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THE DETERMINANTS OF ARTISANAL AND SMALL-SCALE MINING (ASM) PRODUCTION: EVIDENCE FOR GOLD IN BATOURI, EAST CAMEROON

LES DETERMINANTS DE LA PRODUCTION MINIERE ARTISANALE : CAS DE L'OR A BATOURI, EST-CAMEROUN

Adele M. NGO BILONG AMOA
Researcher-Senior Lecturer
Faculty of Mines and Petroleum Industries
Maroua University
adelebilong1@yahoo.fr
+237 699961635

Ousmanou HAMAWA
Mining and Petroleum Economist Ingineer
Faculty of Mines and Petroleum Industries
Maroua University
hamawaousmanou@yahoo.fr

+237 696283022

Andre TSIMI ELOUNDOU
Mining and Petroleum Economist Ingineer
Faculty of Mines and Petroleum Industries
Maroua University
aguitizi@yahoo.fr
+237 65685491

Abstract
This document aims to present the factors influencing the production of Gold in Batouri. This study was carried out as part of research to demystify the contours of the Cameroonian mining sector. To achieve this, we used the student and fisher tests to better assess the significance of each element in the model. Based on the results obtained, it appears at first glance that production depends more on hours of work than on other variable. Then, men exercise more than women and finally awareness is required to improve the level of artisans to better manage their resources from these activities. It should also be noted that the model has a correlation coefficient of 86.75%, a sign of good correlation. Donor agencies should view the artisanal and small-scale mining sector as a potential vehicle for poverty alleviation. It should be seen as a key part of rural development programs.

Keywords: Mining, GoLd, artisanal, Batouri

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Résumé :
Ce document vise à présenter les facteurs influençant la production d'or à Batouri. Cette étude a été réalisée dans le cadre de recherches visant à démystifier les contours du secteur minier camerounais. Pour y parvenir, nous avons utilisé les tests Student et Fisher afin de mieux évaluer la signification de chaque élément du modèle. Sur la base des résultats obtenus, il apparaît à première vue que la production dépend davantage des heures de travail que d'autres variables. Ensuite, les hommes font plus d'exercice que les femmes et enfin une prise de conscience est nécessaire pour améliorer le niveau des artisans afin de mieux gérer leurs ressources issues de ces activités. Il faut également noter que le modèle a un coefficient de corrélation de 86,75%, signe d'une bonne corrélation. Les bailleurs de fonds devraient considérer le secteur minier artisanal et à petite échelle comme un vecteur potentiel de réduction de la pauvreté. Il doit être considéré comme un élément clé des programmes de développement rural
Mots clés : Minier, Or, artisanal, Batouri

Introduction

Artisanal and small scale mining (ASM) has been widespread throughout the world for over 2000 years (Hilson, 2002a), and today features heavily in the rural economy of many developing countries (Hentschel et al., 2003; Hilson, 2002a). , artisanal and small-scale mining (ASM) is largely a poverty-driven activity which plays an important economic role. It is estimated that in the order of 13 million people in about 30 countries are directly engaged in small-scale mining, a significant proportion of whom are women and children. A further 80 to 100 million people across the developing world could depend on small-scale mining for some aspects of their livelihoods. Inded, Africa has about 30% of the planet's mineral reserves, most of which are unexploited. The potential for further discovery and exploitation is immense (Hilson, 2002b). Africa already produces several important minerals, including 40% of the world's gold, 60% of its cobalt and 90% of platinum group metals (Janneh and Ping, 2011; Kogre and Afilaka, 1988; Taylor et al., 2009

All mining experts agree on the subject. Although it is not comparable to the Democratic Republic of the Congo or even South Africa, Cameroon is a real geological scandal, given the large mineral resources available to the country. The inventory of mining potential, drawn up

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by the Cameroonian government up to June 2015, reveals new wealth likely to attract large mining groups to Cameroon. Because 30% of the national territory was explored for the first time, in addition to the 40% that have already been explored since the 1980s. According to official sources, mining in Cameroon contributes so far less than 1% of the country's GDP.

There are diverse definitions of different types of ASM (Drechsler, 2001). Definitions are shaped by stakeholders' perspectives and vary from country to country. The term 'artisanal mining' is widely used as a label for very labour-intensive activities without mechanization (Aryee et al., 2003; Hentschel et al., 2002). Broadly speaking, artisanal and small-scale mining refers to mining by individuals, groups, families or cooperatives with minimal or no mechanization, often in the informal (illegal) sector of the market. ASM is characterized by a number of conditions: Lack of or limited use of mechanization, and a lot of physically demanding work. Low level of occupational safety and health care. Poor qualification of personnel at all levels of the operation. Inefficiency in exploitation and processing of mineral production (low recovery value). Exploitation of marginal and/or very small deposits, which are not economically exploitable by mechanized mining. Low level of productivity. Low level of salaries and income. Periodic operation by local peasants by season or according to the market price development. Lack of social security. Insufficient consideration of environmental issues. Chronic lack of working and investment capital.

In some countries a distinction is made between 'artisanal mining' that is purely manual and on a very small scale, and 'small-scale mining' that has some mechanization and is on a larger scale. In some West African countries (for example, Mali), small-scale mining is differentiated from artisanal mining by the presence of permanent, fixed installations that are established once an ore body is confirmed. Throughout this publication and in accordance with Hentschel et al., 2003; Janneh and Ping, 2011, the terms artisanal and small-scale mining are used interchangeably.

Cameroon, the focus of this paper, has significant mineral resources diamond and bauxite, cement and petroleum are already exploited at industrial scales (Newman,2011;Nting,2009). The country launched an ambitious mineral exploration campaign in the1970s, which identified major resources of gold, diamonds, iron, bauxite, uranium, cobalt and nickel (Nodemetal.,2012) And in order to boost its extractive sector, Cameroonian policy makers have decided to develop industrial and artisanal exploitation of precious stones, ornamental stones and development minerals. In Eastern Cameroon, precisely in Batouri mining activities are developed. Gold panning opposes industrial exploitation and is done through manual methods with rudimentary

tools. What factors influence the artisanal production of Gold and in Cameroon more precisely in Batouri? The interest of the problem addressed in this work is two-way. In the practical sense of the term, it will be a question of optimizing the artisanal production of gold on the one hand and on the other hand, in an intellectual sense, this work makes it possible to enrich the intellectual universe in the field of rural and craft economy and to serve as a working base for future research.

I. PREVIOUS RESEARCH

The ASM sector is widely believed to be comprised of poverty driven activities, typically in the poorest and most remote rural areas of a country and often populated by poorly educated groups with few employment alternatives (Drechsler, 2001; Hilson and Potter, 2005; Mohammed Banchirigah, 2006; Okoh and Hilson, 2011). In sub-Saharan Africa, ASM is an important contributor to rural economies (Jennings, 1999; United Nations Economic Commission for Africa, 2003). As noted, it provides millions of jobs as well as supplements the incomes of poor subsistence farmers (Hentschel et al., 2002; Hilson, 2009; Schure et al., 2011b). Gold exploitation has always existed for a very long time, so several studies have been carried out on related activities. Monkam S. Aurélie B and Tsikam Cyrille spoke about "the impact of the artisanal exploitation of gold on the populations of East Cameroon" on behalf of the Center of Excellence for the Governance of Extractive Industries in Africa Francophone. It has been said that the artisanal exploitation of gold is an important source of income in Kambélé but also, at the origin of several evils. Among the positive impacts, gold panning improves the living conditions of the populations of this area, since it makes it possible to alleviate their existential problems (Nutrition, clothing ...). On the other hand, gold exploitation also has a negative impact on the health of populations since they are exposed to diseases such as pneumonia during operation. Actions have been proposed to mitigate negative impacts and to optimize positive ones. The United Nations Environment Organization also proposed methods and tools in 2017 to estimate the use of mercury and identify the practices of mining and artisanal and small-scale gold extraction (ASM). This artisanal gold council document was produced in conjunction with the United Nations environment program written by O'Neill, JD and Telmer K in 2017.

II. METHODOLOGY

II.1 Data

- Data collection instrument: questionnaire

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To collect data, we use survey research design. We chose that way because it's preferable to conduct researches employing number of people and questioning about their attitudes and opinion towards a specific issue, an event or a phenomenon (Marczyk & Dematteo 2005). The research questions and objectives have been addressed by cross-sectional survey data since the study has been done at a point of time and place.

- Data processing.

Informations receives have been summarize, the data coded manually and entered in to STATA software version 15 and SPSS version 21.

II.2 Empirical strategy

II.2.1 Data analysis

The methods of data analysis used are descriptive statistics and econometric tools. Descriptive statistics such as mean, standard deviation are use to describe socio-economic and mining characteristics and factors affecting gold production. OLS regression model is use to examine determinants of gold's small size mining production factors in Batouri. The survey comprised 80 mining smallholders. It aims is to upgrade knowledge on gold mining sector in Cameroun. These data are also aimed at providing indicators that capture the living standards of the local population in order to be able to follow up efforts made towards the implementation of the poverty reduction strategy paper (PRSP) and the realization of the Millennium Development Goals objectives.

II.2.2 Econometric model

To identify the factors affecting gold production in Batouri, Ordinary Least Square (OLS) regression model was employed. The reason in the continuous nature of dependent variables and the quantity of gold production. Furthermore, according to GUJARATI (2006), with the assumption of classic linear model, OLS estimators are unbiased and have the least variance: they are BLUE (Best Linear Unbiased Estimators). Also, many others researchers such as Babatunde & Qaim (2009) and Olujendo (2008) had used OLS to address similar issues.

$Y = \beta_0 + \beta_i X_i + U_i$ where Y is the dependent variable (quantity of gold produced) , X_i , a vector of explanatory variables, β_i , a vector of coefficients of the explanatory variables (parameters) and U_i the disturbance that assumes to satisfy all OLS assumption (Gujarati, 2006). The economic model's specification of variables is:

$Y_i = \beta_0 + \beta_1 \text{gender} + \beta_2 \text{age} + \beta_3 \text{ educ} + \beta_4 \text{familysz} + \beta_5 \text{workf} + \beta_6 \text{senior} + \beta_7 \text{card} + \beta_8 \text{hours} + U_i$.

Y_i is the continuous dependent variable indicating mining production per week of each

smallholder. **Age** stands for the age of the miner, **educ** stands for his level of education, **familisz** stands for respondent's family, **workf** stands for the quantity of work force or the number of workers, **senior** indicates the number of years of seniority in mining activity, **card** indicates if yes or no the respondent has a smallholder's card, and **hours** represents the number of working hours per week.

II.2.3 Description of variables used in model

The variables used are descript as follow:

Gender: the gender takes two values: 1 if the smallholder is a man and 0 if the smallholder is a woman. Males smallholders are stronger and more capable than females. But females have more opportunities of exchanging mining incomes than males (Malek & Usami, 2010; Abay & Assefa, 2004);

Age: the age is a continuous variable measuring the age of the smallholder;

Education: the education is a continuous variable that measure the number of years spend in schooling. In fact, the educated smallholder is supposed to acquire, analyse and evaluate informations on different mining inputs and market opportunities that potentially can increase mining incomes than illiterate smallholders (Uwaboe &al, 2012). Positive coefficient was expected from the regression result;

Family size: it's a continuous variable measured in number. Large and productive family size could increase mining production trough proper labour division. Small and efficient family size could increase mining production by devoting all their time for mining activities as well by employing mining inputs (Amaza & al,2006). It expected effect in mining production was not determined in priori.

Seniority: it's a continuous variable that indicate the mining experience and proper time allocation for mining activities until a certain age limit and thereafter their mining income would decrease (Edabiyi & Okunlola, 2013; Shumet, 2011; Anyarwu, 2009 and Abay & Assefa, 2004). Hence, negative coefficient was expected from the final regression result.

Table1 provides the descriptive statistics.

Table1: Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
Age	30.025	30.025	15	60
Edu	0.8375	0.7866569	0	3
Familysz	2.0875	2.200079	0	7
Workf	2.175	2.627869	0	10
Senior	8.2375	7.503997	1	32
Hj	8.65	2.643837	5	17

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Hours	51.9	15.86302	30	102
Gender	0.7625	0.428236	0	1
Card	0.3625	0.4837551	0	1

Source: Authors' computation

III. EMPIRICAL RESULTS AND DISCUSSION

Table 2: Correlation and covariance matrix

		Hours	Gender	Edu	Card	Familysize	workf	Senior	Age
correlations	Hours	1.000	0.091	0.017	0.123	0.068	-0.529	-0.039	-0.094
	Gender	0.091	1.000	0.020	0.003	-0.214	-0.274	-0.109	0.098
	Edu	0.017	0.020	1.000	0.057	0.304	-0.059	-0.064	-0.104
	Card	0.123	0.003	0.057	1.000	0.002	-0.141	-0.364	-0.155
	familys	0.068	-0.214	0.304	0.002	1.000	-0.047	-0.057	-0.639
	workf	-0.259	-0.274	-0.059	-0.141	-0.047	1.000	-0.174	-0.122
	Senior	-0.039	0.109	0.064	-0.364	-0.057	-0.174	1.000	-0.347
	Age	-0.094	0.098	-0.104	-0.155	-0.639	-0.122	-0.347	1.000
covariances	Hours	0.001	0.002	0.000	0.003	0.01	-0.003	-8.64e-005	0.000
	Gender	0.002	0.673	0.008	0.003	-0.054	-0.047	0.007	0.005
	Edu	0.000	0.008	0.211	0.026	0.043	-0.059	0.002	-0.003
	Card	0.003	0.003	0.026	0.997	0.001	-0.006	-0.029	-0.010
	familys	0.001	-0.054	0.043	0.001	0.093	-0.030	-0.001	-0.012
	workf	-0.003	-0.047	-0.006	-0.030	-0.003	0.044	-0.003	-0.002
	Senior	-8.64e-005	0.007	0.002	-0.029	-0.001	-0.003	0.007	-0.002
	Age	0.000	0.005	-0.003	-0.010	-0.012	-0.002	-0.002	0.004

Source: Authors' computation

We observe that the variables taken for this study are very weakly correlated. However, it appears that the hours and workf variables are fairly moderately and negatively correlated (-0.529) as well as the familisz and age variables (-0.639).

Graph: Correlation of variables

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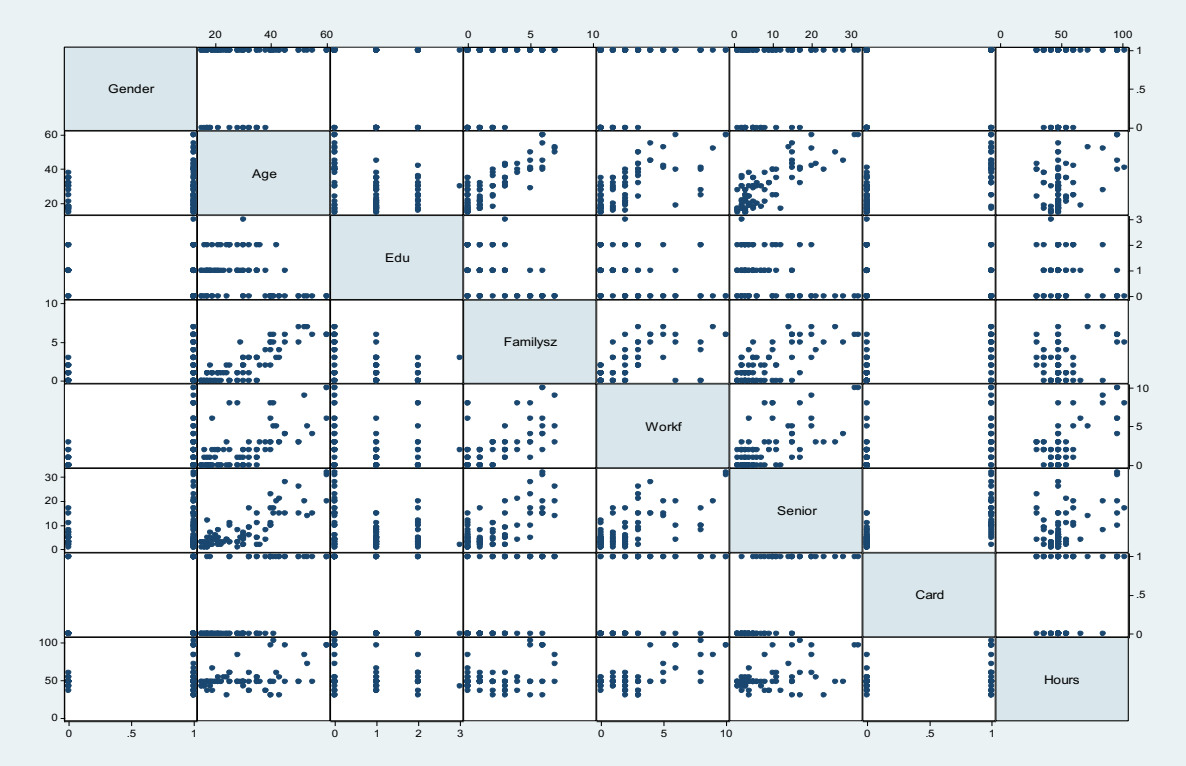

Source: Authors' computation

Table 3: OLS estimation results (Y is dependent variable, quantity of gold produced)

	Y_i	Coef	Std. Err	t	$P \succ \lvert t \rvert$
	Hours	0.004	0.027	0.15	0.885
	Gender	1.84	082	2.25	0.028
	Edu	0.685	0.459	1.49	0.140
	Card	0.916	0.998	0.92	0.362
	familys	0.509	0.305	1.67	0.100
	workf	2.167	0.210	10.30	0.000
	Senior	-0.084	0.081	-0.10	0.917
	Age	-0.004	0.063	-0.07	0.0943
	constant	1.008	1.836	0.55	0.585
F(8,71)=58.10					
prob $\succ$ **F=0.000**					
R-squared =0.8675					
AdjR-squared =0.8526					

Source: Authors' computation

So far, the model is globally significant at a threshold of 0.000% significance. The calculated Fisher statistic is 58.10. Our model displays a a calculated R-Squared of 0.8675 which means that the variables taken into account , in particular gender, age, education, family size, work

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force, seniority, cards and hours explain gold production at 86.75% in Batouri. A significance rate of 5%, only gender and work force variables are significant.

IV. CONCLUSION

With regard to this work, it appears that the most determining variables are the type and quantity of workers. The number of working hours per week is not significant because the working methods are rudimentary which does not allow to obtain returns of scale. The age of the workers is insignificant in the model because parents generally put their children to work while they themselves manage sales. The level of education does not influence production enough because the education these workers receive does not relate to the mine. In view of these observations, the main recommendations that we can make are: - The state should define a real educational policy for artisanal miners. This education should mainly focus on more fruitful working methods and on strengthening managerial capacities; - The State should also think about setting up facilities for access to credits and financing. This will allow its operators to acquire adequate equipment. Finally, donor agencies should view the artisanal and small-scale mining sector as a potential vehicle for poverty alleviation. It should be seen as a key part of rural development programmes and accorded greater priority in spending. ASM assistance projects need to be included in regional and local development programmes.

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