



Economic sustainability of the gold mining industry in Burkina Faso



Youmanli Ouoba

Economics Department, University of Ouaga 2, Burkina Faso

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ABSTRACT

This study analyzes the economic sustainability of the gold mining industry in Burkina Faso. For this purpose, the green gold GDP is used. First, the depreciation of gold stock was estimated using the concept of Hotelling rent and second, the environmental damage from gold mining companies was estimated. The human capital and the “double difference” approaches are used to estimate the environmental damage related to water and air quality deterioration. The results show that approximately 40% of the mining added value represents natural capital depreciation. The depreciation of natural capital is more important than mining revenues invested by the government. This study provides evidence that a sort of resource curse may exist, and as a result, a part of the resource rent is spent inefficiently.

1. Introduction

Burkina Faso's mining sector has grown since 2007 through revision of the mining code in 2003 and the increase in the market price of gold. From one mining company in 2007, the number increased to seven producing gold mines in 2013. The contribution of the mining sector to the country's GDP rose from 0.2% in 2007 to 20% in 2013 (Mining office, 2013). In addition, the gold share in total exports increased from 5.4% in 2007 to 62.9% in 2010 and has risen further in 2012 to approximately 79%. Thus, since 2009, the mining sector has become the primary foreign exchange earner for the country. It generated approximately 9000 direct jobs and 27,000 indirect jobs; these numbers multiplied by 10 between 2005 and 2010 (Sba-Ecosys-CEDRES, 2011).

The main problem is that these figures may hide a strong depreciation in gold stock and environmental damage. The growth of gold GDP, if it is significant from a macroeconomic point of view, cannot provide an answer to economic sustainability because it does not take into account the environmental degradation of these mines and gold stock depreciation (Foy, 1991; Dasgupta and Mäler, 1999). Early, empirical evaluations showed that in countries with rich natural resources, there can be GDP growth with a decrease in well-being (Sachs and Warner, 1995). There are two possible explanations for this phenomenon named “resources curse”. The first is that countries rich in natural resources are not reinvesting enough resource rent in productive capital to offset the depreciation of natural capital (Hartwick, 1977; Solow, 1986). In addition, resources generally managed through funds are spent inefficiently (Ouoba, 2016). The

second explanation is the problem of measurement of well-being (Vincent, 1997). On this last point, Weitzman (1976) notes that the net domestic product (NDP) is a suitable estimation of a country's true economic income. Thus, traditional measures must take into account the depreciation of natural capital as well as the depreciation of productive capital. Previous studies have tried to integrate the depreciation of natural capital to provide a true measure of income using diverse techniques (Repetto et al., 1989). In the case of exhaustible resources in particular, the measures of depreciation are used to evaluate green mining GDP (Figueroa et al., 2002, 2010; Figueroa and Calfucura, 2003) as well as to analyze the effectiveness of the government to capture rent through royalties as a necessary condition for sustainability (Lange and Motinga, 1997; BIGNAUT and HASSAN, 2002; Cantuarias-villesuzanne, 2012). In countries where mining is entrusted to private companies, a necessary condition for sustainable management of the resources would be that the royalties collected by the government (institutional royalties) offset the cost of resource depletion (economic royalties). This necessary condition is rarely considered in green accounting studies that are normally used to assess the economic sustainability of one economic activity.

This study assesses the depreciation of natural capital that integrates the depreciation of gold stock and pollution damage from gold mining companies. The first contribution of this study is to provide a measure of green gold GDP in Burkina Faso. The second contribution is to conduct an analysis of the physical damage of pollution before the monetary valuation is considered. Indeed, most previous studies on the evaluation of environmental damage were done on the basis of a single reference point. They did not take into account changes over time nor

E-mail address: theodoreouoba@yahoo.fr.

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did they compare the affected situations with a controlled situation. This can lead to an overestimation of the damage. This study, however, uses the technique of “double difference” to estimate the net impact attributable to gold companies. Unlike previous studies, it uses the human capital approach to assess the damage that is more consistent with the principle of the market value of traditional accounting systems. The assessment of green GDP in the mining sector is primarily focused on Latin American countries (Figueroa et al., 2002, 2010; Figueroa and Calfucura, 2003) and Asian countries (Repetto et al., 1989; Vincent, 1997). This study provides optimal management of mineral resource prospects for African countries, while showing the effectiveness of the current royalty rates to capture more rent from gold companies in Burkina Faso.

The remainder of this paper is organized as follows. Section 2 describes the methodology used. Section 3 presents the results on the depreciation of gold stock, pollution damage and green gold GDP. Section 4 discusses the policy implications of the results and the related works. Section 5 concludes.

2. Methodology

This section provides a theoretical review of methodology used and data sources.

2.1. Theoretical background and the model formalization

The problem of optimal exploitation of an exhaustible resource was first treated by Hotelling (1931). For exhaustible resources, the opportunity cost of depletion should be included in the extraction cost to ensure equitable consumption between generations. Subsequently, Solow (1974) and Hartwick (1977) analyzed the impact of exhaustion on the sustainability of economic growth. They showed that maintaining a constant total capital stock guarantees a non-decreasing total utility between generations. In particular, the sustainability rule relates to the reinvestment of rent into other forms of capital (human capital and physical capital) to replace the depreciated natural capital (Hartwick, 1977). If natural capital is integrated like physical capital into the national accounts, then green net domestic product can be interpreted as a long-run measure of economic well-being in the sense that it is the stationary equivalent of future consumption (Weitzman, 1976). Thus, adjusted net savings, on the one hand and green net national product, on the other hand are increasingly the main indicators used to analyze the sustainability of growth (D’Autume and Schubert, 2008).

The adjusted net savings (ANS) as defined by the World Bank measure the savings after adjusting gross national saving (GNS) for education expenditure (EE), depreciation of produced capital (Dk_m), depletion of natural resources (Rent), and damage caused by carbon dioxide and particle emissions (Pollution). Formally, the ANS is represented by (Hamilton and Clemens, 1999): $ANS = GNS + EE - Dk_m - Rent - Pollution$

This indicator is subject to much criticism (Stiglitz et al., 2009). For example the World Bank uses total resource rent instead of Hotelling rent to measure economic depreciation of nonrenewable resource stocks (Vincent, 1997). Arrow et al. (2003) showed that ANS ignores the dynamics of population growth. Finally, it considers that the rent must be reinvested only in human capital (such as education) to put the economy on a sustainable path. However, reinvestment in other sectors (health, R&D, infrastructure, etc.) may be relevant especially for developing countries (Figueroa et al., 2002).

The second indicator arises from Weitzman's (1976) work on the net domestic product (NDP). Hartwick (1990) demonstrates that NDP is equal to the current Hamiltonian value. The model supposes a closed economy that produces a composite good and has a stock of a nonrenewable natural resource (Figueroa and Calfucura, 2003). In the absence of new discoveries, the objective function that maximizes

welfare is given by:

$$Max \int_0^{\infty} U(C) e^{\delta t} dt$$

$$S/C$$

$$\dot{K} = F(K, Q) - f(Q) - \delta K - C \tag{1}$$

$$\dot{S} = -Q \tag{2}$$

C is the aggregate consumption, K is the stock of man-made capital, \dot{K} is the net investment in man-made capital, while δ is the rate of depreciation. S is the stock of the exhaustible natural resource, Q is the extraction rate of this resource. $F(K, Q)$ is the production function of the composite good of the economy and $f(Q)$ is the total cost of extracting the nonrenewable resource. Eq. (1) corresponds to the net investment or capital accumulation and Eq. (2) reflects the reserve dynamics characterized by extraction.

The current Hamiltonian value for the problem is:

$$H = U(C) + \lambda_1 \left(\dot{K} \right) + \lambda_2 \left(\dot{S} \right) \tag{3}$$

The first order conditions:

$$\frac{\partial H}{\partial C} = 0 \Rightarrow U' = \lambda_1 \tag{4}$$

$$\frac{\partial H}{\partial Q} = 0 = \lambda_1 (F_Q - f_Q) - \lambda_2 \Rightarrow \lambda_2 = U' (F_Q - f_Q) \tag{5}$$

By replacing the expressions of $\lambda_i (i = 1, 2, 3)$ in the equation, it follows:

$$H = U' C + U' \left(\dot{K} \right) - U' (F_Q - f_Q) Q \tag{6}$$

Assuming a linear utility function $U(C) = U_C C$, non-decreasing in C , like the one proposed by Hartwick (1990), and dividing Eq. (6) by U' , a monetary expression of the value of the Hamiltonian is obtained. This provides an expression for green NDP according to Weitzman (1976):

$$GNDP = \frac{C + K - \delta K}{NDP} - (F_Q - f_Q) Q \tag{7}$$

To obtain the green net domestic product (GNDP), the net domestic product (NDP) must include the depreciation of the natural capital. This depreciation is the second component of Eq. (7). The ecosystem goods and services that are a component of natural capital, should be taken into account to obtain a true measure of the change in economic well-being (Hartwick, 1990; Mäler, 1991; Barbier, 2013). In particular, if economic activity contributes to degradation (by the effect of pollution) of environmental goods and services then economic well-being decreases. The measure of this economic loss due to the effect of pollution should be based on the concept of market value according to the conventional accounting system. Therefore, using contingent valuation, protection costs and abatement costs (or hypothetical cost) methods would reduce the internal consistency of the National Account System (NAS) (Grosclaude, 1995). Because most environmental services have no market value, the environmental accounting system recommended the inclusion of health damage associated with degradation of these services (United Nations et al., 2003). Pearce and Warford (1993) showed that the most important and immediate consequences of environmental degradation take the form of health problems. Medical expenditures to cure diseases arising from pollution and defensive medical expenditures should not be subtracted from NDP whereas production hindrance due to illness occurring from pollution should be subtracted (Huhtala and Samakovlis, 2002).

Pollution damage must be subtracted from NDP to have green net domestic product (GNDP) that is used to analyze economic sustainability.

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