The cost of mismanagement of gold production in Sudan

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Abstract: To assess the size of gold smuggling in Sudan we estimated scale inefficiency of operating mines in the country using primary data survey covering about 18 artisanal mines during the year 2016. The output variable represent gold production of each state and the inputs represent the water mills, and the number of mines (wells) in each state. The findings in the paper indicate about 34% of the artisanal gold production in the country is smuggled. The distribution of the gold smuggling among the states reveal that the states with bigger share of smuggling are those states with internal armed conflicts (South Kordofan and Darfour states) or states bordering loosely controlled borders (Northern and Red see states). This result coincides with our view that weakness in regulatory framework of natural resource management is a major driver of gold smuggling in the country. The regulatory restriction that only gold council members and jewelry traders locating in the capital city of the country are the sole buyers of gold from all miners in the country could be the main cause of smuggling. This requires lifting or easing the exclusive right given to the gold council members and a few jewelry traders in the capital city Khartoum the monopsony power of buying gold from all artisanal miners. Also required to adopt more stringent monitoring regulations on gold exports by jewelry traders.

Keywords: Gold, smuggling, artisanal miners.

1- Introduction:

In recent years, Sudan has witnessed a wide range of gold-mining operations by artisanal miners in many states in the country. As of 2016 about 2 million people from all parts of the country participated in gold mining activities. Despite the rising importance of gold mining in the national economy, the gold industry in general seems improperly managed as artisanal gold mining in the country takes place on geographically extensive territories, while the government administrative bodies have often insufficient resources to monitor the mining activities, in addition to the poor governance system to manage national resources in general. Studies on gold (or precious metals) smuggling are scanty and informal in most cases as data availability is the major constraint to search it in depth. However, recent studies (Mathias and Feys, 2014; Oomes and Vocke, 2003; Bloomberg, June 21,2013) report four major causes behind smuggling of precious metals in developing and under developed countries. First, precious minerals can be smuggled from producer to consumer countries, to finance armed conflicts. This motive can be very strong in countries facing internal armed conflicts, as the

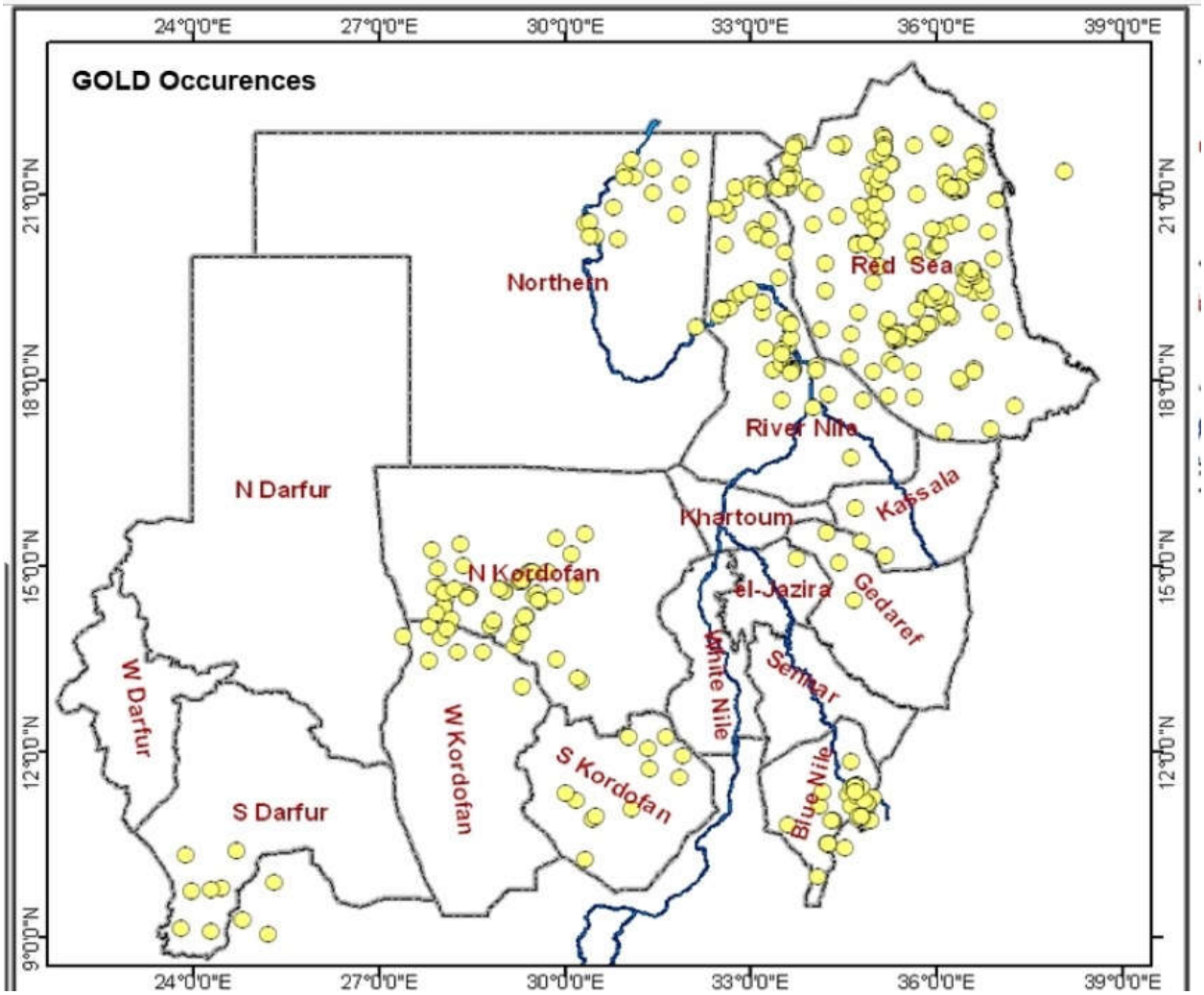
current case in Sudan. Second, it could be the case to avoid domestic taxation, and for that reason producers refrain from declaring the real value of their production to the authorities to minimize their tax exposure. Third, as a vehicle for laundering, as precious minerals can be purchased with illegal funds, such as the proceeds of drug or human trafficking. As an illustration, drug dealers in the U.S. were alleged to have purchased gold with the proceeds of drug trafficking. This gold was then reworked and disguised into everyday items in order to ship it back to a South American nation. Drug gangs in Western Europe have reportedly turned to the diamond trade to launder funds. Also, precious minerals are attractive because they can be used in trade based money laundering schemes, as a cover for laundering illegal funds generated by other crimes, for example through price manipulation or false invoices covering fictitious sales of gold or diamonds when, in fact, the money was generated by various offenses. The proceeds are thus passed off as having been generated by the legitimate buying and selling of gold or diamonds. Fourth, precious minerals can be used as an alternative currency to purchase prohibited or restricted goods, such as gold for cocaine, and diamonds for weapons, or as a mean to store wealth generated by illegal activity and avoid seizure and confiscation.
The current paper addresses smuggling gold production in Sudan. The paper consist of five sections. Section two, describes gold management system, with special focus on the various stakeholders involved with gold production and trading. Section three illustrates the methodology employed in the study. Section four discusses the empirical findings, and the final section concludes the study.

2- Gold management system:

A striking feature of gold management in Sudan at the present time is diversity and multiplicity of stakeholders involved in the operations of gold production and manufacturing (figure 1). Initially, Sudan company for gold mining as a government company takes 10% as royalty from production of any miner of gold. The artisanal miners, as producers of gold get funds for their daily expenses by the dealers who lend them in exchange for raw gold. Natural resource regulations stipulate that dealers can sell their gold quantities either to jewelry traders in Khartoum, or to the council of gold which represent intermediary body between gold producers and the bank of Sudan (the Central Bank). Jewelry traders can either sell in the local market or export to the wholesalers of gold market in Dubai. As indicated by the doted arrow lines in the figure, the current gold management system has some flaws that open venues for smuggling of the gold outside the country. The first venue is that since most mining sites in the country at remote areas from the capital, and at borders with neighboring countries (see the map below) gold dealers may find it costly or unsafe to transport their quantities to jewelry traders or to the gold council in the capital city Khartoum. As a result, it becomes more feasible to smuggle via the nearest border to a neighboring country. The other smuggling venue is that the regulatory setup organizing the export of gold by jewelry traders is also weak, as a result many of these traders may find it tempting to sell their gold outside the country without bringing back the equivalent sales revenue[1].

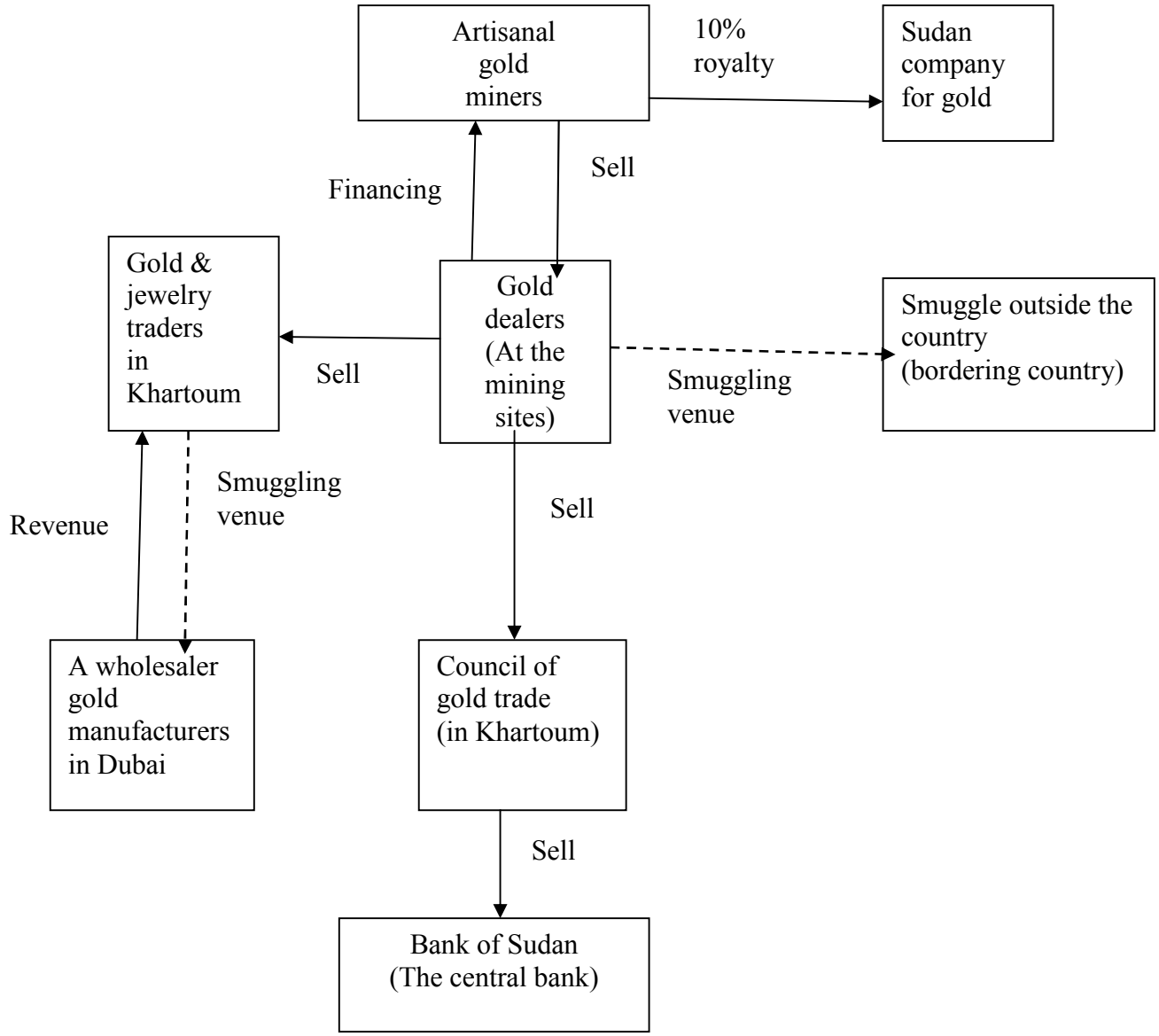
[1] A motive for this is the anticipation of domestic currency depreciation in terms of US$, and other convertible currencies.

Gold mining map:



Source: Google;"Sudan Gold Geology"

Figure (1): Gold management system in Sudan



3- Methodology:

The Data Envelopment Analysis (DEA) differ according to difference in the shape of the efficient frontier. In this paper we employed two DEA models. We use the CCR (Charnes, Cooper, and Rohdes, 1978), and BCC (Banker, Charnes, and Cooper, 1984). The CCR and BCC models differ as the former evaluates scale as well as technical inefficiencies simultaneously, whereas the latter evaluates pure technical efficiency. In other words, for a decision making unit (DMU) to be considered as CCR efficient, it should be both scale and pure technically efficient. For a DMU to be BCC efficient, it only needs to be pure technically efficient. As a result, the ratio of CCR efficiency score over the BCC score gives the scale efficiency index. The main objective of a DEA study is to project the efficient DMU onto the most efficient frontiers of the manufacturing units in the sample, under the assumptions of constant return to scale and change in return to scale. There are two directions, input-oriented approach that aims at reducing the input amounts by as much as possible at a given level of output, and the output-oriented, approach that maximizes output levels at a given input level.

In vector notation the input-oriented CCR model, with a real variable θ and a non-negative vector $\lambda = (\lambda_1, ..\lambda_n)^T$ of variables can be expressed as:

$$\min \theta \qquad (1)$$

subject to:

$$\theta x_0 - \lambda X \geq 0 \qquad (2)$$

$$y_0 - \lambda Y \leq 0 \qquad (3)$$

$$\lambda \geq 0 \qquad (4)$$

Where y_0 and x_0 are respectively the output and the input levels related to the specific manufacturing unit under investigation, and *Y* and X are matrices denoting output and input variables. The objective function in equation (1) specify the minimum value of the scalar θ (the ratio of inputs to outputs) that satisfy the constraint in (2) whereas the constraint in equation (3) stipulates the minimization of inputs within a feasible region, and equation (4) imposes non-negativity constraint of the input and output weights.

The linear programming problem stated above has a feasible solution at θ =1, $\lambda_0 = 1$, $\lambda_i = 0$ ($j \neq 0$). Hence the optimal θ, denoted by θ^*, is not greater than 1. On the other hand, since X>0, and Y>0, the constraint (4) forces λ to be nonzero because y_0>0. Putting all this together, we have $0 < \theta^* \leq 1$.

The input-oriented BCC model evaluates the efficiency of manufacturing units by adding to the constraints in (2) – (4), the new constraint $e\lambda = 1$, and solving for the minimum objective function in equation (1).

Geometrical illustration of the two basic models of technical efficiency measurement, CCR and BCC, can be shown in figure (2).

Figure (2)

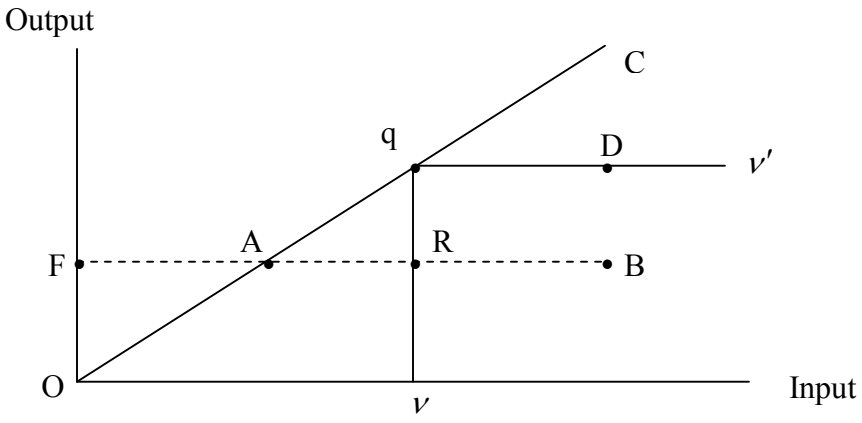


Figure 2, exhibits the units, A, R, B, q, and D each with one output and one input. The efficient frontier of the CCR model is the line (OAC), that passes through the origin. The frontier of the BCC model consists of the lines connecting v, R, q and D. The production possibility set is the area enclosing the frontier lines. At point B, a manufacturing unit is CCR and BCC inefficient. But at point q, a manufacturing unit is CCR and BCC efficient. Generally, the CCR-efficiency does not exceed BCC-efficiency. The inefficiency score of the point B inside the frontier according to CCR model is computed as ratio FA/FB (reflecting how close point B would be to point A, along the radial line OC). Thus, according to CCR model a manufacturing unit should reduce its inputs by $(1-\theta_i)$ in order to be at the efficiency frontier at point A. However, when the BCC model (variable return to scale technology) is taken into account, the overall technical efficiency reveal pure technical efficiency, which is given by the ratio $FR/FB=\sigma_i$, which measures the scope for efficiency improvement at current scale of operation. It is important to note that scale efficiency can be affected by poor management within the organization or disadvantageous operating environment. Thus, scale efficiency which is $\pi_i=\theta_i/\sigma$ measures the extent to which a producer can take advantage of return-to-scale by altering its size towards optimal scale. The fraction of output lost due to scale inefficiency can be computed as $(1-\pi_i)$. Scale efficiency equal one unit at any point along the CCR frontier line OC, at which production technology exhibits constant return to scale. Scale inefficiency can arise due to variable (increasing or decreasing) return to scale. On the other hand, pure technical inefficiency occurs because a manufacturing unit uses more inputs than needed (input waste). Alternatively, pure technical inefficiency can be caused by inefficient implementation of the production plan in converting inputs to outputs (managerial inefficiency). However scale inefficiency could be due to divergence of manufacturing unit from the most productive scale size. Therefore decomposing technical efficiency into pure technical and scale efficiencies allows us to gain insight into the main source of inefficiency.

4- Empirical analysis:

To assess the size of smuggling we employed Data Envelopment Analysis (DEA) using primary data survey covering about 18 mines across the country during the year 2016. The output variable represent gold production of each state and the inputs represent the water mills, and the number of mines (wells) in each state. The findings in the paper indicate that about 34% (14.3 tons out of total of 42.1 tons) of the artisanal gold production in Sudan for the year 2016 is smuggled outside the country. The distribution of the smuggled gold among the states reveal that the states with bigger share of smuggling are those with either of internal armed conflicts (South Kordofan and Darfour states) or border states at loosely controlled borders (Northern and Red see states). This result coincides with our earlier expectation that when mining sites are located at remote areas from the capital, and bordering loosely controlled areas, gold dealers may find it costly or unsafe to transport their quantities to jewelry traders or to the gold council in the capital city Khartoum, as required by regulations.

The policy implications of this research findings are:

a- The size of gold smuggling in each state can reveal the main cause of smuggling.

b- The size of gold smuggling uncover the loopholes in the current natural resource management system.

c- The research findings also highlight the importance of organizing the financing of the artisanal gold mining sector.

Table (1): Technical and scale efficiency

Name of state	CCR efficiency	BCC efficiency	Scale efficiency
Northen	0.24778	1.00000	0.24778
Nile River	1.00000	1.00000	1
Red Sea	0.66921	1.00000	0.66921
Kassala	0.63141	1.00000	0.63141
Gadarif	0.09372	0.09425	0.994377
North Kordofan	0.09181	0.17758	0.517006
West Kordofan	0.26123	0.87192	0.299603
South Kordofan	0.14656	0.65681	0.223139
North Darfor	1.00000	1.00000	1
South Darfor	1.00000	1.00000	1
Blue Nile	1.00000	1.00000	1

Table (2): Estimation of gold smuggling

Name of state	Gold Production (Tons) (1)	Scale Efficiency (2)	Smuggled quantities (Tons) (3)
Northen	5.65	0.25	4.250
Nile River	5.44	1.00	0.00
Red Sea	4.79	0.67	1.580
Kassala	0.43	0.63	0.160
Gadarif	2.91	0.99	0.020
North Kordofan	1.62	0.52	0.780
West Kordofan	4.92	0.30	3.450
South Kordofan	5.24	0.22	4.070
North Darfor	4.56	1.00	0.00
South Darfor	3.47	1.00	0.00
Blue Nile	3.07	1.00	0.00
Total	42.1		14.3

*To estimate smuggling we used the relation: (3)=[1- (2)](1).

5- Concluding remarks

Empirical findings in this paper indicate about 34% (14.3 tons out of total of 42.1 tons) of the artisanal gold production in Sudan for the year 2016 is smuggled outside the country. The distribution of the smuggled gold among the states reveal that the states with bigger share of smuggling are those with internal armed conflicts (South Kordofan and Darfour states) or bordering loosely controlled country borders (Northern and Red see states). This result coincides with our earlier speculation that when mining sites are located at remote areas from the capital, and bordering loosely controlled border areas, gold dealers may find costly or unsafe to transport their quantities to jewelry traders or to the gold council in the capital city Khartoum, as required by regulations. This requires lifting or easing the exclusive right given to the gold council group and jewelry traders in Khartoum as exclusive buyers of gold from artisanal miners. Also required to impose stringent monitoring regulations organizing the export of gold by jewelry traders.

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