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Phasing out mercury through collective action in artisanal gold mining: Evidence from a framed field experiment

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ABSTRACT

The application of practices such as mercury amalgamation makes small-scale gold mining an economic activity with a high negative impact on health and the environment. Associative entrepreneurship – collective action – has been proposed as a scheme that would bring cleaner technologies to miners, in order to reduce the harmful effects of using mercury in the gold recovery. In this paper we investigate the extent to which miners can establish and sustain an association that aims to fulfill these goals. This is done by conducting a framed experiment with small-scale gold miners in Colombia. We test the effect of two institutional arrangements on associative entrepreneurship: exclusion and co-management. We found that miners made contributions that did not allow a sustained acquisition of the technology. However, we found that under co-management players could achieve long-lasting and efficient levels of individual contribution; but, conversely, exclusion did not trigger this kind of collective action. Policy implications of our results and avenues for further experimental research are discussed.

1. Introduction

Several million people in the world are engaged in the extraction of gold that uses artisanal mining methods (Spiegel and Veiga, 2005).[1] For most of them, gold extraction is the most attractive or the unique livelihood activity (Siegel and Veiga, 2010). However, the application of conventional practices, mercury amalgamation being the most representative, makes artisanal and small-scale gold mining (ASM) an activity with a high negative impact on health and the environment.[2] Even though cleaner, more productive, and financially viable technologies are available to miners (Pantoja et al., 2005; Hilson, 2006), mercury amalgamation and other rudimentary techniques continue to be very widely used techniques for gold recovery in ASM.

Mercury use may be both a cause and an effect of poverty in ASM (Hilson and Pardie, 2006; Saldarriaga-Isaza et al., 2013). Specifically, three main factors may explain the massive consumption of mercury in ASM: (i) its low cost; (ii) miners' low degree of education which lead to disregard towards environmental and health-related issues, and lack of the skills to operate better technologies; and (iii) lack of credit facilities and savings of mining households (Saldarriaga-Isaza et al., 2013).

Technology choice for the gold recovery process in ASM can be characterized as a social dilemma. Even though socio-ecological systems involved in ASM fit the definition of a common-pool resource (Saldarriaga-Isaza et al., 2013), the social dilemma involves a trade-off in which miners may tend to maximize short-run individual profits by choosing the cheapest and easiest-to-handle technique available, i.e. mercury amalgamation. However, in the long-run, the entire community, which includes the miners, is worse off than with the choice of a cleaner and more productive technology. In this context, the dilemma that artisanal gold miners face is not found in the extraction and availability of this non-renewable resource or in its depletion. Instead, the dilemma concerns the pollution resulting from the gold recovery process, i.e., a public-good dilemma.[3] This social dilemma is our focus in this paper.

In order to tackle mercury pollution, there have been interventions in the form of training programs and environmental campaigns in several places. In fact, the United Nations in 2002 launched the Global

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[1] In this paper, the terms “artisanal mining” and “small-scale mining” are used interchangeably.

[2] More than a few effects on human well-being attributable to mercury pollution have been documented: neurological disorders ranging from loss of eyesight to tremors and paralysis, kidney damage and lung damage, and effects on the reproductive system (Tirado et al., 2000; Hilson and Pardie, 2006; Tomicic et al., 2011).

[3] In a public-good dilemma – pollution control in this case – people find it costly to contribute to the provision of the public good and prefer others to pay for its provision instead. If everybody follows this strategy, the public good is underprovided and pollution persists. However, the entire community may be better off if everyone contributes (Ostrom, 1998).

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Mercury Project, which is a capacity-building initiative, created with the aim of “removing barriers to the adoption of cleaner practices of small-scale gold mining” (Spiegel and Veiga, 2005, p. 362). However, interventions must go beyond the presentation of technical solutions to the problems of mining and processing, and attention to economic and social issues should also be paid (Jennings, 2003; Davies, 2014). For instance, a complementary form of intervention would be the promotion or strengthening of collective action through miners' associations (Kazilimani et al., 2003; Davies, 2014).

When we use the terms “collective action” or “associative entrepreneurship” in this paper, we refer to the creation of local associations among small-scale gold miners; these associations are meant to acquire more environmentally-friendly technologies with a long-term vision. Thus, entrepreneurship in this context is different to the “get rich quick” notion that states that artisanal gold miners are “fortunate seekers” (Hilson, 2009). This notion prevailed in the 1970s and the 1980s, but it was then reappraised in the 1990s with analyses that link ASM with hardship (Hilson, 2009).

The promotion of associative entrepreneurship has been on the policy agenda of governments and independent agencies working to improve the quality of life of ASM communities. This type of association allows not only the improvement of the relationship with the state, e.g. in formalization processes, but it would also enable miners to accumulate the financial capital required to obtain cleaner and more productive technologies that are beyond the budget of most mining families (Hentschel et al., 2002; Hinton et al., 2003; Hilson and Potter, 2003; Heemskerk and Oliviera, 2004; CDS, 2004; Ghose and Roy, 2007; Spiegel, 2009).[4] This financial capital is difficult to obtain from the financial system, which perceives small-scale mining as a risky activity (Chaparro, 2003). This fact, added to the low tendency of miners to save money for investment (Saldarriaga-Isaza et al., 2013) would partially explain the low rate of adoption of cleaner technologies. Associative entrepreneurship is therefore an option for small-scale miners to increase their financial capital. In this paper we investigate the extent to which miners can establish and sustain an association whose aim is to acquire cleaner technologies to phase out the use of mercury in the gold recovery process and therefore to reduce mercury pollution.

In addition to the environmental benefits, alternative technologies would bring greater productivity to miners who employ them in the gold recovery process.[5] Hereinafter, the corresponding additional profits will be referred to as “private benefits,” in order to differentiate them from the public-good benefits associated with the use of the cleaner technology. Despite the advantages of associative entrepreneurship, aspects such as lack of communication and organization would hinder miners reaching those gains (Hinton et al., 2003). It is then necessary to explore the effectiveness of institutions in fostering collective action that promotes the adoption of cleaner technologies. In this paper we do this by conducting a framed threshold public-good experiment with artisanal and small-scale gold miners in Antioquia, Colombia.

The paper is organized as follows. In the next section, we discuss possible institutional arrangements to foster collective action in ASM. In Section 3 we describe the hypotheses we want to test and the economic experiment that tests them. Then, in Section 4 we describe the experimental protocol and the study site. In Section 5, we present our principal results, which mainly suggest that under co-management miners can achieve an efficient level of contributions that holds up until the end of the game. However, in the framework of our experiment, we do not find evidence that exclusion may foster collective action. Our conclusions, as well as policy recommendations and avenues for further research are presented in Section 6.

2. Institutional Arrangements to Phase Out Mercury

Some of the main institutions that have been proven to have effects on collective action for the sustainable management of common-pool resources and public goods are as follows: external regulation (e.g., Cardenas et al., 2000; Dickinson, 2001), face-to-face communication (e.g., Ledyard, 1995; Ostrom, 2010), and information disclosure (e.g., Ledyard, 1995; Smith, 2010).

In this paper, we analyze the effect of two different institutional arrangements on associative entrepreneurship in ASM, using a framed field experiment. One of the institutions that we investigate is co-management. This institution is understood as the interaction between internal communication among community members and an external non-coercive party. Moreno-Sánchez and Maldonado (2010) showed in a field experiment with fishermen in Colombia, that co-management may perform better than other institutions, such as using only internal communication among community members or an external (coercive) regulation.

External coercive regulation in ASM may be unfeasible, due to widespread informality and lack of operational resources for enforcement (Saldarriaga-Isaza et al., 2013). Thus, considering the difficulties of carrying out external coercive regulation, and the current policy context in which some external organizations are trying to encourage better practices in ASM, we test the effect that co-management may have on associative entrepreneurship in ASM and whether the effect of co-management found by Moreno-Sánchez and Maldonado hold in the case of ASM.

Another institution we are interested in testing is the option that once a better technology is acquired and the public good (lower mercury emissions) is provided, non-contributors may be excluded from the private benefits that the technology providing also generates. In general, the exclusion from the benefits of a public good of those individuals who fail to meet a predetermined minimum contribution requirement, may lead to increases in contributions to the public good (Swope, 2002; Kocher et al., 2005; Croson et al., 2007; Bchir and Willinger, 2008; Maier-Rigaud et al., 2010). This kind of exclusion reduces the individual incentives to free ride and generates Pareto-efficient outcomes. However, Swope (2002) argued that in environments in which individuals fail to coordinate their contributions, exclusion can decrease both contributions and welfare. Czap et al. (2010) found experimental evidence that supports Swope's point.

In our case, we are not interested in exclusion from the positive externalities stemming from the utilization of a cleaner technology. In ASM this kind of exclusion may actually be unfeasible or too costly. Instead, we focus on exclusion from the private benefits that an artisanal gold miner might obtain from the alternative technology, i.e., greater productivity in the gold recovery process. The cleaner and more productive technology could be used in a centralized processing facility (Hilson, 2006), or in a community-based development project. The exclusion of non-contributors would avoid this group of miners benefiting from the recovery of an increased amount of gold in the ore beneficiation process. In such a case, the incentives to free-ride would be linked only to the enjoyment of the environmental benefits and it would be therefore expected that the free-riding rate would decline under this scheme of exclusion.

In order to get the more productive and cleaner technology for gold recovery, miners should contribute to a common fund to raise the minimum financial capital required to buy such technology. Given that there is neither exclusion nor rivalry in the positive externalities derived from the adopted technology for recovery of this mineral, we carry out a framed threshold public-good game (TPGG). In general, public-good games are a useful tool for the analysis of organizational processes that entail dilemmas such as environmental protection or teamwork

[4] There is a not an actual market for the alternative technologies, and therefore there is not a price that we can take as reference. Nonetheless, from a personal communication with the engineer Jorge M. Molina, the cost of an equipment of gravimetric concentration varies between 2500 and 125,000 US dollars.

[5] Contrary to mercury amalgamation in which gold recovery is about 50%, with the use of methods of gravimetric concentration leads to recover up to 95% (personal communication with Jorge M. Molina).