Prediction of creditworthiness of a viable artisanal and small-scale mining operation

O.D. Eniowo and L.D. Meyer

University of Pretoria, South Africa

It has been proven in the body of knowledge that for an investment to attract formal sources of financing, the business must be considered creditworthy by potential lenders. Again, for an investment to be classed as creditworthy, the credit risks associated with the investment must be bearable for the potential lender. This paper develops models that can predict the creditworthiness of a viable artisanal and small-scale mining (ASM) operation. To achieve this, credit risk variables that were identified in the literature, along with primary data on credit risk variables collected from a financial institution, were used to develop a model that could predict that an ASM operation is creditworthy.

Key words: Artisanal and small-scale mining (ASM), creditworthiness, formal funding

INTRODUCTION

Artisanal and small-scale mining (ASM) is a form of mining which is characterised by low tech, labour intensive extraction methods and processing, often practised in the informal sector of the economy[1]. Over the years, this form of mining operations has been creating safety, health, environmental and social concerns, especially in developing countries. To tackle the challenges associated with this occupation, some scholars recommend formalising the operations of ASM by capturing its actors into the formal domain as a way of legalising the operations. In turn, the miners will be required to conform to environmental, safety and health standards. It is expected that the exposure brought about by the formalisation efforts will also provide the miners with the benefit of access to funding with which they can advance their operations and promote safer, healthier and more sustainable operations[2].

Recent studies have however shown that in spite of the widespread effort to formalise ASM operations, the issue of access to funding still remains unsolved[3]. Miners in this occupation still rely on informal sources of funding for sustaining their operations, and with this type of funding arrangement, miners usually do not receive fair market value for the mineral produced, leading to the perpetuation of poverty in the occupation[4]. Thus, to tackle the challenges associated with formalisation, it is essential that miners have access to formal sources of funding, such as bank funding.

[1] Hentschel, T., Hruschka, F., & Priester, M. (2003). Artisanal and Small-Scale Mining - Challenges and Opportunities. *IIED*, 94

[2] Hinton, J. J., Veiga, M. M., & Veiga, A. T. C. (2003). Clean artisanal gold mining: a utopian approach*? Journal of Cleaner Production* 11(2), 99–115.

[3] Siwale, A., & Siwale, T. (2017). Has the promise of formalizing artisanal and small-scale mining (ASM) failed? The case of Zambia. *Extractive Industries and Society*, *4*(1), 191–201.

[4] Perks, R (2016). I loan, you mine: Metal streamlining and offtake agreements as solutions to undercapitalisation facing small-scale miners. *Extractive Industries and Society* 3(2016), 813-822

However, formal lenders are usually unwilling to provide funding for ASM operations. There are a number of reasons in the literature, shown to be responsible for this. Some studies blame the lack of understanding by local banks on how to translate geological assets into a form of collateral that they are familiar with. Other studies point at the inability of ASM operators to present proof of viability of the mineral resource of interest that will provide an assurance of the feasibility of the mining operation[5]. The bottom line is that beneficiaries of banks' investment capital must be creditworthy companies with financially viable operations. For ASM firms to have access to formal sources of funding, their operations must be considered viable by potential investors and lenders.

Thus, it is essential that a simplified method be developed to estimate the viability of ASM operations – a method that is void of the encumbrances seen in banks' due diligence for large mining companies. The dearth of such models in the existing literature necessitates this study. This paper therefore develops a model that predicts the creditworthiness for a viable ASM operation using identified credit-risk variables.

Procedure

In order to obtain data on the requirements for a creditworthy loan application by a bank, a financial institution was contacted – The Nigeria Bank of Industry (BOI). The bank provided the list of requirements that must be fulfilled by a borrower in ASM in order to successfully access a loan. A well-structured research questionnaire was thereafter developed based on the data acquired from the BOI and about 100 selected ASM operators were asked to complete the questionnaire appropriately. ASM operators were selected based on a random sampling technique. Southwestern Nigeria was purposely selected for the study, because it hosts various types of minerals being mined through ASM operations. To ensure responses were not biased, miners were selected across different mineral types which included mineral aggregates, gemstone, metallic ores, and industrial minerals.

A multiple regression model was then developed to predict the credit worthiness of an ASM operation using the identified credit-risk variables. In this multiple regression, the identified variables from formal lenders (predictor variables) were regressed with access to formal fund (dependent variables) to determine the effect of the identified variables on access to formal funding. The predictor variables are the potentially relevant parameters that may drive credit worthiness, and they include the availability of reserve estimate, ability to pay an interest rate, ability to provide a guarantor, availability of feasibility report, membership of mining cooperative society, and proof that the operation has been running successfully for at least a year. The regression models were developed in R studio using R programming language.

Summary of results

The table showing the results of the multiple logistic regression can be found in Table 1 and Table 2. Where KnwResEstyes stands for miner's knowledge of his reserve estimate, hav.quayes stands for ability to provide guarantors (considered as a form of collateral), affort.intyes stands for ability of the miner to pay the expected interest rate on the loan sum and min.coopyes stands for membership of the miner in a registered cooperative society. The predictor variables that were found to be statistically insignificant were removed from the model.

Table 1. Deviance residuals

Min	1Q	Median	3Q	Max
-2.19371	-0.41226	0.04141	0.43471	2.23945

[5] Marin, T., Seccatore, J., De Tomi, G., & Veiga, M. (2016). Economic feasibility of responsible small-scale gold mining. *Journal of Cleaner Production*, *129*, 531–536.

Table 2. Coefficients

	Estimate	Std. Error z value		Pr(>|z|)
(Intercept)	-4.413	1.416	-3.118	0.00182 **
KnwResEstyes	2.003	1.030	1.945	0.05182 .
hav.guayes	1.991	1.020	1.951	0.05102 .
afford.intyes	1.238	1.123	1.102	0.27041
min.coopyes	2.732	1.046	2.611	0.00904 **

Since logistic regression measures likelihood in log (odds), the estimate in Table 2 shows by how much, on a log scale, the predictor variables affect the chances of having access to formal finance. The parameter estimates in Table 2 are the partial regression coefficients; and they show that the model is:

$$\ln(p/(1-p)) = -4.413+2.003(\text{KnwResEstyes})+1.991(\text{hav.guayes})+1.238(\text{afford.intyes})+2.732(\text{min.coopyes})$$

Where p is the probability that a borrower will access formal loans.

To determine the overall effect size of the relationship between the predictor variables and the dependent variable (access to the formal fund), the 'McFadden's Pseudo R-squared' and its p-value are calculated in RStudio. This gives the results 0.5255773 and 3.691443e – 06 respectively. The Pseudo R-squared value is usually on a scale between 0 and 1. In this instance, the p-value associated with this R-squared value is quite small (smaller than 0.05), which implies that the R-squared value for the model is not due to luck, that is, the R-squared value is considered statistically significant in proving the effect of the predictor variables on the dependent variable (access to formal fund).

From Table 2, since all the predictor variables have positive coefficients estimates, it implies that as the value of each of these predictor variables increase, the log odds of the dependent variable tend to increase, indicating that there is a positive relationship between each of the predictor variables and the dependent variable (access to formal loans). In order to better understand the result of the multiple logistic regression model, an odds ratio is computed for each predictor variable while holding other variables constant. This gives the following results:

Odds ratio for KnwResEstyes: $e^{2.003} = 7.411$ (all other variables kept constant)

Odds ratio for hav.guayes: $e^{1.991} = 7.323$ (all other variables kept constant)

Odds ratio for afford.intyes: $e^{1.238} = 3.449$ (all other variables kept constant)

Odds ratio for min.coopyes: $e^{2.732} = 15.36$ (all other variables kept constant)

From the above, it is observed that being a member of a mining cooperative society provides the highest odds for improving the chances of access to formal financing for ASM operators within the sample group. This underpins the role of social collateral, such as being a member of a registered cooperative society, in improving the chances of an ASM operator in accessing formal sources of financing.

Olushola Daniel ENIOWO

Doctoral student
University of Pretoria

Olushola Eniowo is a mining engineer, an academic, and a researcher. He is a graduate of mining engineering, for both bachelor's degree and masters. His areas of research interest include economics of mining, artisanal and small-scale mining, mine management, and project management. He is presently completing his Doctoral study in mining engineering at the University of Pretoria on a thesis titled "Prediction of creditworthiness of viable artisanal and small-scale mining operation". He has published a number of research articles from the study in learned journals including SAIMM journal and he has publications in advanced stages of review in reputable journal publications.