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Gold exploitation and socioeconomic outcomes: The case of Burkina Faso

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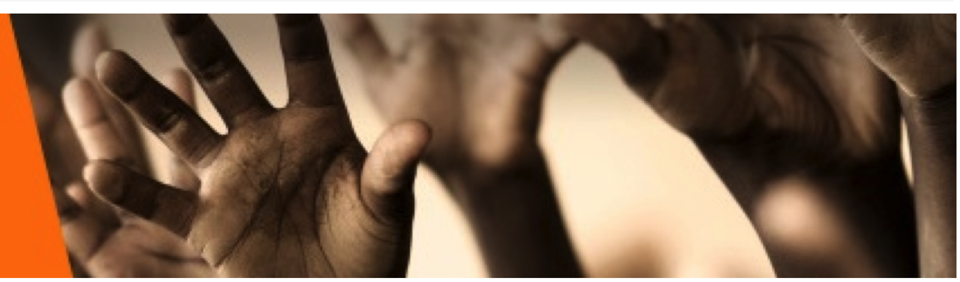

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policy analysis on growth and employment

Gold exploitation and socioeconomic outcomes: The case of Burkina Faso

Abstract

This paper investigates how the gold boom that started in 2007 has affected socioeconomic outcomes in Burkina Faso. A simple theoretical model was developed to show the expected impacts, and these were validated by an empirical analysis. Results suggest that areas hosting gold extraction have better average living standards in terms of headcount ratios, poverty gaps and household expenditures than their counterparts who do not live in such areas. However, this can increase inequality and child labor, and therefore, raises the growing need of governmental interventions to reverse such negative impacts.

JEL: D11; I32; O13; Q33.

Keywords: Gold mining, Poverty, Inequality, Schooling, Child labor, Burkina Faso.

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Executive summary

Burkina Faso is considered to be a low-income country. The principal economic activity is agriculture, and the majority of the people are poor. For instance, almost half of the population was still below the poverty line in 2009. In the same year, the agricultural sector (including forestry, hunting, fishing, crops and livestock production) represented about 35% of the GDP (see statistics from the World Development Indicators, 2009). Burkina Faso also has mining resources. The mining sector (mainly consisting of gold production) plays an increasingly important role in the economy of Burkina Faso. Before 2007, the gold mining sector was dominated by artisanal and small-scale gold mining, and the contribution of the sector to the national revenue was not substantial. However, since 2007 the government has initiated many reforms to increase its revenue from gold production and to reduce poverty. The consequence of these reforms was the gold mining boom experienced during the period of 2007 to 2009.

From 2007 to 2010, seven gold mining companies came into operation and gold production was multiplied thirtyfold. In 2010, the revenue from gold exploitation represented 67% of all export revenue and 9.8% of GDP. Moreover, in 2012, the earnings from gold exploitation substantially raised from 437 billion CFA francs to 806 billion CFA francs. Based on this performance of the country in terms of gold production, some questions arise. Does this gold boom impact the living standards in Burkina Faso, in particular, poverty rates and inequality? What is the effect of this resource boom on schooling and child labor? Our main objective in this study is to answer these questions.

In the literature, the effect of natural resource exploitation on economic performance is diversely discussed. A trend of that literature is to describe a negative impact of natural resources while others consider that natural resource exploitation should not harm the economy. The overall message is that the result depends on the indicator used to assess economic performance, the economic policy, and the institutional environment under which the economy is led. The findings may significantly vary if we consider average income, schooling, poverty and inequality, investment, infrastructure creation, or social stability. Most of the studies have found that the natural resource boom is a source of income increase, but this increase in income is generally challenged by lower schooling or the exacerbation inequalities.

In this paper, we investigate the effects of gold exploitation on poverty, inequality, average income, schooling and child labor. First, we develop a theoretical model to show the effects of gold exploitation on expenditure, inequality and schooling. Second, we estimate the effects using household data.

Based on this model, we find that gold exploitation has a positive effect on expenditure for both industrial and artisanal mining, and that there is more inequality in industrial mining than in artisanal mining. We also find that gold exploitation increases school dropouts.
To estimate the effects empirically, we use microdata from household surveys (*Enquête Burkinabè sur les conditions de vies des ménages*, EBCVM 2003, and *Enquête intégrale sur les conditions de vies des ménages*, EICVM 2009) as well as administrative data. The 2003 survey covers a period in which formal gold extraction was in its infancy and the 2009 survey spans the period of the gold resource boom. The use of the two data sets enables an assessment of the extent to which the gold boom has contributed to improving living standards. Our method consists of comparing the outcomes of two groups. The first group named *producing municipalities* is composed of municipalities in which there is gold extraction and the second group, the *non-producing municipalities* are those without gold extraction.

Our empirical findings show that gold exploitation may help to reduce poverty and increase average income. This suggests that a policy supporting gold extraction could lead to better average living standards in Burkina Faso. Although the effects on inequality, schooling and child labor are not clearly supported, there are good reasons to believe that gold exploitation may increase inequality in Burkina Faso. It may also have a negative effect on schooling, and may have increased child labor in gold mining sites. Therefore, a policy supporting gold extraction should be paired with programs or strategies to prevent negative outcomes such as worsening inequality, school dropouts and child labor.

I. Introduction

The so-called *resource curse* refers to a situation in which abundant natural resources do not help raise living standards of populations. This is a much-researched topic in the economics literature. Most studies have focused on the relationship between the abundance of natural resources and income inequality or income growth in a macroeconomic framework (see, for example, Leamer, Maul, Rodriguez & Scott, 1999, Fum & Hodler, 2010, and Papyrakis & Gerlagh, 2007). Mineral resource abundance, as well as exploitation of natural resources, have been found to have a negative correlation with long-term economic growth. Other studies based on a cross-country analysis report some more nuanced results (see for example Parcero & Papyrakis 2014).

In the case of microdata, the literature has focused on the links between natural resource extraction and poverty, and inequality. The main findings suggest that industrial mining is likely to be more associated with poverty exacerbation while artisanal and small-scale mining has a positive effect on poverty reduction. According to Gamu, Le Billon and Spiegel (2015), this is due to the fact that industrial mining generates fewer employment opportunities than artisanal and small-scale mining. The existence of various empirical studies provides some insights on the relationship between extractive mining and poverty. However, little evidence is focused on low income countries and particularly Burkina Faso, which is endowed with natural resources including gold.

Several reasons could explain why Burkina Faso has been experiencing a gold boom since 2007. In 2007, the country implemented three projects and launched many reforms intended to increase gold revenue in order to lead to poverty reduction. These projects aim to improve the cadastral plan and the financial management of mining activities, to strengthen small-scale mining, to regulate artisanal mining and to create a statistical database for monitoring the effects of mining on the environment (MME, 2013). The major reform is the revision of the 2003 Mining Code to attract foreign direct investments in the gold mining sector. As a result, four commercial mining licenses and 69 exploration rights were allocated in 2007. The combination of these reforms with the increase in gold prices in the international market during this period have led to the gold mining boom, making gold the main product of exports and the main source of economic growth.

Does this gold boom impact the living standards in Burkina Faso? The main objective of this research is to investigate how the gold boom has affected socioeconomic outcomes including poverty, inequality and expenditure. This is important for policy makers to improve the living standards of the population. Furthermore, this research examines the impact of the gold boom on schooling and child labor which were little-discussed in investigations of the resource curse.

We propose a theoretical model to show the effects of gold exploitation on expenditure, inequality and schooling. We find that gold exploitation has a positive effect on expenditure for both industrial and artisanal mining, and that there is more inequality in industrial mining than in artisanal mining. We also find that gold exploitation increases school dropouts. Empirically, we find that areas hosting gold extraction have better average living standards in terms of poverty rates and household expenditures than their counterparts without gold exploitation. Although the effects are not statistically significant on inequality and child labor, they are robustly positive, showing that gold exploitation might increase inequality and child labor.

The rest of the paper is organized as follows. Section 2 presents a brief literature review on natural resources. Section 3 describes the situation of gold exploitation in Burkina Faso. In Section 4, we develop a theoretical model followed by an empirical strategy to assess the effects of gold exploitation on the outcomes. We also describe the data. Section 5 presents the findings and Section 6 concludes.

II. Literature review

The link between natural resources and economic performance has been extensively discussed in the literature. While one trend of the literature describes a negative impact of natural resources, mainly under the hypothesis of Dutch disease (Sachs & Warner, 2001; Davis & Tilton, 2005; Mogotsi, 2002; Corden & Neary, 1982, and Karl, 2004) or under the more general concept of resource curse (Collier & Hoeffler, 2000; Ross, 2004; Leite & Weidmann, 1999), opponents argue that natural resource exploitation should not harm the economy (Petermann, Guzman & Tilton, 2007; Davis, 1995; Stijns, 2005; Torvik, 2001;

Gylfason, 2001). In general, the result depends on the indicator used to assess economic performance, economic policy, and the institutional environment under which the economy is led. The findings may significantly vary if we consider average income, schooling, child labor, poverty and inequality, investment, infrastructure creation, or social stability as economic performance indicators[1]. Most of the studies have found that natural resource booms are a source of income increases. However, the rest of the effects are generally undermined by lower schooling and an increase in child labor. For instance, Santos (2014) shows that the gold boom increased child labor and decreased school attendance in Colombia. In the same vein, Kruger (2007) finds that a coffee boom led to higher child labor and school dropouts, particularly for poor households in rural Brazil.

Goderis and Malone (2011) used a theoretical and empirical analysis to examine the effect of resource exploitation booms on income inequality. In the theoretical model, they consider two types of labor (skilled and unskilled) and two production sectors (traded and non-traded) with a CES utility function. Theoretically, the paper finds that resource exploitation should reduce income inequality in the short term if the non-traded sector is intensive in unskilled labor. This finding is confirmed by empirical analysis. Howie and Atakhanova (2014) applied Goderis and Malone's (2011) theoretical findings to empirically assess the effect of a resource exploitation boom on income inequality. Their results indicate that resource booms decrease inequality, and that institutional quality and public health programs play an important role in that reduction.

Using district-level data from Peru, Loayza and Rigolini (2016) found that mining activity led to an increase in household consumption, and a decrease in poverty rates. However, this positive effect was mitigated by an increase in consumption inequality. In the same country, Aragon and Rud (2013) observed that gold exploitation increased local real income even though this was accompanied by an increase in the local price of non-tradable goods.

Fisher, Mwaipopo, Mutagwaba, Nyange and Yaron (2009) examined artisanal mining (specifically gold and diamonds) in Tanzania. They show that the sector contributed to poverty reduction within the population of mine workers. However, because of the non-

[1] For a more complete survey on the literature about natural resources and the economy, see van der Ploeg (2011).

regularity of mining, it may lead to an insecure standard of living. The effect of artisanal mining may be altered by formal (industrial) mining. This is the case in Burkina Faso where the positive impact of artisanal mining on poverty reduction is enhanced by the effect of formal mining on infrastructure creation. This is shown in an IMF country report from July 2014 (IMF, 2014).

Fum and Hodler (2010) introduced an ethnical aspect in the analysis. The result is that natural resources exploitation leads to civil conflicts and ends up increasing income inequality if the population is ethnically polarized. However, if the population is ethnically homogeneous, natural resources reduce income inequality. With cross-sectional data on different countries around the world, Leamer et al. (1999) concluded that the use of natural resources delays industrialization and reduces the size of highly-educated populations because workers are attracted to the natural resources sector which does not require qualified labor. In contrast, Pegg (2010) found that diamonds have a positive effect on education (size of educated population), savings and infrastructure creation in Botswana, even if the country is still struggling to diversify its economy.[2] Ge and Lei (2013) used a multiplier decomposition method and the social accounting matrix of China and showed that in terms of income increase and poverty reduction, mining activities contribute significantly to economic performance. However, this positive impact is more beneficial to the high and middle income households, rather than to low income households. Buccellato and Mickiewicz (2009) stressed the effect of corruption on natural resource benefit. In their paper the authors considered the case of oil and gas in Russia and mentioned that natural resources lead to higher average incomes. However, because of corruption and weak economic institutions, this increase in income goes hand-in-hand with larger inequality. Papyrakis and Gerlagh (2007) used disaggregated state-level data for the US. They found that, in absence of good institutions, resource abundance has negative impacts on investment, schooling and openness.

In developing countries and particularly in Burkina Faso, artisanal mining may lead to some gender-based social problems. Indeed, on the mining sites, girls and young women are exposed to sexual harassment, violence, exploitation, and infectious diseases, among

[2] See Karl (2004) who mentioned a similar result with oil exploitation. Indeed, the earlier stages of oil boom were characterized by an increase in per capita income, employment rate, and infrastructure creation. But after a while, this good economic performance was mitigated by the incapacity of the country to diversify its economy.

others (Werthmann, 2009). For a good overview of the prevailing situation in artisanal and small-scale gold mining in Burkina Faso, see Luning (2008) and Werthmann (2012).

III. Gold exploitation in Burkina Faso

Burkina Faso has been producing and exporting gold since 1960. Gold mining became a major sector in the country during 2007-09 given the quantity produced and the revenue it generated when world gold prices rose substantially. During the 1980s, the Bureau des Mines et de la Géologie du Burkina (*Office of mines and geology of Burkina Faso*), with the support from the World Bank, identified several potential gold mining sites. Since 1991, the country has had a mining policy. Liberalization of the mining sector began with the adoption of the Mining Code in 1997. This code was revised in 2003 and 2010. A new Mining Code was adopted in June 2015.

Between 2007 and 2010, seven gold mining companies came into operation. Gold production multiplied thirty times over between 2007 and 2010. The country rose to the rank of the third highest gold producer in the West African region in 2015. In 2011, it also became the first African country in terms of the amount spent on gold exploration. Indeed, in 2012, there were more than 80 gold deposit exploration projects, among a total of 250 in all Sub-Saharan Africa.[3] The boom in the gold mining sector is directly related to the increase in gold prices on the international market. Those prices increased by over 450% between 2003 and 2011, reaching $1,895 USD per ounce during 2014.

During the period before 2007, the quantity of gold produced in Burkina Faso remained low and never exceeded 2 tons.[4] From 0.7 tons in 2007, the production jumped to 5.4 tons in 2008, more than seven times the production in 2007. In 2009, gold production was 12.1 tons. This represents an annual increase of more than 100%. In 2014, the production rose approximately to 36.1 tons of extracted gold, giving the country a potential to increase its output.

[3] See for instance KPMG (2013).
[4] See Conseil Économique et Social (2012).

Despite the fact that the opportunities for direct employment in the gold mining industry may be limited due to high-skill labor and the capital intensive nature of gold mining, the increase in the production of industrial mining has led to a significant increase of labor supply within the mining sector. Between 2008 and 2009, the number of permanent jobs created by gold mining companies has grown nearly twofold, from 1,725 to 3,317. In 2012, the number of permanent jobs increased to 5,535 of which 3,698 are occupied by Burkina Faso nationals.[5]

It is also well-known that artisanal and small-scale mining generate more jobs than large-scale mining (see, for instance, Gamu et al., 2015). In the case of Burkina Faso, the increase in the number of people working in artisanal and small-scale gold mines is driven by the presence of significant gold deposits and gold discovery. The artisanal and small-scale mining sector accounts for more than 1 million people exploiting gold (Conseil Économique et Social, 2012). Significant gold reserves have also led to the emergence of large-scale industrial companies in Burkina Faso.

Besides, gold exploitation can positively affect the population's wellbeing through social direct investments from companies. In Burkina Faso, those investments have helped improve access to some basic social infrastructure and services particularly in some mining areas. Although they are not judged sufficient, they include schools, health centers, water, roads and electricity (Chambre des Mines du Burkina, 2013, and Ouédraogo, 2011).[6] However, gold exploitation can also affect the population's wellbeing negatively. For instance, it may lead to environmental degradation and pollution of water.

Gold mining revenues are substantial. For example, in 2012, the production of gold contributed to 806 billion CFA francs in earnings from exportation, whereas it was 437 billion CFA francs in 2010. This last amount represents 67% of export value and 9.8% of GDP. The contribution of mining companies to the government budget was 127 billion CFA francs in 2011 and 46.5 billion CFA francs in 2010. With the falling prices on the international market, the contributions of gold to the government budget fell from 191

[5] This data was obtained from the Ministry of Mines.

[6] When completing the paper, we learned that the government commissioned the Parliament to investigate the social responsibility of mining companies a little more closely.

billion CFA francs in 2013 to 168 billion CFA francs in 2014, representing a 12% reduction.[7] Small-scale mining operations that are often unregistered (and sometimes illegal) have accounted for a significant amount of gold production in Africa before the advent of reforms which increased the presence of large multinational companies (World Bank, 1992). In Burkina Faso, between 1986 and 1997, small-scale and artisanal mining production was 12 tons while the production from large-scale mines was 14 tons. However, currently, in spite of the number of miners involved in artisanal production, the production is not significant. Indeed, in 2012, artisanal gold production accounted for only 3% of the total production. Many small businesses operate without a license and with rudimentary equipment (ITIE-BF, 2014).

Furthermore, child labor is particularly prevalent in artisanal production, and this has potentially negative implications for children's schooling. Besides, the other adverse effects of artisanal extraction are environmental degradation, health-related challenges and conflicts.[8]

Despite the gold boom in Burkina Faso since 2007, the contribution of the sector to poverty reduction could be judged as lower than expected. This suggests that the management and redistribution of the resources from gold exploitation in Burkina Faso remains a problem. For the social benefit from gold exploitation, the new Mining Code adopted in June 2015 provides three provisions: (1) the introduction of royalties on the extracted value (ad valorem) of 1% that will lead to the development of local communities; (2) a corporate income tax; and (3) a tax on income from securities which increases to 6.3%. In addition, a local development fund was established for the improvement of local communities and the fight against environmental degradation, as laid out in Articles 26-28 of the new Mining Code of 2015.[9]

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[7]http://www.burkina-emine.com/?p=3168&lang=fr visited on October 3rd, 2015.

[8]See for instance Cote (2013). Given the lack of information, we are unable to take these variables into account in our estimations.

[9]For more details, see Conseil National de la Transition (2015).

IV. Methodology

Our methodology is based on two components. First, we develop a theoretical model to assess the impact of gold exploitation on a set of socioeconomic outcomes. Second, we follow an empirical strategy to estimate this impact using micro data from Burkina Faso.

4.1. Theoretical model

The starting point is by modeling the representative household utility inspired by Soares, Krueger and Berthelon (2012). In this model, we consider a representative household of the municipality i. We also assume that the household has one adult and one child, and its utility function is given by

$$u(c_i, h_i) = \alpha_i lnc_i + \beta lnh_i, \qquad with\ \alpha > 0\ and\ \beta > 0, \qquad (1)$$

where c_i is the household's consumption and h_i is the human capital of the child. We assume that α_i is a random variable with mean $\bar{\alpha}$. One unit of consumption is diversely valued over the household's population. For simplicity, we abandon the subscript i. Human capital is produced according to the technology

$$h = Ae_c^{\gamma} y^{1-\gamma}, \ \ with\ 0 < \gamma < 1, \qquad (2)$$

where e_c is the time devoted by the child to schooling (time spent in school), and y is the parents' investment in the child's human capital. Actually, y represents the material costs borne by the household and that are required to produce the child's human capital (equipment, tuition fees, etc.). Let us consider the following notations: l_c is the child's labor supply; that is, the time spent by the child in mining activities, t_c is the total amount of time available for the child, l_a is the parents' labor supply in mining activity, l_x is the parents' labor supply in activities other than mining, t_a is the total amount of time available for the parent, $w_c > 0$ is the child's wage in mining activities. As we can observe in Burkina Faso, we distinguish two types of gold mining activities: artisanal mining and industrial mining. w_i and w_a are the wages of the adult respectively in the industrial and the artisanal mining activities; w_x is the adult's wage in the other activities. We assume that $w_a \leq w_x \leq w_i$, $w_i > 0$ and $w_x > 0$. We have

$$t_c = e_c + l_c \text{ and } t_a = l_a + l_x. \quad (3)$$

We denote by 1_D the indicator variable taking a value of 1 if the municipality where the household is located is a gold producing municipality. 1_{DI} is the indicator variable taking a value of 1 if there is an industrial production in the municipality where the household is located. We also assume that the price p of the commodity y is affected by the status of the municipality (producing or not producing); that is,

$$p = p_1 1_D + p_0(1 - 1_D), \quad (4)$$

where p_1 and p_0 refer to the price of the commodity y respectively in the producing municipality and non-producing municipality. Two facts may lead to change in education goods prices. First, gold mining can induce population concentration in gold producing areas. This will increase demand for goods and then it will increase prices. In such a situation p_1 is greater than p_0. In other words, a gold boom leads to higher inflation. Second, gold exploitation may give the local authorities the financial capacity to subsidize education goods, and p_1 will be lower than p_0.[10] A summary of our setup is as follows.

Utility function: $u(c,h) = \alpha lnc + \beta lnA + \beta\gamma lne_c + \beta(1-\gamma)lny$

The household is subject to the following budget constraint:

The budget constraint: $c + py + w_c 1_D e_c \leq w_c 1_D t_c + \left((w_i 1_{D_I} + w_\alpha(1 - 1_{D_I}))1_D - w_x\right)l_a + w_x t_a$.

We normalize the price of consumption goods to one. The problem of the household is

$$\max_{c,l_c,l_a,y} \{\alpha lnc + \beta lnA + \beta\gamma lne_c + \beta(1-\gamma)lny\} \quad (5)$$

$$s.t.\ c + py + w_c 1_D e_c \leq w_c 1_D t_c + \left((w_i 1_{D_I} + w_\alpha(1 - 1_{D_I}))1_D - w_x\right)l_a + w_x t_a$$

$$e_c \leq t_c \quad (6)$$

To solve the problem we consider three different cases: case 1 where $1_D = 0$, case 2 where $1_D = 1$, and $1_{DI} = 1$,, and case 3 where $1_D = 1$, and $1_{DI} = 0$,. For any variable Y we denote by $Y_0, Y_{1.1}$, and $Y_{1.0}$ its values respectively in case 1, case 2 and case 3.[11]

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[10] We may also assume that the price of consumption goods varies from a producing to a non producing municipality.

[11] For more details, see the results derived in Appendix A.

From this model, we obtain that (for a given value of parameters) the outcomes depend on wage distribution across municipalities. Specifically, all the outcomes are non-decreasing functions of wages, except child schooling which decreases child wage. Indeed, a salary increase provides more revenue to households to consume more and be able to send children to school. In contrast, child wage is the cost of schooling. So, if the salary paid to children increases they will prefer gold mining activities to staying in school.

Another result from the model is that, even if schooling decreases with child wage it never gets to zero. Whatever the context, children will go to school. This is due to the importance of education in the utility function (Cobb-Douglas) of the households.

As we mentioned above, the goal of this section is to use a model to predict the effect of gold exploitation (industrial and artisanal) on some variables of interest. Specifically, in the next subsection, we discuss the effect of gold mining on child schooling (e_c), school good expenditure (Y), consumption (c), and inequality in the total expenditure (consumption and school goods) across households.

4.2. Theoretical effect of gold exploitation

To study the theoretical effect of gold exploitation, we calculate for each variable of interest Y the difference between case 1 and the other scenarios (cases 2 and 3). Specifically, we compute $Y_{1.1} - Y_0$ and $Y_{1.0} - Y_0$ For example, to find the effect of gold exploitation on consumption we compute $c_{1.1} - c_0$ $c_{1.0} - c_0$. We also compare industrial exploitation to the artisanal exploitation by computing $Y_{1.1} - Y_{1.0}$ for each variable of interest. Details of calculations are given in Appendix B.

4.2.1. Gold mining effect on child schooling time

Theoretically, children stay less in school when there is gold exploitation. In other words, gold exploitation increases school absence rates as student use a part of their time working in mining activities. Compared to the municipality with artisanal exploitation, children spend more time at school in the municipality with industrial exploitation. This result is due to our assumption that salaries of adults are higher in industrial mining than in artisanal mining. Therefore, because the adults receive a higher income, they do not need to ask their children to work. They are more able to satisfy household needs. However, if the child wage is too low (in comparison to other wages), we observe the same schooling time in gold producing municipalities as in the non-producing ones. Figures 1 and 4 give an illustration of these results.

4.2.2. Gold mining effect on school goods

The effect of gold exploitation on adults' investment in child human capital is ambiguous. The result depend mainly on p_0 (price of schooling goods in the non-producing municipalities) and p_1 (price of schooling goods in the producing municipalities). For instance, gold activities cause population concentration, and then, lead to an increase in goods' demand in mining areas. This may result in an increase in schooling goods prices. In such a situation, parent will invest less in human capital if there is gold exploitation. However, with gold mining, local government could subsidize education and decrease the price of schooling commodities. In such a case, investments in human capital would increase. Figures 5 and 6 give an illustration of these results.

4.2.3. Gold mining effect on household consumption

Theoretically, we find that gold exploitation has a positive effect on consumption. This holds for both industrial and artisanal mining. However, industrial mining increases consumption more than artisanal exploitation does. Indeed, we assume that wages for adults are higher in industrial mining than in artisanal mining. Therefore, higher income allows the households to purchase more consumption goods.[12]

4.2.4. Gold mining effect on expenditure inequality

Although gold exploitation is a source of increase in consumption and school goods, it may aggravate inequality in terms of total household expenditure. The total expenditure of a household is the total amount spent by that household on consumption and in school

[12] Here, we consider that the price of the consumption good is the same regardless of whether or not the household is living in a producing municipality. We could suppose a change in price due to gold exploitation, and the result will be ambiguous as we find for the school good.

goods purchases. Both artisanal and industrial mining may be a source of inequality aggravation. The result depends on the distribution of wages as illustrated in Figure 2. Specifically, it depends on the child relative wage in mining (in comparison with the industrial mining wage, and the wage in the other activity).

Indeed, if the child wage is too low, gold exploitation is not source of inequality. If the child wage is fair, artisanal mining is a source of inequality. Finally, if the child wage is too high, both artisanal and industrial mining are source of inequality aggravation, but industrial mining aggravates inequality more that artisanal mining. We come to this result for a simple reason. In our framework, the adults work full-time in any household, regardless of whether or not the municipality is a producing one. Therefore, what makes the difference between households is whether the child (or children) work. Thus, if the child wage is too low, the situation is close to that of no gold production because no child will work. If the child wage is fair, the situation is equivalent to the artisanal mining situation, because no child will work if mining is industrial. The child wage is not high enough to compensate for a drop in utility due to less schooling. In the case of a high child wage, children will work, income is high and this results in inequality. On the other hand, the effect of the child wage is also conveyed through schooling and then human capital, not only from an increase in income. Indeed, the child wage is the price of a good (schooling) which is directly used in the utility function through the production of education goods. In other words, the child wage is the cost of human capital production. w_c has an impact on the effect on inequality because of education. If human capital has no effect on inequality, then inequality will not depend on w_c. So, inequality aggravation solely depends on w_c because, in our model, there is human capital accumulation only for children, not for adults who work full-time.

Even if gold exploitation has a clear effect on some outcomes, its effect on welfare is ambiguous as the effect on human capital is ambiguous. Mining allows people to have access to consumption of goods, but does not necessarily ensure human capital accumulation for the future generations.

4.3. Data

We gather data from different sources, microdata from household surveys and administrative data. The combining of different data sources is relevant for two reasons. First, in order to assess the effect of gold exploitation on income disparities, the use of microdata appears to be more appropriate. We rely on two nationally representative household surveys (*Enquête Burkinabè sur les conditions de vie des ménages*, EBCVM2003, and *Enquête intégrale sur les conditions vie des ménages*, EICVM 2009). Second, while the 2003 survey covers a period in which formal gold extraction was in its infancy, the 2009 survey spans the period after a remarkable gold resource boom. This will enable an assessment of the extent to which the development of gold mining has contributed to improving local living standards.

Both surveys contain information on socioeconomic characteristics, assets and consumption on around 8,500 households. The two samples cover all the regions and provinces of the country. In fact, Burkina Faso is divided into 13 administrative regions and 45 provinces. Each region is composed of 3 provinces and each province has 7 municipalities on average. The municipality is the smallest administrative area recorded in the data. The information related to gold extraction is also available at the municipality level. We therefore consider the unit of analysis to be the municipality. The 2009 sample contains 284 municipalities while that of the 2003 contains 234 municipalities. However, we rely on the municipalities that are common for both surveys, comprising 201 municipalities. We construct a balanced panel dataset of these 201 municipalities for the two periods of 2003 and 2009.

Two types of municipalities are distinguished: producing municipalities and non-producing municipalities. The first group is composed of municipalities in which gold exploitation existed before 2009. Non-producing municipalities are those which did not host any mining activities before that time. Producing municipalities are not only those hosting industrial gold mining as they are in previous studies (for instance, see Loayza, Teran & Rigolini, 2013 and Zambrano, Robles & Laos, 2014), but also those with artisanal mining activities. We do this in order to account for both artisanal and small-scale mining when estimating the impact of gold exploitation on population living standards. Despite its low contribution in terms of production, artisanal mining is still an important phenomenon throughout the country. It is therefore relevant to take it into account in the analysis.

We consider the municipalities which hosted artisanal mining and for which licenses have been attributed to the holders to formalize small-scale mining activities. Because there are more than 200 artisanal mining licenses, we select only those licenses attributed before 2010. Finally, the sample is composed of 45 producing municipalities of which 5 municipalities host industrial mining, and 156 municipalities are non-producing municipalities. Producing municipalities are considered to be the treatment group and non-producing municipalities are considered to be the control group.[13]

4.4. Empirical strategy

Our identification strategy relies on the assumption that 2003 refers to a period before formal gold mining extraction. In fact, during that time, the government reformed its mining law in order to attract foreign direct investments in the gold sector for the purpose of developing a large scale mining industry. As shown in Figure 3, the year 2009 saw an increase in gold production and is considered as a year of gold expansion. We exploit this source of variation in order to assess the effect of gold exploitation.

As one recalls here, our objective is to estimate the impact of gold mining exploitation on outcomes, as denoted by $Y_{1.1} - Y_0$in the theoretical model. Precisely, we plan to estimate $E(Y_1 - Y_0)$ conditional on some retained set of covariates, and where Y_1 is simply the value of Y when $1_D = 1$and Y_0 is the value of Y_0 when $1_D = 0$. Thus, the objective here is to assess the average effect of the rapid expansion in gold extraction on some specific socioeconomic outcomes in the producing municipalities.

The common raised problem with impact evaluation studies is the selection bias, and where the treated group differs by their characteristics to the control group. The other usual econometric problem is the endogeneity that may exist when the explanatory variables are correlated with the error term, and especially the specific characteristics of the analyzed

[13] Following Loayza et al. (2013), we could distinguish between three categories of municipalities: producing municipalities in which there existed a gold exploitation before 2009, non-producing municipalities in producing provinces and non-producing municipalities in non-producing provinces. This approach is used in the Appendix for the purpose of robustness checks.

entity, *viz*, the municipality in our case. Different econometric approaches can be used to estimate such effects of a boom in gold extraction. According to the panel form of the data we use, difference-in-differences (DID) appears to be the most appropriate one. This econometric specification can be simplified in one linear regression model. Formally, our basic DID model is given by:

$$Y_i = \alpha + \gamma t_i + \delta D_i + \beta^{\prime} X_i + \theta t_i D_i + \mu_i \tag{7}$$

where Y_i refers to a given outcome of municipality i, such as, the headcount ratio, the poverty gap, the inequality index (for instance the Gini coefficient), the schooling rate and child labor; t_i is a binary time indicator; D_i is a dummy variable that it is equal to 1 if the municipality i is producing gold and 0 otherwise; X_i is a set of municipality characteristics (or covariates) and μ_i represents the error terms. We assume that the error terms μ_i are independent and identically distributed.

In this model, θ is the DID estimate of the average effect of gold extraction on the outcome variable, the usual parameter of interest. The intercept α refers to the constant effect for the control group in 2003 and the coefficient γ is the time trend effect common to treatment and control groups. δ is the effect of being targeted for the treatment while the vector β contains the parameters of the covariates for the two groups.

As mentioned above, a main concern in this analysis is that the municipalities that produce gold could be different from the municipalities that do not produce gold, and the fact that this may be correlated with the outcome variable. The main advantage of using the DID model is that it allows us to control for time-invariant unobserved heterogeneity. According to Lechner (2010), there is no need to control for all confounding variables in the case of a DID estimation. However, it is based on the key identifying assumption that the outcome variable in producing and non-producing municipalities would follow the same time trends in the absence of gold extraction. This is often referred to as the common trend assumption in the literature. While there is no formal test to directly verify this assumption, it is common to test whether the time trends in the control and treatment groups were the same in the period prior to the treatment.

When the vector X includes variables that vary across municipalities and time, the linear regression (7) can be rewritten as:

$$Y_{it} = \alpha_i + \gamma t + \beta' X_{it} + \theta D_{it} + \mu_{it}, \tag{8}$$

where Y_{it} is the outcome variable of the municipality i in year t; α_i is a municipality fixed effect; t is a binary time indicator; $D_{it} \equiv t * D_i$ and μ_{it} are the idiosyncratic error terms assumed to be heteroscedastic.[14] Because gold extraction present in one municipality could affect neighboring municipalities, we use robust estimations clustered at the municipality level to avoid potential bias in estimations of the standard errors. In this paper, we rely on the specification (8) as the main econometric model.

As above, θ is the DID estimate of the effect of gold exploitation on the outcome variables. The advantage of dealing with the specification (8) is that one can also consider the case of random-effects (RE) estimation. The related model is given by:

$$Y_{it} = \alpha_i + \gamma t + \beta' X_{it} + \delta D_i + \theta D_{it} + \varepsilon_{it}, \tag{9}$$

where $\varepsilon_{it} = \eta_i + \mu_{it}$ and η_i is a municipality fixed effect. Notice that in the case of the RE model, the set of covariates X_{it} also includes all time-invariant characteristics not presented in (9). Although one can overcome the endogeneity bias due to omitted variables and potential correlation between the municipality characteristics and some regressors by using the fixed-effects (FE) model, the latter cannot be used to investigate the effect of a time-invariant variable whether this variable is of great policy interest or not. Nonetheless, the Hausman test can be used to test for statistically significant differences in the coefficients on the time-varying explanatory variables as it is common in empirical work.

Yet, a major shortcoming of the standard Hausman test is that it requires homoscedasticity and it cannot include time fixed effects. Therefore such a test cannot be used in the presence of heteroscedasticity. Wooldridge (2010) proposes a regression-based approach as an alternative to the standard Hausman test in choosing between an RE model and an FE model. This is given by the following equation:

$$Y_{it} = \alpha + \gamma t + \beta' X_{it} + \delta D_i + \theta D_{it} + \lambda' \bar{X}_i + \mu_{it}, \tag{10}$$

where $\bar{X}_i = (1/T)\sum_t X_{it}$.

[14] Galiani, Gertler, and Schargrodsky (2005) use a similar specification based on municipalities to assess the effect of the privatization of water services on child mortality in Argentina. Given that their analysis includes several years, they added a time fixed effect in the model.

Equation (10) can be estimated by pooled OLS using cluster-robust standard errors to allow for heteroscedasticity. Testing $H_0: \lambda = 0$ using a robust Wald statistic is a way to test for the uncorrelatedness of the municipality fixed effects. We follow the above approach in the empirical analysis.

For a matter of robustness, we estimate the effect of gold exploitation on our set of outcomes using the OLS model of Loayza et al. (2013). This model is based on a cross sectional analysis where the outcome variables of 2003 are covariates in order to control for differences in municipality characteristics in 2003, prior to the gold mining boom. The outcome variables of 2009 are the main variables of interest. Formally, the model is given by the simple regression:

$$Y_i = \alpha + \beta^{'} X_i + \theta D_i + \mu_i \quad (11)$$

where Y_i is the outcome of municipality i, D_i is a dummy variable that it is equal to 1 if the municipality i is producing gold and 0 otherwise; X_i is a set of municipality characteristics (or covariates) which also include the outcomes of 2003 and μ_i is the error term. The parameter θ is the impact of gold exploitation on producing municipalities compared to non-producing municipalities in the same province.

V. Application and results

In this section, we present the results obtained from the descriptive statistics and the estimations of our model. Table 1 describes the variables used in the empirical analysis. In order to ensure comparability between the two surveys regarding the estimation of poverty rates and inequality, the household per capita expenditure of 2003 survey was re-estimated using the poverty map approach.[15] All the variables were computed as the mean value of the municipality. The schooling variable is the net primary school enrolment rate. Based on the official definition of child labor in Burkina Faso, and in order to accommodate both the 2003 and 2009 surveys, we considered children aged from 6 to 14 for child labor. Table 2 provides descriptive statistics of the outcome variables. Producing municipalities were likely

[15] For more details related to this approach, see for example, World Bank (2013) and Elbers, Lanjouw and Lanjouw (2003).

to be less poor than non-producing municipalities, however, they exhibited lower schooling rates and had a higher proportion of child workers compared to the municipalities that did not produce gold.

In Table 3, we present some statistics related to the covariates. This reveals that producing municipalities were, on average, of greater geographical size than non-producing municipalities. This statistical regularity has been pointed out in the case of Peru by Loayza et al. (2013). A simple mean-comparison test shows that the difference was significant between producing and non-producing municipalities regarding geographical area. Nevertheless, our approach allowed us to control for this difference by including the area of the municipality as a covariate.

The main results are presented in Tables 4, 5, 6 and 7. The auxiliary test displayed in Table 8 suggests the use of the RE model for all outcomes. While homoscedasticity is not rejected in the case of schooling, the standard Hausman test also suggests the RE model to be the appropriate empirical strategy. This was also supported by the auxiliary test.

Some consistent findings emerge from theses tables. First, the headcount ratio and the poverty gap decreased by 8 percentage points and 4 percentage points more in producing than in non-producing municipalities, respectively. The average per capita expenditure was 12% higher than non-producing ones.

Second, we did not find an effect of gold extraction on inequality and schooling except in Tables 13 and 14 where we estimated the effect using the approach adopted by Loayza et al. (2013) for the purpose of robustness checks. This may appear somewhat surprising in the case of Burkina Faso, especially when considering the last outcome (schooling). The year 2013 registered a particularly sharp decline in the number of primary school students — those who attended the certificate of primary education exam (MEBA 2014).[16] Moreover, an analysis based on school dropouts showed that this phenomenon was worsened by gold exploitation as the estimated effect was positive and highly significant.

Third, the measured impact was positive and not significant for child labor, however, this positive impact was consistent with the observed increase in child labor in mining sites.

[16] A recent investigation reveals that child labor is the main cause of not attending school in areas close to mining sites. See, for example, Zerbo and Ouédraogo (2014).

Indeed, the magnitude of child labor in mining sites, especially in artisanal mining, is a real concern in Burkina Faso since over 100,000 children are employed on these sites, according to UNICEF (2014) estimates. Given that parents are primarily responsible for their children's education, a use of mutual enforcement strategies including building knowledge on child labor issues as well as involvement of parents and children themselves could lead to positive results in the fight against child labor. It would also be useful to include child labor issues in the primary school curriculum.

Fourth, the average per capita expenditure positively affected schooling and negatively affected child labor according to our results obtained in all tables. This is in line with our results obtained in the theoretical analysis. When parents receive a higher income, they do not need to ask their children to work and accordingly, their children are able to spend more time at school.

Regarding covariates, geographic subdivisions captured by the "proportion of areas with plots" variable always had a significant effect on the outcome variables. The result is robust to all specifications estimated to date. Increased subdivision size was associated with improvements in average living standards: less poverty, larger consumption, higher schooling rates and a lower fraction of children engaged in child labor. The only drawback is that larger geographic subdivisions contributed to rising inequality. One might be tempted to interpret these results as direct effects. However, the economic argument would require at least several channels through which such effects operate. For instance, the increase in geographic subdivisions would lead to urbanization development and thereby economic growth and poverty reduction. Regarding schooling and child labor, the links are less perceptible. It is also noteworthy to report that in the case of industrial mining (which usually occurs in rural areas), companies have the legal obligation to relocate displaced populations to new subdivided areas. This contributes to improving basic services and infrastructure in rural areas. The area of residence was also important in this analysis. Apart from child labor, the proportion of people living in rural areas significantly affected the outcome variables with the expected signs. This is consistent with the findings which have been largely shared in other studies: poverty is a rural phenomenon and inequality is less exacerbated in rural areas than in urban ones. The average expenditure is lower in rural areas.

Our analysis also allows us to confirm what has already been pointed out by Werthmann (2009) in the case of Burkina Faso: the presence of women and girls in mining sites which are frequently represented by men.[17] The findings of Tables 4, 5, 6 and 7 show that an increase in the proportion of females in the municipality increased child labor. In other words, these findings seem to support Werthmann's (2009) argument.

Regarding the context of artisanal extraction in Burkina Faso, we think that there is a need to regulate this activity not only because of child labor, but also because of environmental degradation, health-related challenges and conflicts that result from gold exploitation. These adverse effects could mitigate the positive impacts of gold extraction on the average living standards of producing municipalities. However, due to a lack of information in the data, our analysis does not take into account such limitations.

In the Appendices, we provide results obtained by using the approach from Loayza et al. (2013) (see Tables 13 and 14). On average, producing municipalities had better living standards than the other municipalities with regards to lower headcount ratio, poverty gap and higher consumption. The results remain the same after the inclusion of provincial dummies and with even less covariates, apart from inequality and the poverty gap for which the effect becomes nonsignificant. As performed in other robustness checks, we excluded all the municipalities that hosted industrial mining from the panel data in order to restrict the sample to artisanal mining. These results are shown in Tables 11 and 12. The effect was statistically significant for the headcount ratio and expenditure at the 10% and 5% level, respectively. Artisanal mining may have also contributed to increasing household consumption. Our findings in the theoretical model support this result. Although the effect on the poverty gap is no longer statistically significant at the 10% level when the sample was restricted to artisanal mining, the signs of the coefficients of interest remain as expected.

[17] This study based on gold mining focuses on informal and artisanal mining and highlights the reasons that may explain why women and girls are present in mining camps.

VI. Conclusions and policy implications

This paper examines the impact of gold exploitation on living standard outcomes in Burkina Faso. Using micro data from the 2003 and 2009 household surveys, and administrative data, our results show that gold mining extraction had a positive impact on average per capita household expenditures. This is consistent with the theoretical analysis. Gold mining also contributed to reducing poverty. The panel data and the used econometric models allow us to interpret these effects as causal. The theoretical model shows that gold mining exacerbated inequality and child labor, and that it had a negative effect on schooling. These expectations were confirmed by the empirical analysis, except the case of schooling. However, the estimates were not statistically significant for inequality, schooling and child labor. This can be explained *inter alia* by the nature of the units of analysis and then the relatively small size of the sample.

The derived theoretical and empirical results in this study highlight the effects of a gold mining boom. Gold extraction can help to reduce poverty and increase average income which suggests that a policy supporting gold extraction could lead to better average living standards in Burkina Faso. However, gold exploitation may increase inequality in Burkina Faso. It may also have a negative effect on schooling and may have scaled up child labor in gold mining sites, or in areas close to mining activities. The government of Burkina Faso, with the support of UNICEF and some non-governmental organizations, have already initiated and implemented several programs in the most affected regions to remove children from mining sites. The objective is to encourage children to return to school, to train those who have worked in mines and to support young people in creating small enterprises and income generating activities. Such measures could contribute to increasing school attendance. However, given the magnitude of the phenomenon, challenges still remain. An effort has been made by the transitional government to strengthen the enforcement of existing child labor laws in both artisanal and industrial mining sites. Indeed, the 2015 Mining Code includes articles that address child labor law violations.

In order to prevent the negative outcomes which could undermine the potential for poverty reduction, a policy supporting gold extraction should be paired with programs or strategies against worsening inequality, school dropouts and child labor.

Future research should integrate environmental and health issues in the empirical analysis if data are available. This would be an interesting and useful avenue given that the resource curse literature has not yet explored this question in line with environmental and health challenges.

Table 1: Definition of variables in the dataset

Outcomes variables	Description
Headcount ratio	Municipality poverty rate
Poverty gap	Municipality poverty rate
Inequality	Gini coefficient of the municipality
Average per capita expenditure	Mean of per capita yearly expenditures of the municipality
Schooling rate	Net primary school enrollment rate (aged 6-12 years)
Child labor	Proportion of workers aged 6-14 years
Covariates	
Producing municipality*year	Dummy variable = 1 if the municipality holds gold extraction in 2009
Producing municipality	Dummy variable = 1 if the municipality holds gold extraction
Year	Dummy variable = 1 for 2009 and 0 otherwise
Basic services and area characteristics	
Proportion with access to drinking water	Proportion of people located less than 15 mn from drinking water
Proportion with access to food market	Proportion of people located less than 15 mn from market for agricultural produce
Proportion with access to primary school	Proportion of people located less than 15 mn from a primary school
Proportion with access to secondary school	Proportion of people located less than 30 mn from a secondary school
Proportion with access to health center	Proportion of people located less than 30 mn from a health service
Proportion of areas with plots	Proportion of geographic subdivisions
Log of area	Logarithm of municipality area (in square kilometers)
Proportion of rural area	Proportion of people living in rural area in the municipality
Economic and demographic characteristics	
Household head or spouse is self-employed	Proportion of household heads or spouses who are self-employed
Experience food problems	Proportion of households who experienced food problems during the year
Dropped for lack of means	Proportion of people who dropped out of school because of lack of means
Mining revenue	Logarithm of the government transfer of mining revenue to the municipality
Dropped out of school	Proportion of people who dropped out of school
Economic situation of the household (HH)	Proportion of households who think their situation has improved
Average age of population	Mean age of the municipality
Proportion of women	Proportion of women in the municipality
Log of population	

Source: *EBCVM* 2003, *EICVM 2009* and administrative data from the Ministry of Mines and Energy.

Table 2: Summary statistics of outcome variables

	2003						2009					
	Producers		Non producers		All		Producers		Non producers		All	
Variable	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Headcount ratio (%)	51.99	14.72	54.89	17.41	54.24	16.86	42.88	19.80	47.02	21.16	46.07	20.89
Poverty Gap (%)	18.96	9.34	21.15	9.89	20.67	9.80	13.48	9.57	15.35	9.97	14.92	9.89
Gini index	0.36	0.06	0.39	0.08	0.38	0.07	0.33	0.08	0.34	0.09	0.34	0.09
Average expenditure	227,869	64,414	235,806	91,022	234,037	85,727	190,817	63,821	189,151	69, 635	189,535	68,182
Schooling rate (%)	15.51	13.24	28.29	21.31	25.44	20.47	23.13	19.01	37.28	27.75	34.01	26.63
Child labor (%)	53.26	26.83	44.44	27.31	46.41	27.39	68.34	17.21	52.67	29.93	56.28	28.27
Observations	45		156		201		45		156		201	

Source: Produced by the authors using the 2003-2009 data. Std. dev. stands for standard deviation.

Table 3: Summary statistics of covariates

Variable	Producers	Non-producers	All
Proportion with access to drinking water (%)	69.63	72.40	71.78
	(20.11)	(23.09)	(22.46)
Proportion with access to food market (%)	19.13	27.57	25.68
	(18.49)	(26.92)	(25.50)
Proportion with access to primary school (%)	35.26	36.10	35.91
	(25.16)	(27.38)	(26.87)
Proportion with access to secondary school	12.20	19.24	17.67
	(19.69)	(26.13)	(24.99)
Proportion with access to health center (%)	24.73	35.13	32.80
	(24.73)	(32.69)	(31.36)
Proportion of areas with plots (%)	10.84	11.85	11.62
	(22.90)	(23.55)	(23.39)
Area (square km)	1,402	825.02	954.19
	(1,014)	(624.14)	(767.10)
Proportion of rural area (%)	90.11	93.01	92.36
	(23.03)	(20.79)	(21.32)
Household head or spouse is self-employed	23.92	23.84	23.86
	(10.00)	(9.44)	(9.55)
Experience food problems (%)	64.57	66.53	66.09
	(21.82)	(23.52)	(23.14)
Dropped for lack of means (%)	2.52	3.07	2.95
	(3.00)	(3.46)	(3.36)
Mining revenue	329,818	96,144	148,459
	(870,778)	(477,950)	(595,793)
Dropped out of school (%)	3.45	4.17	4.01
	(3.43)	(4.14)	(4.00)
Household situation improved (%)	57.44	60.25	59.62
	(20.95)	(22.27)	21.99
Average age	20.97	21.25	21.19
	(2.02)	(2.19)	(2.15)
Proportion of women (%)	51.12	51.66	51.54
	(3.15)	(3.84)	(3.70)
Population	57,070	56,005	56,243
	(31,955)	(117,478)	(104,548)
Observations	90	312	402

Source: Produced by the authors using the 2003-2009 data (standard deviation in parentheses)

Table 4: DID estimation

	Headcount	Poverty	Gini	Expenditure	Schooling	Child
DID	-0.0851**	-0.0389*	0.0118	0.127**	0.0165	0.0272
Producing municipality	-0.00339	-0.000166	0.00222	0.0125	-0.0307*	0.0181
Year of the survey	-0.192***	-0.130***	-0.0786***	-0.0960**	-0.0101	0.279***
Basic services and area characteristics						
- Proportion with access to drinking water	0.103*	0.0413	-0.0436**	-0.201**		
- Proportion with access to food market	0.0469	0.0325	-0.00318	-0.115*		
- Proportion with access to primary school	-0.0464	-0.0309	0.0190	0.122*	0.0960***	
- Proportion with access to secondary	-0.105	-0.0504	0.0187	0.142	0.158***	
- Proportion with access to health center	0.0299	0.00493	-0.000876	-0.00143		
- Proportion of areas with plots	-0.133***	-0.0608***	0.0512**	0.340***	0.178***	-0.231***
- Log of area	-0.0341**	-0.0226***	0.00305	0.0553***		
- Rural area	0.185***	0.0814***	-0.0912***	-0.459***	-0.151***	0.0942
Economic and demographic						
- HH head or spouse and is self-employed	-1.001***	-0.610***	-0.00648	1.679***	-0.132	0.856***
- Experience food problems	0.0331	0.0328	-0.00241	-0.0706		
-School dropout due to lack of means	0.199	0.0640	0.0229	-0.439		
- Mining revenue	0.00272	0.00190	0.00202**	-0.000102	0.000431	
- Average age of population	-0.00700	-0.00437*	-0.00197	0.00666		
- Log average expenditure					0.0224	-0.0152
- Dropped out of school					0.821***	-0.422*
- Economic situation of the HH						0.157***
- Proportion of women						0. 0.802***
- Log of population of the municipality						-0.0324*
Constant	1.004***	0.529***	0.484***	11.75***	0.00621	0.238
Observations	402	402	402	402	402	402
R^2	0.250	0.271	0.286	0.496	0.408	0.304

Source: Produced by the authors using the 2003-2009 data. Robust estimations clustered at the municipality level. * p<0.10, ** p<0.05, *** p<0.010

Table 5: DID estimation with regional dummies

	Headcount	Poverty gap	Gini	Expenditure	Schooling	Child labor
DID	-0.0790*	-0.0362	0.0126	0.120**	0.0181	0.0347
Producing municipality	-0.0150	-0.00436	0.000161	0.0135	-0.0204	-0.00531
Year of the survey	-0.190***	-0.131***	-0.0791***	-0.100**	-0.0111	0.279***
Basic services and area characteristics:						
- Proportion with access to drinking water	0.0637	0.0203	-0.0388*	-0.133*		
- Proportion with access to food	0.0336	0.0289	-0.00521	-0.0997		
- Proportion with access to primary	-0.0420	-0.0299	0.0189	0.113*	0.121***	
- Proportion with access to secondary	-0.0895	-0.0373	0.0210	0.113	0.148***	
- Proportion with access to health center	0.0197	-0.000530	0.00153	0.0225		
- Proportion of areas with plots	-0.150***	-0.0810***	0.0481**	0.383***	0.153**	-0.154***
- Log of area	-0.00580	-0.0115*	0.00572	0.0168		
- Rural area	0.193***	0.0833***	-0.0894***	-0.458***	-0.138***	0.106*
Economic and demographic characteristics:						
- HH head or spouse and is self-employed	-0.995***	-0.613***	-0.00976	1.624***	-0.165	0.989***
- Experience food problems	-0.0127	0.00713	-0.00674	-0.00570		
- School drop due to lack of means	0.0646	-0.0138	0.00962	-0.169		
- Mining revenue	0.00272	0.00205	0.00189*	-0.00115	0.00126	
- Average age of population	-0.00163	-0.00166	-0.00226	-0.000830		
- Log average expenditure					0.0665*	-0.0735
- Dropped out of school						-0.409*
- Economic situation of the HH						0.151***
- Proportion of women					0.532**	0.707**-
- Log of population of the municipality						0.0329**
Region:						
- Hauts Bassins	0.0300	0.0220	0.00445	-0.000835	-0.103***	0.0490
- Boucle Du Mouhoun	0.00676	0.0292	-0.00747	-0.0487	-0.0585	0.00566
- Sahel	-0.117***	-0.0264	0.00614	0.192***	-0.114***	-0.104**
- Est	0.123***	0.0832***	-0.00431	-0.189***	-0.0964***	-0.0716
- Sud Ouest	0.134***	0.0911***	0.00829	-0.185***	0.0280	-0.0148
- Centre Nord	-0.0945***	-0.0390***	0.0181	0.217***	-0.0966***	0.179***
- Centre Ouest	0.0444	0.0480***	-0.00154	-0.0925**	-0.0109	-0.00158
- Plateau Central	0.0444*	0.0244*	0.00991	-0.0680*	0.0413	-0.159***
- Nord	0.130***	0.0787***	0.00636	-0.159***	-0.0571*	0.0357
- Centre Est	0.0946***	0.0637***	0.00589	-0.133***	-0.0307	-0.0914**
- Centre	0.0539**	0.0741***	0.0365***	-0.103**	0.0786	-0.0649
- Cascades	-0.0524	-0.00471	-0.00601	0.0638	-0.0267	-0.0207
Constant	0.725***	0.397***	0.468***	12.13***	-0.488	0.969
Observations	402	402	402	402	402	402
R^2	0.398	0.411	0.297	0.618	0.473	0.407

Source: Produced by the authors using the 2003-2009 data. Robust estimations clustered at the municipality level. * p<0.10, ** p<0.05, *** p<0.010

Table 6: **Fixed-effects estimation**

	Headcount	Poverty gap	Gini	Expenditure	Schooling	Child labor
Producing municipality*year	-0.0835**	-0.0368*	0.0112	0.124**	0.00717	0.0559
Year of the survey	-0.199***	-0.129***	-0.0738***	-0.0817	-0.00842	0.299***
Basic services and area characteristics:						
- Proportion with access to drinking water	0.0653	0.0107	-0.0463	-0.130		
- Proportion with access to food market	0.00568	0.0349	-0.00534	-0.110		
- Proportion with access to primary school	-0.0333	-0.0316	0.00817	0.118	0.100**	
- Proportion with access to secondary school	-0.0475	-0.0337	0.0121	0.0639	0.136**	
- Proportion with access to health center	0.0433	0.0104	-0.00481	-0.0185		
- Proportion of areas with plots	-0.203***	-0.106***	0.0352	0.466***	0.132*	-0.0890
- Rural area	0.0590	0.00348	-0.0850**	-0.259	-0.188***	0.0529
Economic and demographic characteristics:						
- HH head or spouse and is self-employed	-1.063***	-0.638***	-0.0438	1.751***	-0.158	1.179***
- Experience food problems	0.0752	0.0417	0.0160	-0.0841		
- School drop due to lack of means	0.309	0.176	0.0763	-0.582		
- Mining revenue	0.00222	0.00139	0.00128	-0.000403	0.00270	
- Average age of population	-0.00322	-0.00120	-0.000643	-0.000514		
- Log average expenditure					0.0926**	-0.0873
- Dropped out of school					0.603*	-0.524
- Economic situation of the HH						0.206***
- Proportion of women						0.787*
- Log of population of the municipality						0.0565*
Constant	0.829***	0.406***	0.477***	12.03***	-0.800	1.281
Observations	402	402	402	402	402	402
R^2	0.218	0.263	0.251	0.551	0.300	0.331
Wald test for homoscedasticity (*p*-value)	0.000	0.000	0.000	0.000	1.000	0.000

Source: Produced by the authors using the 2003-2009 data. Robust estimations clustered at the municipality level. * p<0.10, ** p<0.05, *** p<0.010

Table 7: Random-effects estimation

	Headcount	Poverty gap	Gini	Expenditure	Schooling	Child labor
Producing municipality*year	-0.0853**	-0.0389*	0.0118	0.127**	0.0156	0.0280
Producing municipality	-0.00358	-0.000197	0.00222	0.0126	-0.0320*	0.0181
Year of the survey	-0.194***	-0.130***	-0.0786***	-0.0923*	-0.00954	0.280***
Basic services and area characteristics:						
- Proportion with access to drinking water	0.0984*	0.0394	-0.0436**	-0.191**		
- Proportion with access to food market	0.0417	0.0328	-0.00318	-0.115*		
- Proportion with access to primary school	-0.0448	-0.0310	0.0190	0.122*	0.0965***	
- Proportion with access to secondary school	-0.0979	-0.0495	0.0187	0.131	0.155***	
- Proportion with access to health center	0.0319	0.00532	-0.000876	-0.00398		
- Proportion of areas with plots	-0.143***	-0.0640***	0.0512**	0.360***	0.173***	-0.227***
- Log of area	-0.0335**	-0.0225***	0.00305	0.0548***		
- Rural area	0.177***	0.0786***	-0.0912***	-0.443***	-0.154***	0.0937
Economic and demographic characteristics:						
- HH head or spouse and is self-employed	-1.012***	-0.613***	-0.00648	1.695***	-0.132	0.865***
- Experience food problems	0.0379	0.0332	-0.00241	-0.0712		
- School drop due to lack of means	0.202	0.0673	0.0229	-0.441		
- Mining revenue	0.00272	0.00190	0.00202**	-0.000343	0.000637	
- Average age of population	-0.00645	-0.00416*	-0.00197	0.00548		
- Log average expenditure					0.0289	-0.0169
- Dropped out of school					0.800***	-0.425*
- Economic situation of the HH						0.159***
- Proportion of women						0.799***
- Log of population of the municipality						-0.0330*
Constant	1.000***	0.528***	0.484***	11.76***	-0.0685	0.262
Observations	402	402	402	402	402	402

Source: Produced by the authors using the 2003-2009 data. Robust estimations clustered at the municipality level. * p<0.10, ** p<0.05, *** p<0.010

Table 8: Auxiliary test (Mundlak, 1978)

	Headcount	Poverty gap	Gini	Expenditure	Schooling	Child labor
Wald for λ = 0	7.56	11.4	6.84	8.16	11.60	11.20
p-value	0.8185	0.4949	0.8680	0.7725	0.1699	0.1906
R^2	0.2627	0.2868	0.2956	0.5056	0.4206	0.3211
Observations	402	402	402	402	402	402

Source: Produced by the authors using the 2003-2009 data.

Figure 1: Child schooling time as a function of child wage

We set $A = 1$, $\alpha = \beta = 0.5$, $t_c = 2$, $t_a = 1$, $w_i = 4$, $w_x = 2$, $p_0 = p_1 = 1$

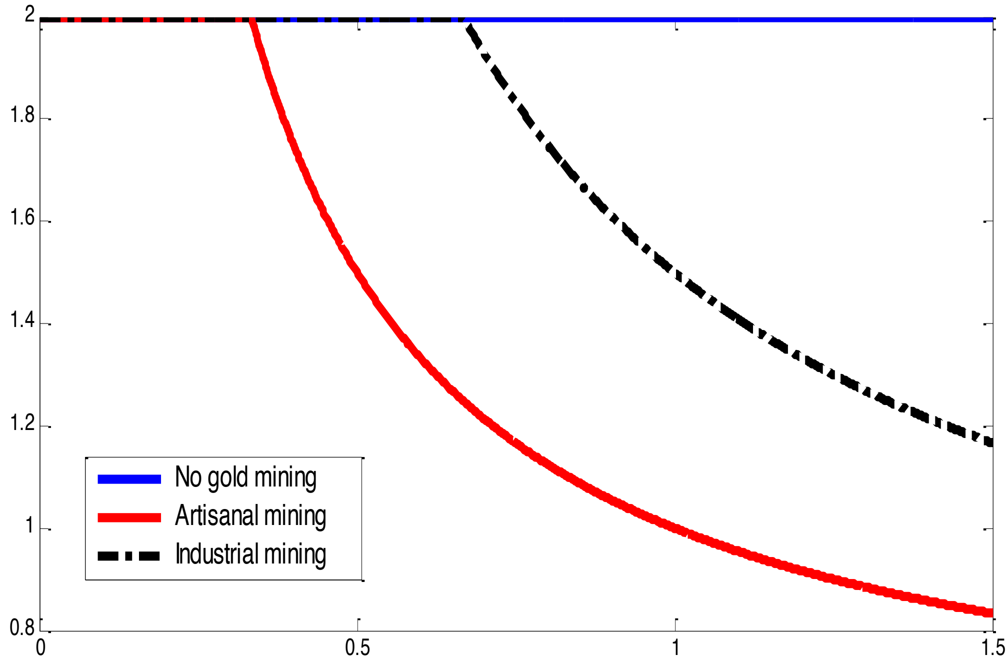


Figure 2: Inequality as a function of child wage

We set $A = 1$, $\alpha = \beta = 0.5$, $t_c = 2$, $t_a = 1$, $w_i = 12$, $w_x = 6$, $p_0 = p_1 = 1$

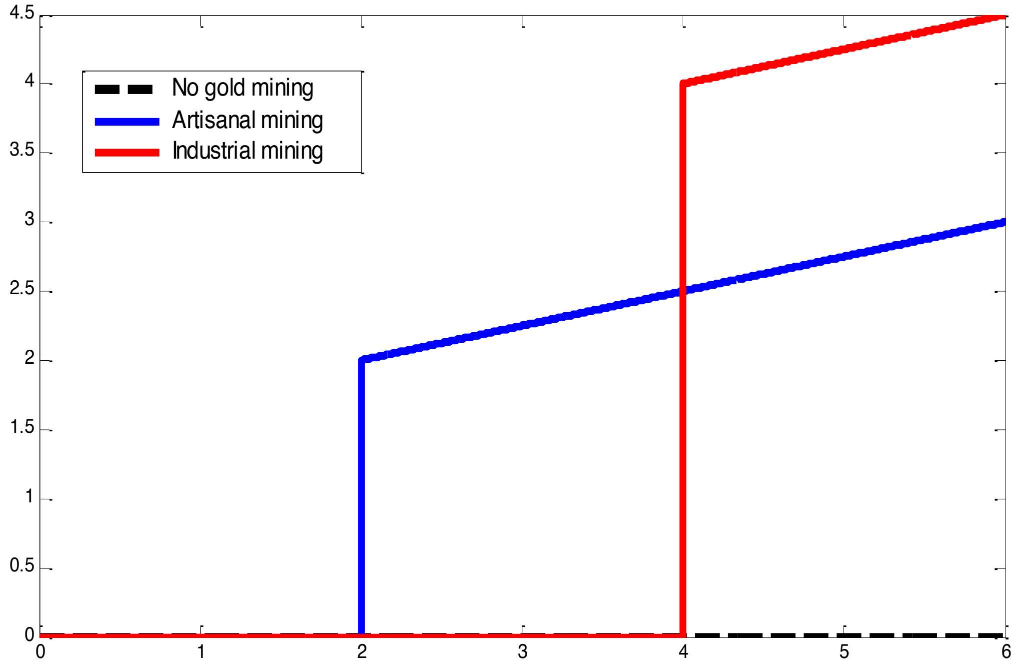
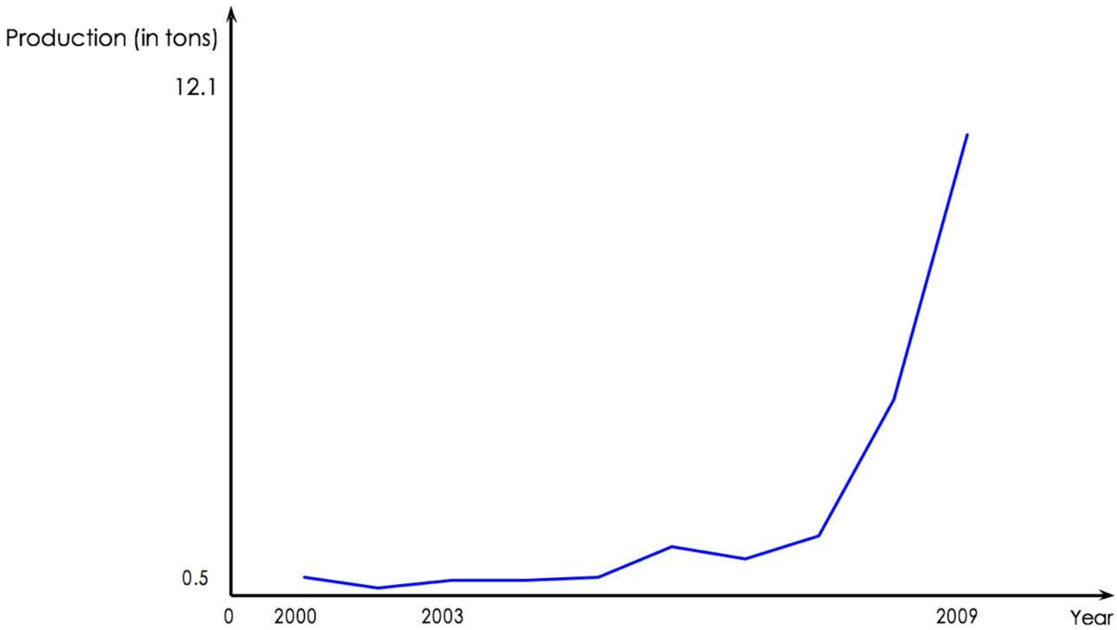


Figure 3: Evolution of gold production between 2000 and 2009



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Appendices

A. Results of the theoretical model

The optimal value is straightforward. If $(w_i 1_{DI} + w_a(1 - 1_{DI}))1_D - w_x > 0$ then $l_a = t_a$ and if $(w_i 1_{DI} + w_a(1 - 1_{DI}))1_D - w_x < 0$ then $l_a = 0$. The Lagrangian of the problem (5) is

$$
\begin{aligned}
£ = \ & \alpha lnc + \beta lnA + \beta\gamma lne_c + \beta(1-\gamma)lny \\
& + \lambda\Big[w_c 1_D t_c + w_a\Big(\big(w_i 1_{DI} + w_a(1 - 1_{DI})\big)1_D - w_x\Big) l_a + w_x t_a - c \\
& - py - w_c 1_D e_c\Big] + \mu(t_c - e_c)
\end{aligned} \quad (12)
$$

The first order conditions are

$$\frac{\partial £}{\partial c} = \frac{\alpha}{c} - \lambda = 0 \quad (13)$$

$$\frac{\partial £}{\partial y} = \frac{\beta(1-\gamma)}{y} - \lambda p = 0 \quad (14)$$

$$\frac{\partial £}{\partial e_c} = \frac{\beta\gamma}{e_c} - \lambda w_c 1_D - \mu = 0 \quad (15)$$

Let's consider $\mu > 0$. So $e_c = t_c$. From (13) and (14) we find that $y = \frac{\beta(1-\gamma)c}{\alpha p}$. Using the first constraint which is bounded, we can find that

$$c = \frac{\Big[\Big(\big(w_i 1_{DI} + w_a(1 - 1_{DI})\big)1_D - w_x\Big) l_a + w_x t_a\Big]}{\alpha + \beta - \beta\gamma} \quad (16)$$

We can then find $c_0, c_{1.0}, c_{1.1}$ $y_0, y_{1.0}$ and $y_{1.1}$. We then find the expression of μ for each of the three cases we consider, i.e, $\mu_0, \mu_{1.0,}$ and $\mu_{1.1}$. We have

$$\mu_0 = \frac{\beta\gamma}{t_c} > 0 \quad (17)$$

$$\mu_{1.0} = \frac{\beta\gamma}{t_c} - \frac{(\alpha + \beta - \beta\gamma)w_c}{w_x t_a} \quad (18)$$

$$\mu_{1.1} = \frac{\beta\gamma}{t_c} - \frac{(\alpha + \beta - \beta\gamma)w_c}{w_i t_a} \quad (19)$$

$\mu_{1.0,} > 0$ if $w_{c,} \leq \theta \frac{t_a}{t_c} w_x$ and $\mu_{1.1,} > 0$ if $w_{c,} \leq \theta \frac{t_a}{t_c} w_i$. So, depending on the values of the parameters, we can easily identify the solutions that are valid.

Let's now consider $\mu = 0$. So, we should have $e_c < t_c$. We can solve the first order conditions and check for $e_c < t_c$.

B. Predicted effect of gold mining

First case: $w_{c,} \geq \theta \frac{t_a}{t_c} w_i$.

It is easy to find that $e_{c0,} > e_{c1.1,} > e_{c1.0}$ *. Also, it is trivial to find* $c_{1.1} > c_{1.0}$ *.* $\frac{c_{1.0}}{c_0} = \frac{\alpha+\beta-\beta\gamma}{\alpha+\beta}\left(\frac{w_c t_c}{w_x t_a} + 1\right)$*. We can check that* $\frac{c_{1.0}}{c_0} > 1$ *if* $w_{c,} \geq \theta \frac{t_a}{t_c} w_i$
Depending on the prices, we follow the same procedure to compare $y_0, y_{1.0}$ *and* $y_{1.1}$*. we can show that* $y_{1.1} > y_{1.0}$

Second case: $\theta \frac{t_a}{t_c} w_x \leq w_c \leq \theta \frac{t_a}{t_c} w_i$

We can prove that $y_{1.1} > y_{1.0}$.

$e_{c0} = t_c, e_{c1.0} < t_c$ *and* $e_{c1.1} = t_c$*. So* $e_{c1.0} < e_{c1.1} = e_{c0}$.

We can show that $\frac{c_{1.0}}{c_{1.1}} > 1$ *if.*

$$w_c > \theta \frac{t_a}{t_c} w_i + \frac{t_a}{t_c}\left(1 - \frac{w_x}{w_\alpha}\right) \quad (20)$$

But (20) cannot hold because we are in the case where $w_c \leq \theta \frac{t_a}{t_c} w_i$*. So* $\frac{c_{1.0}}{c_{1.1}} \leq 1$.

Third case: $w_c \leq \theta \frac{t_a}{t_c} w_x$

$e_{c0} = e_{c1.0} = e_{c1.1}$.

$c_0 = c_1 < c_{1.1}$.

$y_{1.0} < y_{1.1}$.

C. Gold exploitation and expenditure inequality

The total expenditure is a random variable as it depends on α (random variable capturing the importance of consumption for the household). We see how the variance of the expenditure changes with gold exploitation. For this purpose, we use the Delta method by approximating the expenditure as a function of α. Let E'_0; $E'_{1.1}$ and E'_0; $E'_{1.1}$ *and* $E'_{1.0}$ be the first derivative with respect to α of E_0; $E_{1.1}$ *and* $E_{1.0}$ respectively. E_0; $E_{1.1}$ and $E_{1.0}$ stand for the total expenditure respectively in non-producing, industrial, and artisanal mining. We have

$$var(E_0) = \left[E'_0 | \alpha - \bar{\alpha}\right]^2 var(\alpha) \quad (21)$$
$$var(E_{1.1}) = \left[E'_{1.1} | \alpha - \bar{\alpha}\right]^2 var(\alpha) \quad (22)$$
$$var(E_{1.0}) = \left[E'_{1.0} | \alpha - \bar{\alpha}\right]^2 var(\alpha) \quad (23)$$

First case: $w_c \geq \theta \frac{t_a}{t_c} w_i$.

$E'_0 = 0$, $E'_{1.0} = \frac{\beta\gamma}{(\alpha+\beta)^2}(w_c t_c + w_x t_a)$, and $E'_{1.1} = \frac{\beta\gamma}{(\alpha+\beta)^2}(w_c t_c + w_i t_a)$.

Since $w_i > w_x$, the prof ends.

Second case: $\theta \frac{t_a}{t_c} w_x \leq w_c \leq \theta \frac{t_a}{t_c} w_i$

We have

$E'_0 = 0$, $E'_{1.0} = \frac{\beta\gamma}{(\alpha+\beta)^2}(w_c t_c + w_x t_a)$, and $E'_{1.1} = 0$.

From the equations just above we can find the result.

Third case: $w_c \leq \theta \frac{t_a}{t_c} w_x$

We have

$$E'_0 = E'_{1.0} = E'_{1.1} = 0$$

D. Tables

Table 9: Results for the theoretical model.

$\theta \equiv \frac{\beta\gamma}{\alpha+\beta-\beta\gamma}$. w_c is the child wage in mines, w_i is parents' wage in industrial mines, w_x is parents' wage in other activities, t_a is the total time available for the child, ta is the total time available for parents.

	If $w_c \leq \theta \frac{t_a}{t_c} w_x$	If $\theta \frac{t_a}{t_c} w_c \leq w_x \leq \theta \frac{t_a}{t_c} w_i$	If $w_c \geq \theta \frac{t_a}{t_c} w_i$
e_{co} (schooling in non-prod. municipality)	t_c	t_c	t_c
$e_{c_{1.0}}$ (schooling in artisanal production)	t_c	$\frac{\beta\gamma}{(\alpha+\beta)w_c}(w_c t_c + w_x t_a)$	$\frac{\beta\gamma}{(\alpha+\beta)-\beta\gamma}(w_c t_c + w_x t_a)$
$e_{c_{1.1}}$ ((schooling in industrial production)	t_c	t_c	$\frac{\beta\gamma}{(\alpha+\beta)w_c}(w_c t_c + w_x t_a$
c_0 (consumption in non-prod. municip.)	$\frac{\alpha w_x t_a}{\alpha+\beta-\beta\gamma}$	$\frac{\alpha w_x t_a}{\alpha+\beta-\beta\gamma}$	$\frac{\alpha w_x t_a}{\alpha+\beta-\beta\gamma}$
$c_{1.0}$ (consumption in artisanal production)	$\frac{\alpha w_x t_a}{\alpha+\beta-\beta\gamma}$	$\frac{\alpha}{\alpha+\beta}(w_c t_c + w_x t_a)$	$\frac{\alpha}{\alpha+\beta}(w_c t_c + w_x t_a)$
$c_{1.1}$ (consumption in industrial production)	$\frac{\alpha w_x t_a}{\alpha+\beta-\beta\gamma}$	$\frac{\alpha w_x t_a}{\alpha+\beta-\beta\gamma}$	$\frac{\alpha}{\alpha+\beta}(w_c t_c + w_i t_a)$
y_0 (school good in non-producing municip.)	$\frac{\beta(1-\gamma)w_x t_a}{p_0(\alpha+\beta-\beta\gamma)}$	$\frac{\beta(1-\gamma)w_x t_a}{p_0(\alpha+\beta-\beta\gamma)}$	$\frac{\beta(1-\gamma)w_x t_a}{p_0(\alpha+\beta-\beta\gamma)}$
$y_{1.0}$ (school good in artisanal production)	$\frac{\beta(1-\gamma)w_x t_a}{p_1(\alpha+\beta-\beta\gamma)}$	$\frac{\beta(1-\gamma)}{(\alpha+\beta)p1}(w_c t_c + w_x t_a)$	$\frac{\beta(1-\gamma)}{(\alpha+\beta)p_1}(w_c t_c + w_x t_a)$
$y_{1.1}$ (consumption in industrial production)	$\frac{\beta(1-\gamma)w_i t_a}{p_1(\alpha+\beta-\beta\gamma)}$	$\frac{\beta(1-\gamma)w_i t_a}{p_1(\alpha+\beta-\beta\gamma)}$	$\frac{\beta(1-\gamma)}{(\alpha+\beta)p_1}(w_c t_c + w_i t_a)$

Table 10: Expected effects of gold mining

Interest variables	The effect of mining
Schooling	-
Consumption	+
Education goods	+
Inequality aggravation	+ or no effect

Table 11: DID estimation in case of no industrial mining

	Headcount	Poverty gap	Gini	Expenditure	Schooling	Child labor
DID	-0.0779*	-0.0333	0.0202	0.129**	0.0158	0.0357
Producing municipality	0.00690	0.00197	-0.000306	-0.00137	-0.0312*	0.0146
Year of the survey	-0.193***	-0.130***	-0.0809***	-0.102**	-0.00876	0.281***
Basic services and area characteristics:						
- Proportion with access to drinking water	0.101*	0.0380	-0.0472***	-0.199**		
- Proportion with access to food market	0.0573	0.0392	0.00249	-0.124*		
- Proportion with access to primary school	-0.0368	-0.0264	0.0211	0.114*	0.0971***	
- Proportion with access to secondary school	-0.102	-0.0484	0.0272	0.158*	0.159***	
- Proportion with access to health center	0.0252	0.00166	-0.00535	-0.00267		
- Proportion of areas with plots	-0.140***	-0.0648***	0.0452**	0.338***	0.176***	-0.233***
- Log of area	-0.0323**	-0.0215***	0.00257	0.0504**		0.102*
- Rural area	0.189***	0.0829***	-0.0901***	-0.461***	-0.149***	
Economic and demographic characteristics:						
- HH head or spouse and is self-employed	-0.994***	-0.606***	-0.0149	1.638***	-0.130	0.863***
- Experience food problems	0.0384	0.0325	-0.00381	-0.0735		
- School drop due to lack of means	0.273	0.117	0.0647	-0.527		
- Mining revenue	0.00311	0.00208	0.00222**	-0.000215	0.000425	
- Average age of population	-0.00740	-0.00451*	-0.00209	0.00710		
- Log average expenditure					0.0263	-0.0144
- Dropped out of school						-0.359
- Economic situation of the HH					0.815***	0.144***
- Proportion of women						0.758**
- Log of population of the municipality						-0.0264
Constant	0.986***	0.521***	0.492***	11.80***	-0.0441	0.182
Observations	392	392	392	392	392	392
R^2	0.251	0.272	0.293	0.499	0.406	0.304

Source: Produced by the authors using the 2003-2009 data. Robust estimations clustered at the municipality level. * p<0.10, ** p<0.05, *** p<0.010

Table 12: Random-effects estimation in case of no industrial mining

	Headcount	Poverty gap	Gini	Expenditure	Schooling	Child labor
Producing municipality*year	-0.0779*	-0.0334	0.0202	0.129**	0.0147	0.0363
Producing municipality	0.00671	0.00195	-0.000306	-0.00109	-0.0324*	0.0146
Year of the survey	-0.195***	-0.130***	-0.0809***	-0.0977**	-0.00818	0.281***
Basic services and area characteristics:						
- Proportion with access to drinking water	0.0967*	0.0360	-0.0472***	-0.190**		
- Proportion with access to food market	0.0528	0.0398	0.00249	-0.124*		
- Proportion with access to primary school	-0.0372	-0.0270	0.0211	0.116*	0.0974***	
- Proportion with access to secondary school	-0.0950	-0.0472	0.0272	0.147	0.155***	
- Proportion with access to health center	0.0263	0.00175	-0.00535	-0.00411		
- Proportion of areas with plots	-0.150***	-0.0681***	0.0452**	0.356***	0.171***	-0.230***
- Log of area	-0.0317**	-0.0213***	0.00257	0.0500**		0.102*
- Rural area	0.182***	0.0801***	-0.0901***	-0.447***	-0.152***	
Economic and demographic characteristics:						
- HH head or spouse and is self-employed	-1.007***	-0.610***	-0.0149	1.658***	-0.131	0.871***
- Experience food problems	0.0417	0.0325	-0.00381	-0.0716		
- School drop due to lack of means	0.280	0.125	0.0647	-0.532		
- Mining revenue	0.00309	0.00208	0.00222**	-0.000427	0.000628	
- Average age of population	-0.00689	-0.00428*	-0.00209	0.00612		
- Log average expenditure					0.0328	-0.0159
- Dropped out of school						-0.360
- Economic situation of the HH					0.797***	0.146***
- Proportion of women						0.755**
- Log of population of the municipality						-0.0269
Constant	0.983***	0.520***	0.492***	11.79***	-0.118	0.204
Observations	392	392	392	392	392	392

Source: Produced by the authors using the 2003-2009 data. Robust estimations clustered at the municipality level. * p<0.10, ** p<0.05, *** p<0.01

Table 13: Loayza et *al.* model estimations with provincial dummies

	Headcount	Poverty gap	Gini	Expenditure	Schooling	Child labor
Producing municipality	-0.108***	-0.0480**	0.00631	0.142***	-0.0883**	0.0889**
Headcount ratio in 2003	-0.101	-0.0819	-0.0579	0.106		
Literacy rate in 2003	-0.208	-0.0774	0.180***	0.440**		
Proportion of areas with plots	-0.258***	-0.127***	0.104***	0.608***		
Log of area	-0.00235	-0.00854	0.0277***	0.0484		
Log of rural population	-0.000615	0.000577	0.00181	-0.00105	-0.0142**	0.0169**
Producing province					-0.0678*	0.0691*
HH head or spouse is self-employed					-0.124	0.280
Economic situation of the HH					0.0185	0.0998
Proportion of women					0.621	0.589
Log average expenditure					0.172***	-0.121**
Constant	0.707***	0.286***	0.0884	11.40***	-1.937***	1.496**
Observations	201	201	201	201	201	201
R^2	0.475	0.475	0.417	0.583	0.142	0.110

Source: Produced by the authors using the 2003-2009 data. The last two columns do not include the provincial dummies. * p<0.10, ** p<0.05, *** p<0.010

Table 14: Loayza et *al.* model estimations with less covariates

	Headcount	Poverty gap	Gini	Expenditure	Schooling	Child labor
Producing municipality	-0.0766**	-0.0339*	0.0228*	0.140**	-0.0598	0.0615
Headcount ratio in 2003	0.225***	0.0754*	-0.0932**	-0.449***		
Literacy rate in 2003	-0.0889	-0.0501	0.0943**	0.196		
Proportion of areas with plots	-0.249***	-0.123***	0.0787***	0.555***		
Producing province					-0.0684**	0.0644**
HH head or spouse is self-employed					-0.119	0.0882
Economic situation of the HH					-0.0406	0.129**
Proportion of women					0.404	0.372
Log average expenditure					0.152***	-0.109***
Constant	0.453***	0.161***	0.326***	12.05***	-1.708***	1.666***
Observations	201	201	201	201	284	284
R^2	0.147	0.126	0.158	0.265	0.097	0.067

Source: Produced by the authors using the 2003-2009 data. The last two columns do not include the provincial dummies. * p<0.10, ** p<0.05, *** p<0.010

E. Figures

Figure 4: Child schooling time as a function of industrial wage

We set $A = 1$, $\alpha = \beta = 0.5, t_c = t_c = 2$, $t_a = 1$, $w_c = 1$, $w_x = 1.5$, $p_0 = p_1 = 1$

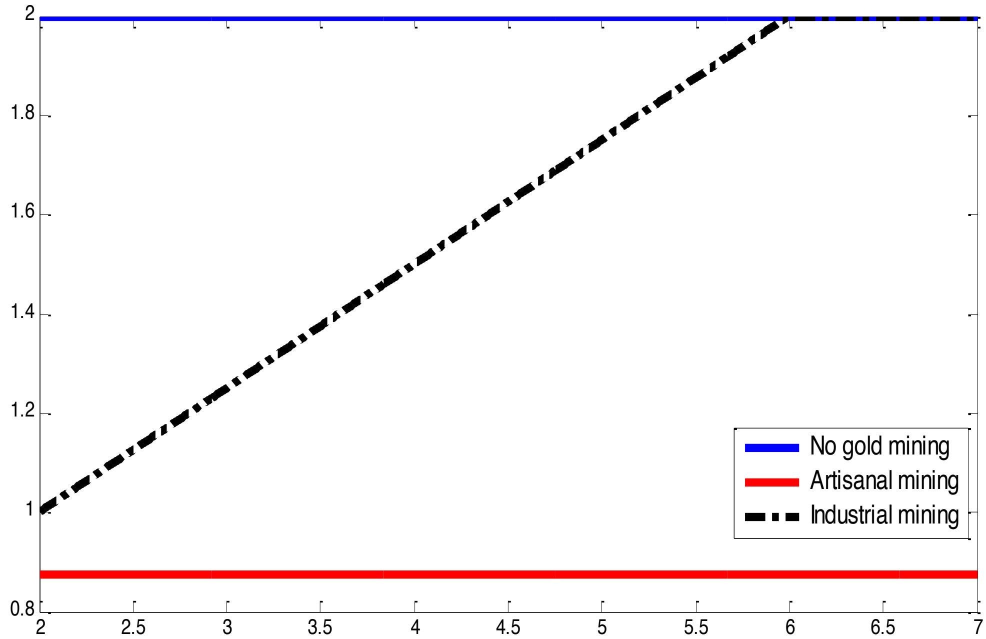

Figure 5: School goods expenditure as function of child wage

We set $A = 1$, $\alpha = \beta = 0.5$, $t_c = 2$, $t_a = 1$, $w_i = 4$, $w_x = 2$, $p_0 = p_1 = 1$

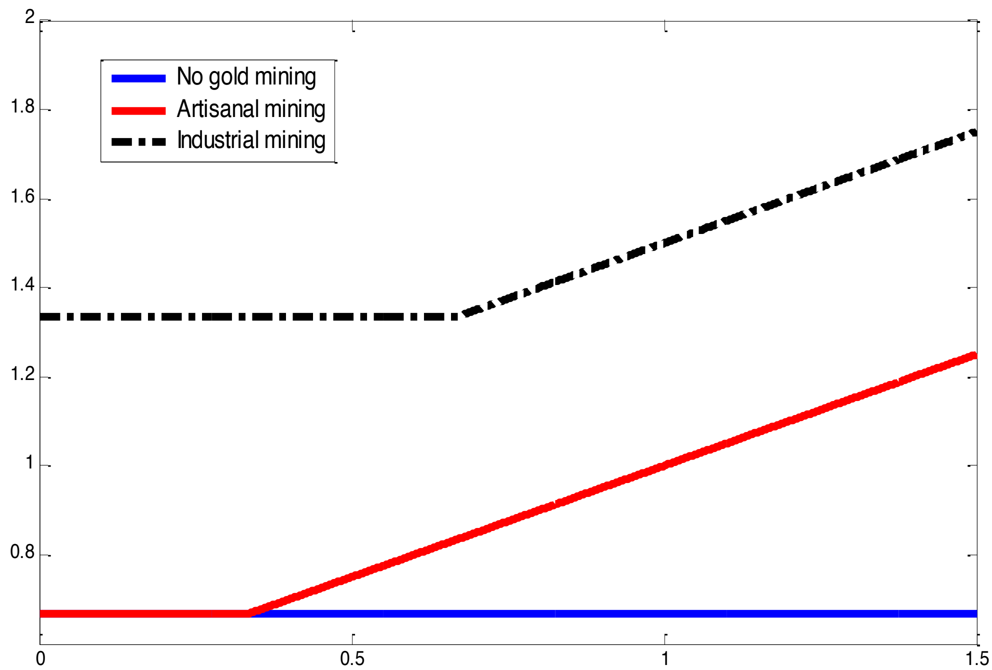

Figure 6: School goods expenditure as function of child wage

We set $A = 1$, $\alpha = \beta = 0.5$, $t_c = 2$, $t_a = 1$, $w_i = 4$, $w_x = 2$, $p_0 = 1$, $p_1 = 6$