate of return is high and gives financial relief to investors when the rate of return is low. A tax regime that is adaptable to realized profits is deemed to be stable by the investor [5]. A fiscal regime that promotes stability is able to adjust both to high and low profits without adversely affecting a projects profit or pressuring governments to unilaterally alter the fiscal terms [9]. This means a progressive tax regime has a lower bearing on investor perception of risk. Notwithstanding these benefits, progressive tax regimes affect many factors including investment incentives and distribution of risk between mining companies and the Host State (HS) [10].

c) Revenue Raising Potential

A government can capture economic rent by taxing the mineral sector as much as possible but this must be consistent with the need to attract and retain investment. However, Daniel et al. [5] argues that it is difficult to tax economic rent satisfactorily because of the following reasons:

- Inaccurate estimation of the economic rent base;
- Possible presence of quasi-rents; and
- Continued demand for incentives by mining companies to fuel their operations.

Like any other tax evaluation measure, revenue raising potential affects other canons of taxation including neutrality, progressivity and investor perception of risk. Appiah [11] notes that there are few developing countries that can adopt tax reforms that offer great loss in revenue no matter how desirable they can be from other perspectives.

d) Risk

Risk is a source of worry both to the mineral investor and the HS. In order to instigate a win-win situation between the two parties the HS must design mineral policies that advocate for equal risk sharing. However, accomplishing this is no easy task.

Mineral prices are highly stochastic and as a consequence so is the revenue inflow to the mining project [7]. Low revenue inflow to the mining investor translates in high government risk.

Mining is a risky venture, due to this reason, mine owners are always in constant fear of project failure. Risks faced by mining owners include long payback period before initial investment is recouped, volatile mineral prices and difficulties encountered in envisaging political, economic and technical problems. Taking into consideration the intensity of capital injected into mining activities, it is only rational for mine owners to be risk averse. To the contrary, most governments are risk neutral. This is because of docile equity participation in mining activities. However, those dependent on just a few projects tend to be risk averse.

e) Administrative Efficiency

An administrative efficient tax regime signifies that which generates low compliance costs between the government and the tax payer. To attain this, host governments must implement mineral tax policies that are administratively clear. This means that tax policies should be simple and easily understood by the common tax payer. Complicated tax regimes usually result in low administrative efficiency, it is for this reason why most industrialized mineral economies advocate for the implementation of tax instruments that are based on simple formulations.

f) Economic Allocative Efficiency

An economically efficient tax regime is one that promotes redistribution of resources of the economy to their most productive use to produce the ever-changing mix of goods and services that the society requires and at the lowest possible unit cost [7]. In the mining context, an economic allocative efficient tax is one that does not distort an investor's decisions concerning exploration, development and exploitation of a mineral resource. In taxation, there is usually a tradeoff between administrative efficiency and economic allocative efficiency. This means that a tax that is economic allocative efficient might not be administrative efficient on the other hand. For instance, an ad valorem royalty has high administrative efficiency but a low degree of economic allocative efficiency. To the contrary, a profit based tax has a high degree of economic allocative efficiency but low administrative efficiency. Thus, a tax regime that employs both tax instruments possess a high probability of balancing the two measures than that based on a single tax component.

2. Materials and Methods

2.1. Software Application

Microsoft Excel was used to simulate different evaluation results. This was chosen as the most suitable software for application because it provides a cheap and easy platform for undertaking spreadsheet modeling on which this research was based.

2.2. Data Collection

For the purpose of this study, both primary and secondary data have been used. The primary data has been collected from government national speeches, electronic mail and government documents. The secondary data, on the other hand, has been collected from textbooks borrowed from public libraries and from journal and research articles collected from World Wide Web sites.

2.3. Lumwana Mine Profile

Lumwana Mine project owned by Barrick Gold Corporation was used as a case study in this research. This mine is situated in the North Western region of Zambia, 220 km west of the Copperbelt province and 65 km west of the town of Solwezi. The mine is a multi-pit, multi staged operation mining approximately 139 Mt of ore and waste per annum and producing copper concentrates containing an average of 140,000 tonnes of copper metal per year over a thirty-seven (37) year mine life. This makes Lumwana Mine the largest single open cut copper mine in Africa. The mining license covers 1,355 km² and includes two major copper deposits, Malundwe and Chimiwungo, as well as 25 exploration prospects. The license is valid for 25 years (from January 2004) and is renewable for a further 25 years. The construction of the mine started in late 2006, and was carried out by 4,700 workers. Injected construction cost amounted to approximately $760 million.

2.4. Framework of Economic Appraisal

This sub-section presents an in-depth review of the quantitative methodological set up used to undertake an economic appraisal of Zambia's mineral taxation regimes.

a) Test for Revenue Raising Potential

The revenue raising potential of each mineral fiscal regime was measured using single case time profile graphs of revenue based on the status quo and worst case scenario. Table 2 shows the price fluctuation percentages associated with these two scenarios. Under this criterion, the status quo scenario asserts the current status of forecasted copper prices whilst the worst case scenario asserts adverse price conditions.

Table 2: Price fluctuations for revenue raising test

Scenario	Status quo scenario	Worst case scenario
Price Fluctuation Percentages	0	-20

b) Test for Progressivity

Progressivity of Zambia's mineral taxation regimes was analyzed by comparing the governments take in the pre-tax cash flows of the mining company (i.e. Average Effective Tax Rate (AETR)) over a range of pre-tax Net Present Values (NPVs). The various AETRs and pre-tax NPVs were generated by exclusively fluctuating the yearly copper prices over the forecasted years. This evaluation criterion was examined using a scenario analysis. Two scenarios were adopted for examination. These include the status quo and worst case scenario. The status quo scenario under this indicator asserts a situation of the current status of risk. Conversely, the worst case scenario asserts a situation of high risk. The risk factor has been encapsulated in the discount rate (i.e. a high discount rate to mean high risk). The worst case discount rate has been obtained by adding 3 percentage points to the status quo discount rate. The added 3 percentage points represent increased risk. Table 3 depicts the discount rates associated with these two scenarios.

Table 3: Discount rates for progressivity test

	Discount rates	
	Status quo scenario (%)	Worst case scenario (%)
Government of Zambia (GRZ)	8	11
Lumwana Mine	15	18

c) Test for Neutrality

Neutrality was examined using three fundamental indicators; namely AETR, Marginal Effective Tax Rate (METR) and a comparability analysis of pre- to post tax Internal Rate of Return (IRR). These indicators were evaluated based on the status quo and worst case scenario.

i) Average Effective Tax Rate (AETR)

The AETR can be defined as a ratio of the NPV of tax payments at government's discount rate to the NPV of a company's pre-tax cash flows at the mining firm's discount rate. Equation 1 has been employed to calculate the AETR.

$$\text{AETR} = \frac{\text{NPV}_\text{G}}{\text{NPV}_\text{M}} \text{X } 100\% \qquad (1)$$

Where, NPV_G is the NPV of tax payments at government status quo discount rate ($); and NPV_M is the NPV of a company's pre-tax cash flows at a mining firm's status quo cost of capital ($). A tax regime which generates a high AETR asserts that which has a high degree of non-neutrality and vice versa.

ii) Marginal Effective Tax Rate (METR)

Daniel et al. [5] describes METR as unity less the ratio of post-tax IRR to pre-tax IRR. Equation 2 shows the calculation of METR.

$$\text{METR} = \left[1 - \frac{\text{Post-tax IRR}}{\text{Pre-tax IRR}}\right] \text{X } 100\% \qquad (2)$$

A taxation regime yielding a large value of METR asserts one which has a high degree of non-neutrality and vice versa.

iii) Comparability analysis of pre- to post-tax IRR

A comparability analysis of pre- to post-tax IRR was undertaken. A tax system yielding a small difference between pre- and post-tax IRR is termed to have a high degree of neutrality. Conversely, a tax regime yielding a large difference between these parameters has a high degree of non-neutrality.

These three indicators of neutrality were evaluated on the basis of the status quo and worst case scenario shown in Table 4. The worst case scenario asserts a situation of adverse price conditions whilst the status quo scenario reflects an unbiased (i.e. current status) forecast of copper prices.

Table 4: Price fluctuation percentages for neutrality test

Scenario	Status quo scenario	Worst case scenario
Price Fluctuation Percentages	0	-15

d) Test for Investor Perception of Risk

The investor perception of risk of Zambia's mineral taxation regimes was evaluated by analyzing the cumulative probability distribution of post-tax NPV of Lumwana Mine discounted at 15% and 18%. These discount rates represent the status quo and worst case scenario. Under this criterion, the status quo scenario signifies the current state of risk as reflected by the use of a low discount rate whilst the worst case scenario asserts a state of adverse risk as reflected by the use of a high discount rate. Different values of post-tax NPV were generated by undertaking a series of price fluctuations. Therefore, this criterion assumes price to be the only source of uncertainty or risk.

e) Test for Government Risk

The uncertainty of revenue inflow is a source of worry to mineral dependent economies. This has called for the

development of mineral fiscal tools to combat this risk. The Coefficient of Variation (CV) parameter has been used as a measure of risk in this research study. A taxation regime yielding the lowest value of CV of government revenue (i.e. NPV of tax revenue) reduces the host state's exposure to risk because it limits the dispersion of revenue inflow. Different NPV values were obtained by solely fluctuating the yearly forecasted real copper prices. Table 3 shows the government discount rates that have been employed in evaluating this criterion based on the status quo and worst case scenario. Under this criterion, the status quo scenario signifies the current state of risk as reflected by the use of a low discount rate whilst the worst case scenario asserts a state of adverse risk as reflected by the use of a high discount rate.

2.5. Justification of Evaluation Criteria

The evaluation process of this research has employed five criterions which include neutrality, progressivity, revenue raising potential, government risk and investor perception of risk. These measures have been selected as a criteria of evaluation because they best explain and encapsulate the revenue generating objective of a tax regime. However, it must be mentioned that other important evaluation measures exist including international competitiveness, administrative efficiency and susceptibility of taxation regimes to tax planning schemes. These measures require an in-depth analysis and are thus beyond the scope of this research.

3. Results and Discussion

This section gives an analysis of the data gathered. It also undertakes a critical discussion of the results. Firstly, it gives an elaborate explanation of the spreadsheet modeling process of the case study mine. It ends with a thorough discussion on appraisal results.

3.1. Results of Spreadsheet Modeling

Spreadsheet modelling was adopted to estimate Discounted Cash Flows (DCFs) of the Lumwana mining project under Zambia's mineral taxation regimes. Table 5 shows the forecast of key parameters of the Lumwana Mine project.

a) Forecast of Copper Prices

The World Bank [13] real price forecast was used to determine the prices of copper at different points in time.

b) Forecast of Production

A linear regression production forecasting model for Lumwana Mine was developed using Microsoft Excel. Past copper prices were plotted against past copper ore production values with an aim of determining a relationship between the two variables. Figure 1 depicts the graphical representation of the linear production forecasting model.

The linear production forecasting model in Figure 1 can be written as Equation 3.

Table 5: Forecast of parameters for Lumwana Mine project

FORECASTED LUMWANA MINE MODEL												
Year	**Units**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Copper prices	$/t	6451	6351	6225	6158	6059	5960	5860	5761	5663	5566	5470
Ore production	Kt	15880	15827	15774	15720	15667	15614	15560	15507	15454	15400	15346
Operating cost	$M	332.67	331.55	330.43	329.32	328.20	327.08	325.96	324.85	323.73	322.61	321.49
Capital expenditure	$M	33.27	33.16	33.04	32.93	32.82	32.71	32.60	32.48	32.37	32.26	32.15

Other key parameters

1. Average mill grade = **0.75%**
2. Average mill recovery = **85.1%**
3. Percentage of paid copper at the smelter = **96.5%**

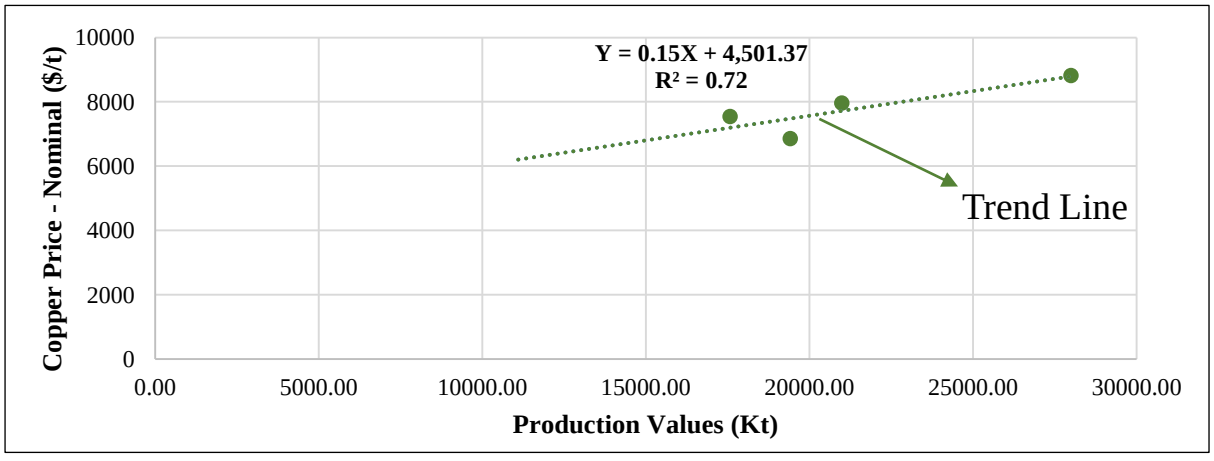


Figure 1: Graphical representation of the linear production forecasting model

$$CP_n = 0.15(P) + 4501.37 \quad (3)$$

Where, CP_n is the nominal copper price ($/t) obtained from the World Bank [13] price forecast and P is the copper ore production (Kt). Rearranging Equation 3 gives:

$$P = 6.67(CP_n) - 30{,}009.13 \quad (4)$$

c) Forecast of Operating Cost and Capital Expenditure

To forecast operating cost the average unit operating expenditure has been adopted for application. Yearly capital expenditure was assumed to be 10% of yearly operating cost. This assumption conforms to Zambia's Ministry of Mine's methodology of determining capital expenditure. This assumption was made because data was not made readily available by the revenue authority because of confidentiality reasons.

d) Cost of Capital

An appropriate status quo cost of capital had to be selected for the case study mine and GRZ. A status quo real discount rate of 15% has been applied for Lumwana Mine. However, for the case of the Zambian Government a risk free rate has been adopted for application. This is because the Zambian Government owns passive equity and thus does not actively participate in the risk faced by the investor. Zambia has a market risk premium of 6.6% [12]. The difference between this market risk premium and the Lumwana Mine cost of capital of 15% gives the risk free rate to be applied for the case of Zambia. Thus, 8% has been adopted as a reasonable status quo discount rate to be applied for government's assessment. However, a scenario analysis can always be undertaken to examine the effects of different discount rates.

3.2. Results of Economic Appraisal

This section presents the evaluation results in terms of neutrality, revenue raising potential, investor perception of risk, government risk and progressivity based on the status quo and worst case scenario.

a) Results of Revenue Raising Test

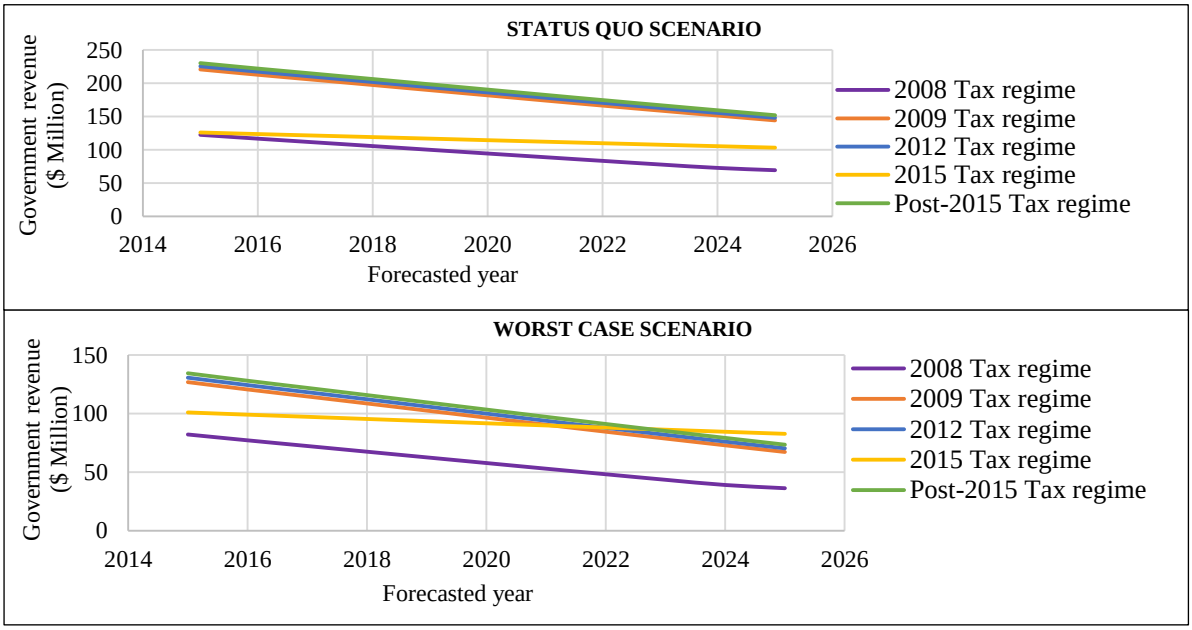


Figure 2: Results of revenue raising test

The revenue raising potential of Zambia's mineral taxation regimes has been analyzed using time profile graphs of revenue based on the status quo and worst case scenario. Figure 2 depicts the graphical representation of the forecasted government revenue in a span of 10 years (2015-2025).

The revenue raising pattern of Zambia's mineral taxation regimes in Figure 2 reflects the World Bank real copper price forecast employed in this study. In this case, both the copper price forecast and the revenue raising pattern (i.e. on the side of government) exhibit a downward trend. Thus, it's suffice to say that the revenue raising profile has mainly been determined by the copper price forecast. Production has no counter effect on this revenue raising pattern because it too solely uses price as a forecasting parameter thus conforming to its plunging tendency.

Under the worst case scenario, it can be deduced that the 2015 taxation regime has the highest revenue raising potential. This is because it begins to generate revenue above that which is generated by each individual taxation regime beyond 2023. This pattern is bound to continue as long as copper prices continue to plummet. These results ascertain that mineral royalty extracts a fairly substantial amount of revenue for the government in times of low mineral prices (i.e. low business profit).

b) Results of Progressivity Test

Progressivity of Zambia's mineral taxation regimes was analyzed by comparing the governments take in pre-tax cash flows of Lumwana Mine (AETR) over a range of pre-tax NPVs. The variation in AETR and pre-tax NPV (reflecting project profitability) was generated by solely varying the forecasted copper prices. Figure 3 shows the results of the progressivity test. The AETR in Figure 3 represents the share of government revenue in pre-tax cash flows of Lumwana Mine.

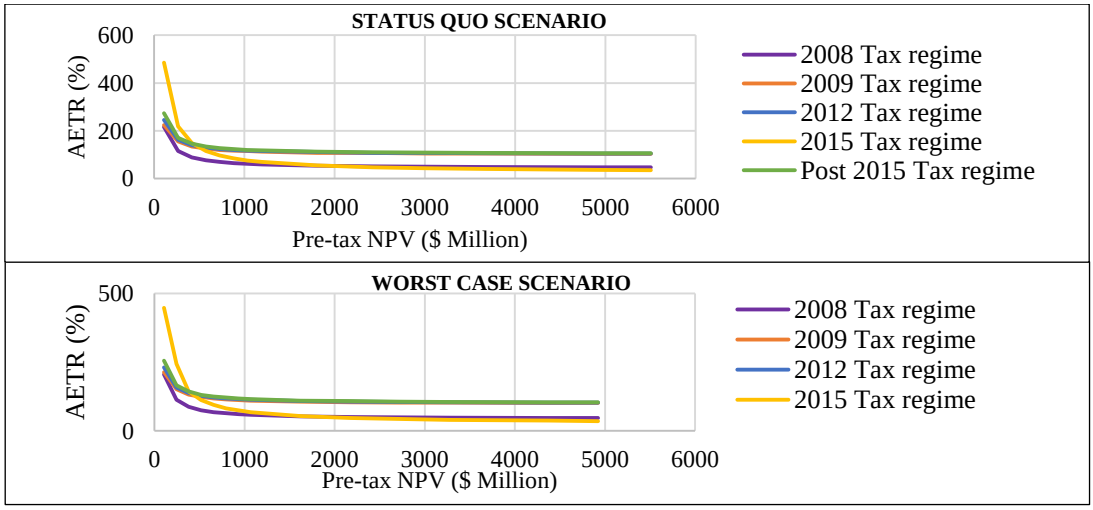


Figure 3: Results of progressivity test

It should be noted that there is a disadvantage of using the AETR as a measure of profitability. This disadvantage is that the AETR masks the relative progressivity of taxation regimes when presented graphically [5].

"Progressivity" here means that the capacity of a taxation regime ensures that the government receives a rising share of project cash flows as the intrinsic profitability of the project increases. Figure 3 under both scenarios shows that all taxation regimes move in tandem as the pre-tax NPV just starts to increase. This suggests that all trigger similar changes in government take at lower profitability. However, as the pre-tax NPV continues to increase, the progressivity graphs of the Post-2015, 2012 and 2009 taxation regimes coincide and are above those generated by the 2008 and 2015 regime. This signifies that the Post-2015, 2012 and 2009 taxation systems grant higher take than the 2008 and 2015 regimes at higher profitability.

The coinciding of the Post-2015, 2012 and 2009 graphs in Figure 3 asserts that the three tax regimes have the same level of progressivity. This ranking is followed by a sequential ranking of the 2008 and 2015 regime as reflected in Figure 3. From these results, it can be concluded that hybridized mineral tax regimes (i.e. 2008, 2009, 2012 and Post-2015 regimes) are more progressive than single tier taxation system based on mineral royalty (i.e. 2015 regime).

c) Results of Neutrality Test

Neutrality of Zambia's mineral taxation regimes has been examined using three fundamental indicators, namely; AETR, METR and a comparability analysis of pre- to post-tax IRR. Table 6 shows the neutrality results of these three indicators based on the status quo and worst case scenario.

A tax system that generates lowest values of AETR and METR asserts one which has a high degree of neutrality. Similarly, a tax regime that yields a small difference between pre- and post-tax IRR signifies that which has a high degree of neutrality. Under both scenarios (i.e. worst case and status quo), the 2008 tax regime can be ranked as the most neutral followed by a sequential ranking of the 2015, 2009, 2012 and lastly Post-2015 regime. This ranking profile shows that the 2009 regime ranks higher in neutrality than the 2012 and Post-2015 regime. This can be attributed to its low mineral royalty rate. Similarly, the 2012 tax system ranks higher than the Post-2015 regime because the former has a lower royalty rate than the latter. These results highlight that mineral royalty (i.e. Ad valorem) has a high degree of non-neutrality. This means that all things being equal an increase in the royalty rate results in decreased neutrality of the taxation regime as a whole.

d) Results of Government Risk Test

Government is more concerned with the stability of revenue inflow from the mineral sector. This volatility has been used as surrogate measure of risk. The Coefficient of Variation (CV) parameter has been employed to measure this volatility. Table 7 shows the results of the government risk test. Different NPV values were generated using a range of different price sensitivities.

Table 6: Results of neutrality test

STATUS QUO SCENARIO					
	MINERAL TAXATION REGIME				
INDICATOR	**2008**	**2009**	**2012**	**2015**	**POST 2015**
Average effective tax rate (%)	59	113	115	70	118
Marginal effective tax rate (%)	47	86	88	49	90
Pre-tax IRR (%)	261	261	261	261	261
Post-tax IRR (%)	139	37	31	133	25
Difference between pre-tax IRR and post-tax IRR (%)	122	224	230	128	236

WORST CASE SCENARIO					
	MINERAL TAXATION REGIME				
INDICATOR	**2008**	**2009**	**2012**	**2015**	**POST 2015**
Average effective tax rate (%)	65	117	120	85	123
Marginal effective tax rate (%)	52	92	95	60	100
Pre-tax IRR (%)	197	197	197	197	197
Post-tax IRR (%)	95	16	9	79	0.1
Difference between pre-tax IRR and post-tax IRR (%)	102	181	188	118	197

Table 7: Results of government risk test

STATUS QUO SCENARIO					
	MINERAL TAXATION REGIME				
INDICATOR	**2008**	**2009**	**2012**	**2015**	**POST-2015**
Standard Deviation ($ Million)	403.88	938.12	947.42	251.64	956.85
Mean NPV ($ Million)	1574.56	3355.87	3407.37	1371.37	3458.8
Coefficient of Variation (%)	25.65	27.95	27.80	18.35	27.66

WORST CASE SCENARIO					
	MINERAL TAXATION REGIME				
INDICATOR	**2008**	**2009**	**2012**	**2015**	**POST-2015**
Standard Deviation ($ Million)	352.92	819.64	827.89	247	836.13
Mean NPV ($ Million)	1381.60	2939.02	2983.96	1183.83	3028.89
Coefficient of Variation ($ Million)	25.54	27.89	27.74	20.87	27.61

Under both scenarios (i.e. worst and status quo), the 2015 taxation regime possesses the lowest risk to the government as reflected by low values of CV. This regime is followed by a sequential ranking of the 2008, Post-2015, 2012 and 2009 taxation systems. This order of ranking is mirrored by the order of magnitude of CV values in Table 7.

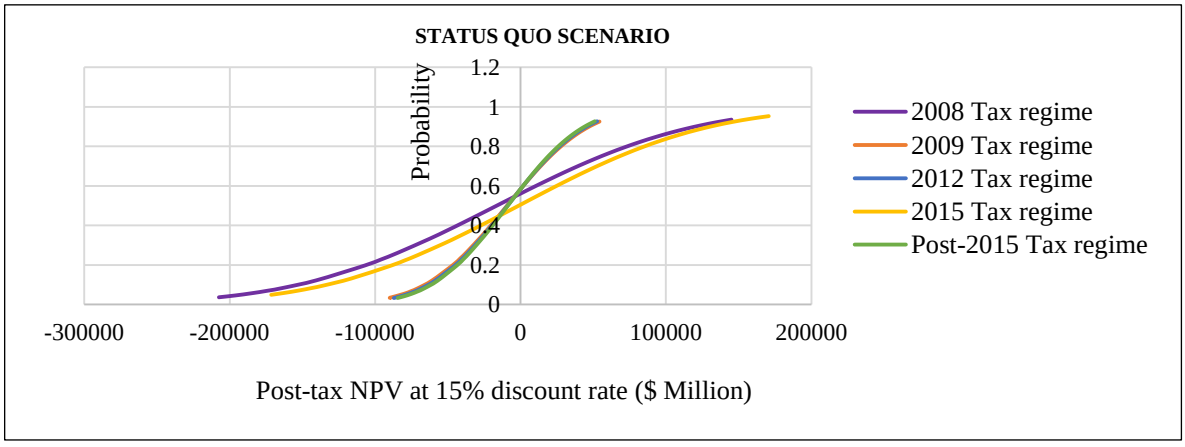
The following list provides a rationale for this ranking profile:

- The 2015 mineral taxation system possesses the least risk to the Zambian Government because it is solely based on mineral royalty and at a higher rate (i.e. 20%);
- The 2008 tax regime ranks second lowest in terms of government risk because it is mainly dominated by production based taxes (i.e. windfall tax and mineral royalty);
- The Post-2015 taxation system ranks third because it has a higher royalty rate than the 2012 and 2009 regime (i.e. 6%);
- The 2012 regime ranks higher than the 2009 taxation system because the former has a higher royalty rate than the latter (i.e. 6%); and
- The 2009 regime possesses the highest government risk because it has the lowest royalty rate (i.e. 3%).

These results highlights that mineral royalty (i.e. ad valorem) minimizes the risk of revenue inflow into government coffers.

e) Results of Investor Perception of Risk Test

The investor's perception of risk of Zambia's mineral taxation regimes was evaluated by analyzing the cumulative probability distribution of post-tax NPV discounted at 15% and 18%. Figure 4 shows the cumulative probability distribution of investor post-tax NPV of Zambia's mineral taxation regimes under the status quo and worst case scenario.



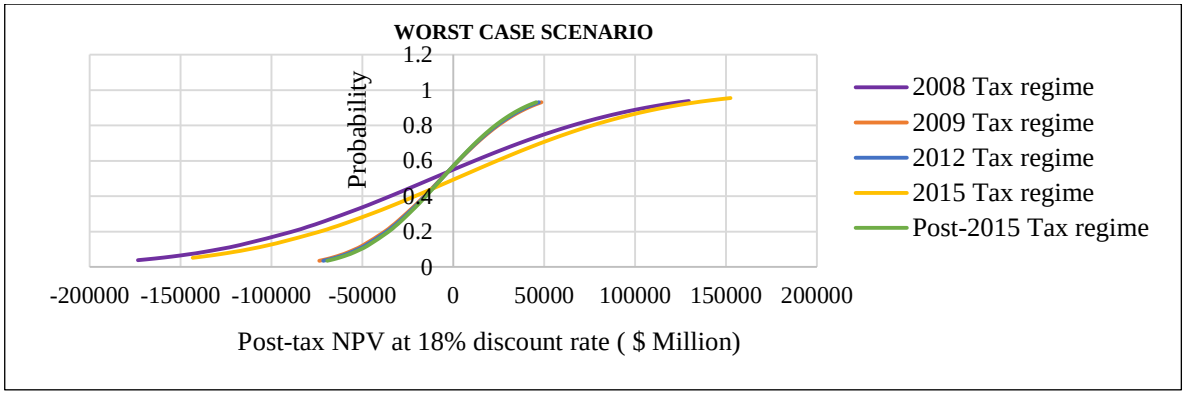


Figure 4: Results of investor perception of risk test

Different values of post-tax NPV were generated by undertaking a series of price fluctuations. Therefore, this criterion assumes price to be the only source of uncertainty or risk. In Figure 4, under both scenarios, the 2008 and 2015 regimes show a relatively low probability of expected positive outcomes and a high probability of expected negative outcomes. To the contrary, the 2009, 2012 and Post-2015 regimes which have coinciding graphs show a relatively low probability of expected negative outcomes and a high probability of expected positive outcomes. This directly signifies that the 2008 and 2015 regimes have a higher bearing on investor perception of risk when compared to the 2009, 2012 and Post-2015 taxation systems. Most investors are risk averse and thus prefer to reduce negative returns as much as possible. Assuming that the Lumwana mining investors are risk averse it is suffice to say that the 2015 taxation regime has a lower bearing on investor perception of risk than the 2008 regime. This is because the 2015 tax system offers a lower probability of expected negative outcomes (i.e. post-tax NPV) when compared to the 2008 regime.

3.3. Ranking of Taxation Regimes

Table 8 shows the ranking of Zambia's mineral taxation regimes based on progressivity, revenue raising potential, neutrality, government risk and investor perception of risk.

Table 8: Ranking of mineral taxation regimes

EVALUATION CRITERION	**ZAMBIA'S MINERAL TAXATION REGIMES**				
	2008	2009	2012	2015	POST-2015
Revenue raising potential	5	4	3	1	2
Progressivity	4	1	1	5	1
Neutrality	1	3	4	2	5
Government risk	2	5	4	1	3
Investor perception of risk	5	1	1	4	1
Total ranking points	17	14	13	13	12

From Table 8, the Post-2015 taxation regime is the most robust based on the five evaluation criterions as reflected by the lowest ranking point. This is followed by a sequential ranking of the 2015 and 2012; 2009; and 2008 regime. As can be deduced from Table 8, the aggregate ranking points entail that the Post-2015, 2015, 2012 and 2009 taxation systems are relatively robust in design except the 2008 regime. This is because the latter has a weakly constructed tax structure that lacks proper harmonization of its taxation instruments. Similarly, the former taxation regimes are relatively robust because of the proper harmonization of their taxation instruments. However, it is imperative to be cognizant with the fact that there is a tradeoff among the five evaluation criterions. Thus, the most solid measures adopted in determining a robust mineral taxation regime depends on the taxation doctrine of the policy formulator and what is to be achieved.

4. Conclusions and Recommendations

4.1. Conclusions

The research results indicate that Zambia's mineral taxation systems have different intensities of robustness based on the evaluation criterion that is employed. Thus, the most solid measures adopted in determining a robust mineral taxation regime depends on the taxation doctrine of the policy formulator and what is to be achieved. This research has shown that Zambia's mineral taxation regimes based on the five evaluation criterions are relatively robust in capturing mining revenue except the 2008 regime. This is because of its weak tax structure that does not exhibit proper harmonization of its taxation instruments. The research has also reviewed that the current taxation system (i.e. Post-2015) is the most robust in design based on the five evaluation criterions. This has been attributed to the robust harmonization of taxes encapsulated in its tax structural design. The ranking of this taxation regime has been followed by a sequential ranking of the 2015 and 2012; 2009; and 2008 taxation system. From these results, it can be deduced that it is not a single tax that affects a mineral fiscal regime but the lump sum of all the taxes and how they harmonize with each other.

4.2. Recommendations

The study recommends that the Zambian Government should review and optimize the current mineral taxation system (i.e. Post-2015). Additionally, it should optimize mining taxation based on all the taxation instruments encapsulated in the mining tax structure rather than achieve this cause by optimizing a single taxation instrument. This is because it is not a single tax that affects a mineral taxation regime but the lump sum of all taxes and how they harmonize with each other. Lastly, the government must increase the institutional capacity of ZRA so as to improve on administrative efficiency. Achieving this endeavor will help curb tax planning schemes such as transfer pricing, hedging manipulation, misreporting of grade and production values etc.

References

[1] Zambian Economist, "Government Position on Mining Taxation Regime." Internet: www.zambian-economist.com/2015/02/government-position-on-mining-taxation.html, [April. 12, 2015].

[2] D. Manley. "A Guide to Mining Taxation in Zambia." Research report, Zambia Institute of Policy

Analysis and Research (ZIPAR), Lusaka, 2013.

[3] T. Baunsgaard. "A Primer on Mineral Taxation." Working paper 01/139, International Monetary Fund (IMF), Washington D.C, USA, 2001.

[4] C. Nakhle. "Petroleum Taxation: A Critical Evaluation with Special Application to the UK Continental Shelf." Ph. D. thesis, University of Surrey, UK, 2004.

[5] P. Daniel, B. Goldsworthy, W. Maliszewski, D.M. Puyol and A. Watson. "Evaluating Fiscal Regimes for Resource Projects: An Example from Oil Development." Working paper 9/23/2008, International Monetary Fund (IMF), Washington D.C, USA, 2008.

[6] G.C. Watkins. "Atlantic Petroleum Royalties: Fair Deal or Raw Deal?." The Aims and Gas Papers-paper no.2, Atlantic Institute for Market Studies, Halifax, 2001.

[7] P. Guj. "Mineral Royalties and Other Mining Specific Taxes." Research Report, International Mining for Development Centre, Perth, 2012.

[8] A. Mohammed. "Fiscal Regime Analysis: What lessons will Ghana Learn from Norway." Research Paper CAR Volume 16, Centre for Energy, Mineral Law and Policy (CEMLP), Dundee, 2012.

[9] S. Briggs. "How Competitive are the Fiscal Regimes of Chile and Colombia for Foreign mining Investment." Working paper, Dundee, 2003.

[10] A. Smith. "Rethinking Fiscal Stability in Mining Investment Contracts: Is There a Way to Achieve Fiscal Stability and Douse Parties' Concerns?." Working research paper, Centre for Energy, Petroleum and Mineral Law and Policy (CEPMLP), 2012.

[11] H.L. Appiah. "Tax Reforms & Revenue Mobilisation: A Case Study of the Mining Sector of Ghana." Master thesis, University of Ghana, Ghana, 2013.

[12] P. Fernandez, J. Aguirreamalloa and C. Luis. "Market Risk Premium used in 56 Countries in 2011: A Survey with 6014 Answers." Working paper WP-920, IESE Business School, University of Navarra, Spain, 2011.

[13] World Bank, "Commodity Markets Outlook." Research Report, World Bank Group, Washington D.C, USA, 2014.