Assessing the impact of the Fairmined Certification on the well-being of the small-scale miners

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List of Acronyms

ARM Alliance for Responsible Mining.
ASGM Artisanal and Small-Scale Gold Mining.
ASM Artisanal and small-scale mining.
HDI Human Development Index.
ILO International Labor Organization.
LSM Large and medium scale mining.
NGO Non-governmental organization.
OECD Organization for Economic Cooperation and Development.
PSM Propensity Score Matching.
SDG Sustainable Development Goals.
UN United Nations.

Abstract

In the last decade, there has been a growing trend in the adoption of certifications. The Fairmined certification is one, between only two, available to certificate responsible and fair practices of the artisanal and small scale mining. One of the reasons behind the growing trend in the adoption of these kind of certifications is that it as a way to improve the livelihood of the small producers or miners involved. Different authors estimate the effect of such certifications in the well-being of certified individuals; however, in the artisanal and small scale mining sector, I do not find any article that asses the effect of the Fairmined certification on the well-being of the certified miners.

First, I propose a Fairmined well-being index following the well-being indices in the literature. My index considers 27 indicators classified in 6 dimensions. These components are not only material well-being but also mental and physical health, labor conditions and subjective well-being. Second, the information for the index is collected through 321 phone surveys to both, certified and non-certified miners in Colombia and Peru. The period of the data collection is from July to November 2020. Then, I find that on average, miners working on a certified mining organization, have a higher well-being level. That means, that miners working on a Fairmined certified mining organization are better-off, by about 4 percentage points, than those who are not part of a certified mining organization. Acknowledging that the results might suffer from selection bias, I re-estimate the effect using propensity score matching, finding that the results are consistent with the previous estimation. Finally, I also ratify the results when I zoom in the components. Fairmined miners are on average better off than non-certified miners in the components of health and safety, social connections and subjective well-being.

Relevance to Development Studies

Fairmined Certification is a specialized sustainability standards certification scheme for the artisanal and small-scale gold mining (ASM). Impact evaluation on this certification, offers an opportunity to assess the changes in well-being conditions of its target population: the miners. These miners are part of the rural communities and they are exposed to several risks due to the characteristics of its activity. Additionally, they are mainly located in the Global South where ASM plays a key role in local development and its contribution to sustainable development goals.

Fairmined is part of the certifications that promotes the adoption of responsible practices for improving the working conditions of the people that depend on this activity. Unfortunately, artisanal and small-scale mining is associated with risks, environmental degradation and poverty. Consequently, the sector is usually stigmatized because its negative impacts. Certifications, such as Fairmined, intends to dignify the miners' hard work and to promote better business practices and offer responsible alternatives to consumers. These type of certifications become more relevant in times where humanity needs to be more conscious and responsible for the use of resources. Therefore, the business practices must guarantee the protection of the human rights and the well-being

of the people. Finally, this research may encourage the development of other initiatives to continue promoting the responsible practices in mining for the development of the local communities.

Key words

Responsible artisanal and small-scale mining (ASM), Fair gold, Sustainable mining, Propensity score matching (PSM), Well-being, Average treatment effect analysis.

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1 Introduction

The literature in impact evaluation of voluntary sustainability certifications takes more relevance each day. This is explained, mainly, because of the increasing responsible sourcing and consumption trends, the international sustainability agenda and the pressure from governments. Corporations are requested to guarantee traceable, environmentally friendly and human rights protection within the production, sourcing and trade practices.

Extractive industries, such as gold mining, are not the exception in this shift towards sustainability. The companies in the sector try to fit into the trend of development and implementation of sustainable practices at all levels, from extraction, refining, marketing and manufacturing. In response, voluntary certification schemes have been developed to offer solutions to regulations and the growing interest of companies and consumers.

This research is focused on the impact of one of the voluntary sustainability mineral certification schemes for artisanal and small-scale mining: the Fairmined Certification. The problem emerged from the need to understand the impact of the certification on the well-being of the artisanal and small-scale miners, who are part of certified organizations in fair trade practices under the Fairmined label. The hypothesis is that certified miners benefit for being part of these mining organizations. Since these organizations are certified, they are complying with the country's and international law and good practices, they provide decent working conditions and meet a set of demanding sustainable standards which include organizational, environmental and social criteria.

The impact evaluation literature is extensive in assessing the fair trade certification impact in small producers mainly working in the agriculture sector. The predominance is in fair trade or sustainable agriculture labels because fair trade origins dated back from these kinds of commodities. These research use qualitative and quantitative methods. Then, as my focus is the minerals sector, I find researchers who evaluate the characteristics of the certification of minerals. However, they predominantly use qualitative approaches and they have not measured the impact on the well-being of artisanal miners. Consequently, these conditions give a window of opportunity for the development of the present research to contribute to the literature in the field of the quantitative approach to evaluate impacts of the fair trade certification schemes in minerals, such as gold. For this purpose, this paper proposes to conduct a quantitative approach to measure the benefits on the well-being of the miners certified by Fairmined certification.

The overall Fairmined Certification's objective is "*to promote the progressive organization and formalization of the ASM sector, bringing with it improved labor rights, safer working conditions for miners, and strengthened miners' organizations with the capacity to campaign for legislation and public policies that promote their rights and enable a responsible ASM sector*" (Alliance for Responsible Mining, 2014, p. 4). Currently, the Fairmined certification has certified mines in three countries, Colombia, Peru, and Mongolia with 9 certified units (Alliance for Responsible Mining, 2020). Due to Colombia

and Peru share some geographical, historical, economic conditions, language, traditions and mining regulations, I focus my efforts only on these two countries.

This research assess one of the fundamental goals of the Fairmined Certification. That is, Fairmined certified mining organizations provide better living conditions to its members, the miners. To asses such impact, I create a well-being index using the dimensions that represent the agreed concepts on material and subjective well-being. Through phone call surveys, I collect socioeconomic characteristics of miners, certified and non-certified, related to their quality of life. For measuring the impact of the Fairmined certification on the well-being of the miners, I use Propensity Score Matching. The aim of the measurement is to know if being part of the Fairmined certification scheme translates to better labor, economic, social, environmental conditions. I choose this method because the cross-section nature of my data and because this method also reduces the selection bias of the estimates. Propensity Score Matching takes into consideration the non-randomized nature of data.

The rest of the article is structured as follows. Initially, in section 1, I present an introduction where I cover the problem I want to solve, the justification for it and the objective. Additionally, in this section I also present the contribution, with special emphasis on development studies, and describe the scope, limitations and research question I address in this research. In section 4, I review the relevant literature; to then, in section 5 and 6, present the data collection and the methodology that I use. Finally, in section 7, I present the analysis of the results. I conclude in section 8.

1.1 Problem

The interest of companies and consumers to access more responsible providers, mainly because international and national regulations, open the opportunity for the creation of voluntary sustainability standards certifications. All of these schemes intend to facilitate the sourcing choices for buyers but they are also supposed to positively impact the livelihoods of certified individuals. Companies decide to buy commodities from certification schemes because they also expect to contribute to the development of the producing countries. They expect by buying certified products, they are creating transparent and fair commercial relationships. Additionally, they are supporting the adoption of better production and trade practices.

Voluntary sustainability certifications are based on a set of requirements listed in standards that are created by non-state and multistakeholder groups to promote sustainability conducts in specific sectors (Bartley, 2007, Tröster & Hiete, 2018). In the last two decades, these certifications have earned interest to guarantee responsible sourcing practices. For instance, Bennett (2017) lists 33 certifications in her analysis of the most known voluntary sustainable standards. The voluntary sustainability certifications have similar characteristics in terms of enhancing responsible production and trade practices to follow legislation and to create positive impacts on producers and actors involved in the supply chains. Fairtrade was the pioneering initiative. It marked the starting point of responsible production labels in 1992 (Fairtrade Foundation, 2020). Its goal was to

bring agricultural commodities from the developing to the rich world with the promise to support the poor producers.

The tendency shows that voluntary sustainability certifications are a solution for companies and consumers to engage with sustainable production. The solution has worked because there are certifications schemes in all kind of sectors like agriculture, mining, fishing, forestry, among others. Particularly, the interest of this research is in one commodity in the mining sector: the gold. According to Kickler and Franken (2017), Tröster and Hiete (2019), there are 19 sustainability schemes in the minerals supply chains. In the gold industry alone, there are 11 certifications depending on the role of the supply chain actors: miners, refiners, traders, smelters, downstream companies (jewelry, electronic, banking, milts) or depending on the size of the mining sites, large scale mining (LSM) and artisanal and small-scale mining (ASM). For the extraction or production point, there are 53% of schemes for LSM, 16% for ASM and 31% for all companies scales (Kickler & Franken, 2017, p. 20). Particularly, as the interest of this research is certified gold produced by ASM, the voluntary certification schemes for the ASM sector are only Fairmined and Fairtrade Standards.

The need to measure the expected impacts of these schemes grows at the same time with the increasing number of sustainability certification schemes. Petrokofsky and Jennings (2018) point out that the assessment of impacts and effectiveness of these certifications in producers' livelihoods, environment, community development is broad. Especially for agricultural commodities. For instance, many authors have carried out quantitative impact analysis in the lives of certified producers for tropical commodities such as cocoa, banana, coffee (Jena & Grote, 2017, Mitiku, de Mey, Nyssen, & Maertens, 2017, Mojo, Fischer, & Degefa, 2015, Nunn, Dragusanu, & Nunn, 2018) and fish (Alemu & Azadi, 2018, Marschke & Wilkings, 2014). On the contrary, there are fewer studies for minerals supply chains. Particularly, I did not find impact analysis for the gold which is the commodity of interest in this research. At the same time, for the artisanal and small-scale mining, I do not find any author, in academia or in the development agencies, who evaluate the impact of the fair trade certifications on the well-being of the ASM miners using a quantitative approach.

1.2 Justification

In the minerals sector, the concerns of the origin and condition of the production started in 2000. The trigger was the link of extraction of minerals with the commission of gross human rights violations, the control of non-state armed groups in the mining operations and the financing of conflicts in developing countries. One of the most common references for the international alert about this critical situation is the "blood" or "conflict" diamonds. Blood diamonds are associated with the wars in Sierra Leone, Angola, Liberia, Democratic Republic of Congo and Ivory Coast (King, 2020). The international reaction to this problem was the beginning of gradual changes in industry policies towards the adoption of responsible sourcing practices in the minerals sector. One action from the United Nations was the creation of the Kimberley Process Certifi-

cation scheme in 2003 (European Union Commision, 2018). The purpose was tackling the situation in these countries and preventing the entry of conflict diamonds into the markets.

Moreover, from a broader reaction, the result was a call to have an international framework to define responsible minerals supply chains between public and private stakeholders. At the same time, to increase the awareness in consumer demands for sustainable minerals and to develop a more responsible industry with the commitment of companies that source minerals for consumer final products such as jewelry, banking and electronics. In this area, an opportunity for sustainability certifications emerged to facilitate the connection with artisanal and small-scale miners in developing countries. These miners are willing to formalize and with the possibilities to do so, they expect to connect with ethical international buyers who are willing to recognize the efforts of mined minerals under responsible practices.

The result of increasing international concerns was the creation of guidance and regulations in the sector. The most predominant and first regulations are the Organisation for Economic Co-operation and Development (OECD)'s Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas, the The United States Dodd-Frank Act in 2010 and the European Union Commision Conflict Minerals Regulation in 2017. All of these regulatory frameworks escalated the pressure and direction of the minerals importing companies to source commodities assuring the implementation of due diligence practices, the mitigation of impacts of the companies' operations and the protection of human rights, working conditions and environment of the producing countries.

Due to the dynamics and the need of responsible and formal mineral supply chains, in 2004, the not-for-profit initiative Alliance for Responsible Mining (ARM), located in Colombia, began an international discussion to get a common agreement about the concept of responsible artisanal and small-scale mining sector. ARM carried out a large participatory process to define the requirements of responsible mining with a global group of participants and experts. The result of these consultations was the creation of the Standard Zero for Fair Trade Artisanal Gold and Associated Silver and Platinum (Alliance for Responsible Mining, 2020, Hruschka & Echavarria, 2011). Then, in 2008, ARM, in partnership with Fairtrade Foundation, created a sustainability standard and the certification scheme called Fairtrade-Fairmined. However, in 2013, the organization split and the outcome is two separate fair trade standards certification labels for artisanal and small-scale miners: Fairmined and Fairtrade (Alliance for Responsible Mining, 2013).

Both schemes have the intention to certify gold extracted from artisanal and small-scale miners and to connect the miners to ethical markets to improve the commercial conditions and the well-being of the miners. The purpose of this fair trade movement in the ASM is pointed out by Hilson, Gillani, and Kutaula *"It seeks to change conventional trading practices by empowering and assisting marginalized producers from the Global South, and to protect and improve their social and economic well-being" (Hilson et al., 2018, p. 896).*

My aim with this research is to evaluate the well-being of the miners in the Fairmined certification scheme. I focus on the Fairmined Certification because it is the pioneering initiative in the ASM sector. Additionally, it is managed by Alliance for Responsible Mining, the NGO situated in Colombia, which specializes in supporting the same sector with cooperation development projects. It also has more trajectory certifying the ASM operations. Since 2014, Fairmined has certified 24 mining organizations in Colombia, Peru, Bolivia and Mongolia (Alliance for Responsible Mining, 2020). The last important point, they granted me access to the data. On the other hand, Fairtrade certifies a large list of agricultural products and other commodities. The certification of gold becomes only one commodity of the list within the other products. Since 2014, the number of certified organizations is less than those of Fairmined. Fairtrade has certified 13 mining organizations in Peru, Kenya and Uganda (Fairtrade, 2020).

1.3 Objective

The objective is to assess the impact on the well-being conditions of the miners that are part of a Fairmined certified mining organization in Colombia and Peru.

1.4 Research question

What is the impact on the well-being of the miners that are part of a Fairmined certified mining organization in comparison to miners that are not part of a Fairmined certified organization?

My hypothesis is that miners who are part of a Fairmined certified mining organization have better living conditions because these organizations adhere to the compliance of the Fairmined Certification. This fair trade and sustainable scheme covers a set of demanding labor, social and organizational requirements. Therefore, the organizations are formal and in compliance with mining and labor regulations. They provide better labor conditions aligned with the respect of human rights and cleaner and safer environments and workplaces. Additionally, these certified organizations receive better commercial conditions and an economic incentive to keep their progressive improvement path. All these responsible practices are expected to impact the livelihoods of miners.

2 Contribution

The contribution of the research is two-fold. First, I contribute to the literature related to impact evaluation of sustainability standards and their effects on those who seek to benefit from it, the small producers. Secondly, I find outcomes that are policy-relevant for governments and international organizations and help in the decision for companies and consumers to engage in buying responsible gold from ASM.

The evaluation of the impact on the well-being of producers in other commodities is largely using both qualitative and quantitative methods. However, it is still incipient

for the minerals supply chains. I find that there is a gap in the literature, which is considered a potential for this project. The gap is that there are studies either quantitative, qualitative for other sustainability certifications for small producers; nonetheless, there are not research on the particular sector of artisanal and small-scale mining and the relation with impact evaluation to the sustainability certification. Consequently, my contribution to the literature is from the perspective of impact evaluation, using one of the statistical techniques, Propensity Score Matching, on the issue of well-being of the miners in the artisanal and small-scale mining sector who are part of a fair trade certification scheme, named Fairmined certification.

On the other hand, I provide insights using quantitative analysis to the public and civil sector such as governments, development agencies and NGOs. With this research, governments will count with evidence to evaluate the impact of the minerals certification schemes to determine the possible connection between the responsible practices in the ASM and the formalization of the sector with local development. The private sector also benefit by having more information to make better decisions when they support fair trade certifications in minerals such as Fairmined. Besides, the industry and consumers have insights to facilitate the comprehension of their contributions when they choose Fairmined over non-responsible minerals.

Finally, this research brings out arguments for the sustainability and permanence of the initiatives such as Fairmined and Fairtrade. The main objective of this research is to understand the impacts of the application of one of those standards on the quality of life of the miners. Indeed, this impact is indicated as a long term impact in their theories of changes. At the same time, this research provide elements to identify aspects to improve their certification programs, in terms of monitoring the conditions of miners and to revise the connection between the sustainability elements of theirs standards and the impact on the miners to keep credibility and trust among their stakeholders.

2.1 Connection with the current development debates

The adoption of certifications and better practices is expected to produce positive impacts. These benefits are in terms of the well-being of the miners and their families, the reduction of negative environmental impacts and the creation of employment and income to the local economies.

The impact evaluation of the Fairmined Certification fits in the current debates about the role that plays minerals certification schemes and their linkage and contribution with the ASM's formalization and development. For instance, boosting formalization of the ASM sector (Intergovernmental Forum on Mining Minerals Metals and Sustainable Development (IGF), 2017); the improvement of the conditions of lives of producers (Childs, 2014); the contribution of the ASM in the Sustainable Development Goals (SDG) (De Haan, Dales, & Mcquilken, 2020a); the contribution of ASM in the developing economies (Hilson, 2002, Hilson & Maconachie, 2020); the South responses for fair trade gold (Sippl, 2020); the ethical gold from ASM (Hilson et al., 2018, McQuilken, 2016); the responsible and sustainable minerals supply chains (Sauer & Seuring, 2017,

Young, 2018); the long-term challenges for certifications initiatives (Hilson, Hilson, & McQuilken, 2016); the ethical consumption and the expectation of stakeholders in the sector of mineral resources (Tröster & Hiete, 2019) and the critics of the application of certification in Africa for helping the poorest miners (Fisher, 2018).

Particularly, Hilson and Maconachie (2020, p. 1) clearly define the role of ASM in the local development as *"its contribution to regional mineral outputs; how operations create employment opportunities for millions of people directly, and millions more in the downstream and upstream industries they spawn; and the links the sector has with subsistence agriculture, dynamics which have important implications for food security and gender equality"*. De Haan et al. (2020a) affirm the existence of interlinkage between all 17 SDGs and ASGM and the formalization, on the other hand, Hilson and Maconachie (2020) point out more specifically the direct contribution from the ASM sector to the SDG to SDG1 (End Poverty), SDG3 (Good Health and Well-Being), SDG8 (Decent Work and Economic Growth), SDG15 (Life on Land) and SDG16 (Peace and Justice; Strong Institutions).

Furthermore, if the ASM in itself generates local development, then, ASM complying with responsible practices may maximize favorable effects, both for those who are part of certification schemes, as well as the areas and countries where they are. This hypothesis is supported by De Haan, Dales, and Mcquilken (2020b) and Ugarte, D'Hollander, Tregurtha, and Haase (2017). They emphasize that more responsible small-scale production is driven by the emergence of sustainability schemes. Therefore, the certification schemes in the ASM have a role to play in the SDG's achievement which it has not been well explored and it may have the potential to other avenues of research.

3 Scope and limitations

One of the common limitations to carrying out impact evaluation in any certification schemes is the lack of baseline data or studies. Indeed, I decide to collect primary data because the lack of Fairmined certified miners well-being data. Even though Fairmined has the audit information and the list of the miners of each certified organization, the certification scheme does not have baseline data about the living conditions of the Fairmined certified miners. Therefore, this research offers a big opportunity, for the first time, to have a baseline regarding the living conditions of the Fairmined certified miners. My first action to collect the data was to define an instrument to capture miners' characteristics and especially their well-being conditions. The procedure was to create a questionnaire to collect the socio-economic conditions and the subjective well-being of miners.

According to the Fairmined website (www.fairmined.org), at the moment of the data collection, between July and October 2020, there were nine Fairmined certified mining organizations in Colombia (3), Peru (4) and Mongolia (2). However, I encounter limitations to collect primary data in all three countries because of the short time period

and the language barrier. Consequently, I concentrate the efforts in Colombia and Peru because ARM has staff on the ground near the certified organizations. Besides, both countries are Spanish speakers and are pioneers in the adoption of responsible practices for ASM.

As part of the application procedure to enter the Fairmined certification scheme, the mining organization needs to submit a list of the miners to ARM. For this research, ARM provided me with access to the list of miners. In total, the population of certified miners in Colombia is 206 and in Peru is 536. These miners are from 6 out of 7 certified organizations Colombia and Peru. I omitted one organization because it has not sold Fairmined gold during its certified period and because it did not want to participate in the research. The remaining six mining organizations comprise 721 miners: 185 miners in Colombia and 536 miners in Peru. These figures were taken in December 2019, right before the COVID-19 pandemic crisis. The six mining organizations represent 85% of the total of Fairmined mining organizations in Latin America and 65% if I consider the two organization in Mongolia. In addition to the certified miners, I need to consider the collection of surveys to non-certified miners. The latter will serve as the control group when I estimate the impact using Propensity Score Matching.

Initially, my plan was to make in-person surveys with the support of ARM staff. As certification owner, ARM has a presence in the mining territories and has a direct connection with the certified and non-certified miners. However, the situation with the pandemic of COVID-19 put some pressure on the data collection process. The certified and non-certified organizations had to stop their operations to avoid the spread of the virus in their companies because national regulation and safety protocols for four months. Additionally, many of the workers are seasonal or temporary which reduces the number of the population to study. According to ARM, the mining organizations reduce their personnel by approximately 30% because of the cease of operations.

Due to the interest and potential of the research, I decided to continue with the method of the data collection although the difficulties for accessing the miners with in-person surveys. The solution for collecting the data was to turn to non-contact surveys (phone surveys and using Whatsapp to share the link for the online survey) as the world turn to online mode because the pandemic. Then, for carrying out phone surveys, I need to make an additional effort to get the phone numbers of the miners with the mining organizations representatives because ARM did not have the phone numbers of all miners, only, the certified mining organizations representatives.

Afterward, the next limitation was that miners provide the phone numbers of their partners and workers. For facilitating the engagement, I take some strategies to capture the information: submitting official letters, talking with the organization representatives and sharing the survey in advance to build trust. This process takes time but it was worthy because it allows getting some miners list with phone numbers. Particularly, the most complicated was getting information about non-certified miners because they do not have the interest to be part of the research. Basically, they are not perceiving benefits of Fairmined.

When I get the certified miners lists with contact information, I count with the

support of numerators to make the phone surveys that facilitate conducting the calls and the follow-up. Nonetheless, many miners did not answer the phone. The sector is highly insecure and lacks confidence to provide information. ASM miners suffer of extended stigmatization and sometimes persecution. Not to mention the problems with connectivity in rural areas and the level of insecurity to be exposed to extortion or robberies. Even though the phone surveys were a solution, they do not create a complete trust environment that would make in-person surveys. At the same time, the possibility to make contact meetings to apply the survey was forbidden in both countries because of the risk to spread the virus. I cannot allow putting any risk to the participants neither to put in troubles the mining organizations. Although the complications for making phone surveys and the particularities of my target population, that affect negatively the quantity and quality of the collection of data, the best method available was to make phone surveys.

On the other hand, the second stage and most challenging was the data collection was to the non-certified miners. The argument is that I have the access to certified miners because they are under the Fairmined certification treatment and the level of confidence is higher with the miners to participate in the research. However, for the data collection of non-certified miners, ARM had a small pipeline list of mining organizations. I contacted the representatives of these organizations but they did not share the full list of the employees' contact information. To sum up, this second stage in the data collection. I apply surveys to some of the Fairmined pipeline organizations, additionally, I also contact ASM miners leaders to support the connection with other miners who must be formal under the regulation to make the comparison robust enough considering the chosen impact evaluation method.

For strengthening the collection of data, some personnel of the certified miners became numerators. They help to complete the survey collection because the restrictions of mobility in the mining areas were slowly easing. Finally, after several setbacks in the data collection process and the implementation of a combined set of strategies to complete the phone surveys, the result was 321 surveys, 208 certified miners and 113 non-certified miners. The implication for the results is that my sample size is 42% of the total population of the Fairmined certified miners. Nonetheless, it is a considerable representation taking into account the collection of information in this challenging times for the miners in the context of the COVID-19 pandemic.

4 Literature review

The literature review section consists of a three-level exercise. First, I detail the characteristics of the particular sector, the artisanal and small-scale mining and its contribution to development. Second, I explore the impact of certification for small producers, in my case, on small-scale miners. Therefore, I evaluate the existing literature and methodologies that study the subject but in other commodities such as agriculture, forestry and fishery. The reason is there is a strong basis on various qualitative and

qualitative studies of the owners of these fair trade and sustainable schemes, scholars or development agencies. In this particular section, I give a context of the minerals sustainability schemes and I dive into the fair trade schemes for artisanal miners. Here, I describe the characteristics of the Fairmined Certification and the particularities of Colombia and Peru. In the last stage, I review the literature about well-being measures. I delve into statistical methods possibilities to calculate the impacts of programs such as Fairmined on the well-being of producers or communities. For this point, I also consider the characteristics of the target data population, to choose the best statistical method to apply between the existing alternatives.

4.1 The artisanal and small-scale mining sector and its role in the gold supply chain

The gold is a metal with diverse uses such as in jewelry, electronics and investment by central banks and investors. In 2019, the demand for gold was 4,366 tonnes of gold. The origin of the gold is 3,470 (79%) tonnes from mined gold and 1,390 (21%) tonnes from recycled gold. The jewelry sector purchased 2,118 (48.5%) tonnes, the technology industry purchases 326 (7.5%) tonnes, investments 1,275 tonnes (29%) and the central banks, 648 tonnes (15%) (World Gold Council, 2020b). The mined gold is extracted by large or medium scale mining (LSM) or artisanal and small-scale mining (ASM). Approximately, up to 20% of the world gold production comes from ASM (World Bank, 2013).

This research is interested in exploring the impact of Fairmined Certification, this is one of the certification schemes for the most vulnerable group in the gold supply chain: the artisanal and small scale miners. To dive into the particularities of this scheme, it is necessary to define the ASM sector. According to Organisation for Economic Co-operation and Development (OECD) (2016, p. 65), *"ASM is the formal and informal mining operations with predominantly simplified forms of exploration, extraction, processing, and transportation. ASM is normally low capital intensive and uses high labor-intensive technology*".

The data of ASM is not exact or up-to-date. The most recent estimation of the total of ASM miners, according to World Bank (2020), is that the ASM sector employs at least 42.6 million people worldwide. Women working in ASM represents 30% and men 70% (World Bank, 2019). Moreover, 150 million people depend on the revenues of ASM in over 80 countries, almost all of them in the developing world. Roughly 80% of the activity is carried out mainly under informality and precarious working conditions (Intergovernmental Forum on Mining Minerals Metals and Sustainable Development (IGF), 2017).

This ASM activity is made by individuals, family units or small enterprises located in rural communities. The activity is considered poverty-driven and the main or alternative livelihood for many people in rural areas. In particular, for the gold sector, it employs 10-20 million miners (50% of global ASM miners). The ASM gold sector contributes with 90% of the total employment in gold mining, the rest 10% is from

large scale mining companies. Approximately 100 million women, men, and children are economically supported by this largely informal industry (Intergovernmental Forum on Mining Minerals Metals and Sustainable Development (IGF), 2017).

Overall, the minerals regulations emphasize the engagement with the most vulnerable sector: the artisanal and small-scale mining. To answer these needs, there are some programs and initiatives to support the ASM sector in the formalization process and the adoption of better practices, sometimes under the framework or adoption of sustainable standards. Such as NGOs as Alliance for Responsible Mining (ARM), Solidaridad, Fairtrade, PACT, Impact, among others.

The interest of this research is the ASM sector because it contributes to local development, however, it still has challenges in the formalization of the operations and the adoption of responsible practices. Although the bad reputation in the media associated the ASM as a sector that fuels criminal activities (McDonald, 2019), that has links with human rights violations (Human Rights Watch, 2018), or that brings challenges for government management due to the bad practices and conditions, such as, mercury pollution, environmental degradation and health and safety problems (Sippl, 2015). However, there is another perspective about the ASM sector. The academic literature and development agencies reports emphasize that ASM has a socio-economic significance as an alleviator of poverty, creator of rural employment, opportunities for women, a promoter of development and a source of revenues from the countries in Africa, Latin America and Asia (Hentschel, Priester, & Hruschka, 2002, Hilson, 2002, Hruschka & Echavarria, 2011, Siegel & Veiga, 2010). In the same line, other authors such as Echavarria (2014), Hilson (2002), Siegel and Veiga (2010) agree on the active and transformative role of the ASM and its potential to create local development; however, they insist on the need that governments and cooperation support measures regarding the formalization and implementation of sector-specific legislation. Additionally, the needed support in education technology transfer, training and assistance become indispensable to get the ASM miners out of the poverty trap.

4.2 Fairmined Certification in the context of fair trade or responsible practices for small producers

Although the panorama for sustainability schemes in the minerals supply chains is relatively vast, 19 certification schemes, they are designed depending on the role of the companies of the supply chain (Kickler & Franken, 2017, Tröster & Hiete, 2019). Punctually, for artisanal and small-scale gold mining (ASGM), there are two certifications: Fairmined and Fairtrade. The first one is created by the NGO Alliance for Responsible Mining and the second one by Fairtrade Foundation. Both certifications share the concept of supporting small producers, a fair price, premiums and third-party assurance verification (Hilson et al., 2018, Stähr & Schütte, 2016, Tröster & Hiete, 2019).

Both certifications were created to bring opportunities for the artisanal and small-scale mining sector, to promote progressive organization and formalization, to engage the responsible ASM miners with the ethical markets. Hilson (2008) indicates that

Fairmined and Fairtrade were created under the same purpose as other labels that promise to contribute to the development of the producers from the Global South communities. The buyers pay more for the gold that it is extracted under sustainable practices. Fairmined and Fairtrade are created under the same philosophy and values of fair trade products such as banana, cocoa, coffee, tea, etc.

The voluntary sustainability certifications have similar characteristics in terms of enhancing responsible production and trade. The origin of the pioneering non-governmental initiative was Fairtrade between 1988 and 1992. That was the starting point of responsible production labels (Fairtrade Foundation, 2020); mainly, in the agricultural sector. Dragusanu, Giovannucci, and Nunn point out that the aim of Fairtrade was to ensure that crop producers in poor countries are well paid. With the purpose to differentiate those products, they created a label. The name was Max Havelaar, a fictional character who opposes *"the exploitation of coffee pickers in Dutch colonies"* (Dragusanu et al., 2014, p.3).

Even though, the existence of fair trade certifications dated from almost twenty years ago, the success of the value proposition of fair trade on the impact of small producers is not conclusive. Dragusanu et al. (2014) mention two sides of the debate regarding the effectiveness of the fair trade concept. Particularly, the authors ask if Fairtrade produces economic and social impacts in the producers and if the results are sustainable in the long-term. The first side of the debates that put some doubts come, for example, from Collier (2008) and de Janvry, McIntosh, and Sadoulet (2015). The authors consider Fairtrade is a charitable initiative that perpetuates the poverty of the producers. Other scholars, such as Raynolds (2009), considers that fair trade initiatives offer solutions to farmers and that it improves their market access and conditions. Furthermore, the literature has attempted to measure such impact in different commodities supply chains, however, the results remain ambiguous.

In what respect to the particular study of the minerals certifications for ASM, Smith (2012) presents Fairmined as an innovative approach. Nonetheless, in the last years, concerns about the evidence of the impacts of these certifications are increasing. Sippl (2020, p. 1) indicates that *"the actual impacts of certification programs on the problems they were created to solve is unclear"*. Other scholars focus on criticizing the limitations of the application of the certification, especially, in African contexts where ASM is a largely informal sector. Likewise, the fair trade model in agriculture that is copied to the gold is not covering the most impoverished and poorest miners target which represents the base of the sector (Hilson et al., 2018, McQuilken, 2016, Young, 2018).

Examining the methods in the literature on impact evaluations of fair trade schemes. I find that from the standards-setting organizations, they carry out a more qualitative evaluation, for instance, *"The impact of Fairtrade labeling on small-scale producers"* by (Havelaar France, 2009). On the other hand, Ann Elliott (2018), Bray and Neilson (2017), Giuliani, Ciravegna, Vezzulli, and Kilian (2017), Negash (2016), Oya, Schaefer, and Skalidou (2018) assess the impacts in a more quantitative approach. Particularly, my research takes the inspirational works of impact evaluations of certified coffee farmers by Bro, Clay, Ortega, and Lopez (2019), Jena, Chichaibelu, Stellmacher, and Grote

(2012), Jena and Grote (2017), Lampach and Morawetz (2016), Mojo et al. (2015). They apply different quantitative techniques in their assessments such as Ordinary Least Squares (OLS), Propensity Score Matching (PSM) and the poverty index measures.

4.3 Fairmined Certification characteristics

The main objective of the Fairmined Standard is to contribute to the formalization of the sector and to bring development in their communities. The long term impact in the theory of change in the Fairmined Certification for Alliance for Responsible Mining (2015) is that organizations that are complying with the Fairmined Standard will bring more well-being to miners, their families and their communities. Additionally, the impacts are for the environment and the local economy, for example with the reduction of negative impacts on the environment and the contribution to local and national economic development and job creation. My aim with the research is to focus, especially, on the first aspect, the well-being of the miners.

Gold importers and companies that use gold as input for their final products for the European and North American markets led the responsible sourcing tendency. For assuring the traceability of the gold, the engagement with Fairmined is part of the added value to their business models or the corporate awareness to source from responsible origins. They are interested in minerals that are extracted under high-level performance standards. In other terms, the gold from the formal operation, with low environmental impacts, better working conditions and impacting positively on local development. Since 2014, companies in these continents are paying more than 95% of the international price and a premium of 4,000 USD per kilogram of gold (Alliance for Responsible Mining, 2014, p. 39-40). They expect that buying Fairmined gold, although more expensive, they are complying with the laws of conflict minerals and expect the gold to be free of worst practices as child labor and mercury pollution. The companies consider they are giving a step forward contributing to the positive transformation to the sector, paying an economic reward (the premium) for continuous improvement and investments in the organizational strengthening and local development.

Currently, there are nine Fairmined certified mining organizations in Colombia, Peru and Mongolia. The list of the Fairmined certified mining organizations profiles of the certification is studied based on the published information at the official website of Fairmined Certification (`www.fairmined.org`). The scheme benefits 1,200 miners and 250 companies and brands purchase Fairmined gold in 35 countries worldwide. Since 2014, the 24 Fairmined certified small-scale mining operations have included 3,400 people. In total, they have produced 1.4 tonnes of gold under the compliance of Fairmined Standard and received 5,640,000 USD Dollars of premium to invest in the organizational, labor and social development (Alliance for Responsible Mining, 2020).

4.4 Fairmined Certification in Colombia and Peru

My geographical scope is Colombia and Peru because of their role in the implementation of the Fairmined Certification. At the same time, these countries represent the region for the level of gold extraction, the efforts to promote formalization, the trajectory of adopting responsible mining and the feasibility to access the data for the research.

Fairmined has its beginning and ongoing application in Colombia and Peru. The first Fairmined organization was certified in 2014, the operation is located in Huila, Colombia and the organization still holds the certification up-to-day. Then, other mining organizations got the certification such as Cecomip (2016), Macdesa (2017) and Oro Puno (2018) in Peru and Chede (2018) in Colombia. Both countries are representatives in gold production, being the sixth, Peru, and twentieth, Colombia, in the ranking of world gold production. In 2018, Peru produced 158.4 tonnes of gold and Colombia 43 tonnes (World Gold Council, 2020a). Particularly, the gold production from ASM represents 28% in Peru and 46% in Colombia (UN Environment programme, 2020).

Stähr and Schütte (2016) describe that the artisanal and small-scale mining in Peru has been active for many years. They claim that *"a formalized ASM sector would have the potential of social, ecological and economic development actions"*. They also point out the existence of different programs to support the formalization and adoption of sustainability standards and certifications. The initiatives are the Alliance for Responsible Mining (with the Fairmined Certification), Fairtrade Gold, the Better Gold Initiative, a program from the Swiss private and cooperation sector, the Artisanal Gold Council as well as the NGO Solidaridad. Stähr and Schütte (2016) also analyze the sector in Colombia. The authors emphasize that many programs support the development of the ASM in Colombia. Programs from the government and cooperation, such as the Alliance for Responsible Mining, Legal gold program as part of BioREDD by Chemonics/USAID among others. One important point to highlight is Colombia is a reference for the implementation of the responsible standard, Oro Verde, a local program to connect artisanal miners with ethical jewelry that started in 2004.

4.5 Well-being measures

First and all, I need to define the concept of well-being that I use in the research. For this purpose, I contextualize using the literature and the evolution of the concept, its dimensions and the international agreement and measurements. Another point to consider in this document is that the well-being term is used as synonymous of quality of life, happiness and life satisfaction.

Greyling and Tregenna (2017), VanderWeele et al. (2020) provide a description of the evolution of the well-being measures. They indicate that the literature of well-being measures started in 1990 with the purpose to build multidimensional composite indices. The most known index is the Human Development Index (HDI). The main characteristics of this measure are the combination of only three indicators: life expectancy, educational attainment and income. The creator is the United Nations Development

Program (UNDP) (2020) and its basis is Sen's "*capabilities and functionings*" theory of human development. United Nations Development Program (UNDP) (2020) also points out that one of the main critiques is that this index only has three dimensions and each one has the same weight.

For overcoming this problem, there are other composite indices that are used in the development literature and that are used as international references in policy making. The most referenced indices are the Physical Quality of Life Index (Morris, 1978), the Quality of Life Index (Dasgupta & Weale, 1992), the Comprehensive Quality of Life Survey (Cummins, 2005), the Combined Quality of Life Indices (Diener, 1995), the Index of Economic Well-being (Osberg & Sharpe, 2002), the Economist Intelligence Unit's Quality of Life Index ("Economist Intelligence Unit Quality of Life Index", 2014), the Commission on Measurement of Economic Progress (Fitoussi Jean-Paul, Amartya Sen, 2009) and the OECD Better life index (Organisation for Economic Co-operation and Development (OECD), 2020).

Consequently, one critical issue for building the index to measure the well-being of the miners is the lack of a common agreement in academia to measure well-being. However, I intend to create an index aligned with the literature and at the same time, it represents the dimensions that the Fairmined Certification expects to impact in the miners. Another consideration with the international framework of well-being indices is that these measures are mainly focused on the national well-being to compare the quality of life between countries and to measure progress over time.

Based on the scenario of the existence of multiple indices, table 4.1 compares the above indices. The objective is to facilitate the comprehension and analysis of the well-being literature and to choose the index dimensions that reflect better the impacts of the Fairmined certification. The first column of the table lists the elements included in the Fairmined miner's well-being index. Furthermore, I find that these indices use similar components of life conditions and they cover in some cases, more or less the same dimensions, such as income, housing, employment, education, civic engagement, governance, health, subjective well-being or life satisfaction, community involvement, safety, environment condition and work-life balance. For the purpose of this research, I primarily use the OECD Better life index (Organisation for Economic Co-operation and Development (OECD), 2020) as guidance to construct the well-being index for the certified miners. The reason is that the OECD Better life index has more dimensions that aid the construction of well-being with a more integral approach.

4.6 Propensity score matching and impact evaluation

The impact evaluation literature and the analysis of treatment effects use different approaches. Greene (2012) presents regression methods, difference in difference, Propensity Score Matching (PSM), and discontinuity regression. Likewise, Gertler, Martinez, Premand, Rawlings, and Vermeersch (2016) recommend randomized assignment of treatment, instrumental variables, discontinuity regression, difference in difference, and matching.

Dragusanu et al. (2014) emphasize that scholars use matching methods due to the existence of difficulties to reduce bias in the estimates when they try to measure impacts of fair trade certifications. Their expectation is that matching particular characteristics, it is easier to compare between fair trade producers with non-certified producers with similar characteristics. The problem surges in the selection of the variables to match the characteristics and that the omitted factors are observable. Otherwise, the bias is not controlled. Additionally, Dammert and Mohan (2015) indicate that PSM is used in fair trade impacts to correct the issue about random assignment of the producers and to correct the potential selection bias. The main reason is that randomizing the assignment is complicated because external reasons such as political and institutional contexts.

Greene (2012, p. 935) remarks the benefits of the method indicating that "individuals with similar propensity scores are paired and the average treatment effect is then estimated by the differences in outcomes". Similarly, Becker and Ichino (2002) emphasize that PSM reduces the bias created by the unobservable confounding factor when the treatment and control group are not random. One important point to consider later in the estimation is "*the bias is eliminated only if the exposure to treatment can be considered to be purely random among individuals who have the same value of the propensity score*" (Becker & Ichino, 2002, p. 1).

Because of the above considerations, I decide to use Propensity Score Matching (PSM). Specifically, I follow Rosenbaum and Rubin (1983)'s seminal paper in Propensity Score Matching. Additionally, I revise Caliendo and Kopeinig (2008) who explain how to apply the method in a step-by-step basis.

Table 4.1: Well-being indices: literature comparison

Well-being index: Fairmined	**Literature**	**Indicators**
Income and Wealth and Housing	Better life index, OECD (2020)	Household income, Household wealth, Housing affordability, Households with internet access at home
	Physical Quality of Life Index, Morris (1979)	GNI per capita
	The Quality of Life Index (Dasgupta and Weale, 1992)	Per capita income
	The Comprehensive Quality of Life Survey (Cummins, 2005)	Material well-being
	Combined Quality of Life Indices (Diener, 1995)	Purchasing Parity Power, Per Capita Income
	The Index of Economic Well-being (Osberg and Sharpe, 2002)	Consumption flows, Wealth stocks and Inequality
	Where-to-be-born index, QLI, The Economist Intelligence Unit (2014)	Material well-being
Labor conditions	Better life index, OECD (2020)	Employment rate, Labour market insecurity, Earnings
	Where-to-be-born index, QLI, The Economist Intelligence Unit (2014)	Economic Security
Physical Health and environmental quality	Better life index, OECD (2020)	Life expectancy, Perceived health, Deaths from suicide, alcohol, drug, Air pollution, Access to green space
	Physical Quality of Life Index, Morris (1979)	Life expectancy
	"Human Development Index, UN "	Life expectancy at birth
	The Quality of Life Index (Dasgupta and Weale, 1992)	Life expectancy
	The Comprehensive Quality of Life Survey (Cummins, 2005)	Health
	Combined Quality of Life Indices (Diener, 1995)	Basic Physical Need Fulfillment, Physicians per capita
	Where-to-be-born index, QLI, The Economist Intelligence Unit (2014)	Health
	Commission of Measurement, Stiglitz et al (2009)	Health
Subjective Well-being	Better life index, OECD (2020)	Life satisfaction, Negative affect balance
	The Comprehensive Quality of Life Survey (Cummins, 2005)	Emotional well-being
	Combined Quality of Life Indices (Diener, 1995)	Suicide Rate Subjective, Subjective well-being

Social relations	Better life index, OECD (2020)	Time spent in social interaction, Social support, Satisfaction with personal relationships
	The Comprehensive Quality of Life Survey (Cummins, 2005)	Intimacy and friendship/Community
	Where-to-be-born index, QLI, The Economist Intelligence Unit (2014)	Family life, Community life
	Commission of Measurement, Stiglitz et al (2009)	Social connections
Education	Better life index, OECD (2020)	Student skill, Years in education
	Physical Quality of Life Index, Morris (1979)	Literacy rate
	Physical Quality of Life Index, Morris (1979)	Expected year of schooling
	The Quality of Life Index (Dasgupta and Weale, 1992)	Literacy rate
	The Comprehensive Quality of Life Survey (Cummins, 2005)	Productivity
	Combined Quality of Life Indices (Diener, 1995)	Literacy Rate, College/university attendance
	Commission of Measurement, Stiglitz et al (2009)	Education (in terms of achievement)
Not included in the index because Fairmined Certification does not affect directly the following elements		
Safety	Better life index, OECD (2020)	Homicides, Feeling safe at night,Road deaths
	The Comprehensive Quality of Life Survey (Cummins, 2005)	Safety
	Combined Quality of Life Indices (Diener, 1995)	Homicide rate, Monetary Savings Rate
	Where-to-be-born index, QLI, The Economist Intelligence Unit (2014)	Political stability and security
	Commission of Measurement, Stiglitz et al (2009)	Personal insecurity
Work-life balance	Better life index, OECD (2020)	Long unpaid working hours
Recreation and leisure	Better life index, OECD (2020)	Time off
	Commission of Measurement, Stiglitz et al (2009)	Personal activities
Civic Engagement	Better life index, OECD (2020)	Voter turnout
	The Quality of Life Index (Dasgupta and Weale, 1992)	Index political rights + index civil rights
	Where-to-be-born index, QLI, The Economist Intelligence Unit (2014)	Political freedom
	Commission of Measurement, Stiglitz et al (2009)	Political voice and governance
	Combined Quality of Life Indices (Diener, 1995)	Gross Human Rights Violations, Income Equality (GINI)

5 Data collection

The source of the data is primary data collection through phone surveys to the miners (partner and workers) of the certified mining organizations and non-certified mining organizations in Colombia and Peru. Basically, the survey technique consists of using a questionnaire to ask many individuals the same questions regarding their living and working conditions and the perception or satisfaction with different elements of quality of life (O'Leary, 2018, p. 417). To facilitate the data collection and processing of the results, I use the online solution Kobo Tool box (https://www.kobotoolbox.org). It is an open-source field data collection tool. The specific link for the Colombian survey is https://ee.kobotoolbox.org/x/etDgUUG4 and the Peruvian survey is https://ee.kobotoolbox.org/x/pviSduCB. Appendix A presents a translated version of it.

The survey design takes into account the quality of life measures questions, the well-being components definition and the ASM characteristics of the sector. The questions are variables to use in the index and the regression. The questions are observable characteristics and perception measures in the well-being literature. I designed two different survey templates to take into account the particularities of the countries and the national census questions regarding the quality of life from the National Administrative Department of Statistics of Colombia (DANE) and National Institute of Statistics and Informatics in Peru (INEI) to be consistent with the quality of life measure in each country. Likewise, the questionnaire includes the same number of possibilities to facilitate the integration of the data for the analysis.

The survey consists of 50 questions divided into four sections. The first section comprises the informed consent, the name of the mining organization and the socio-demographic and health attributes of the individual. Then, the second section has a set of questions regarding the characteristics of their households. The third part encompasses labor conditions. Finally, the last section combines different perceptions and satisfaction questions regarding all the elements mentioned before with categorical answers between 0 and 10. The survey template is presented in the Appendix A.

After the design of the survey, I move to collect the data in each country. I get the contacts of the mining organizations representatives from the Alliance for Responsible Mining with its staff members. Initially, I planned, they will support the collection in the territories as part of their activities. Nonetheless, the health crisis with the COVID-19 affected this plan because the NGO suspended in-person activities with the miners. So, I changed the strategy to phone surveys with six numerators, three in Colombia and three in Peru. Each numerator accesses to the country tailor-made survey to carry out the calls. The data collection is done between July 1 to November 1, 2020. The survey application was more successful in Colombia than Peru because I could get more surveys from certified miners. The main challenges during the process were that the mining organizations did not have or provide a full list of the phone numbers; in some cases, they do not have a list with phone numbers. Besides, the sector is highly untrustworthy and do not provide personal or housing information by phone; mainly because the stigmatization and security issues or fear to be extorted or stolen.

All in all, my sample is 321 surveys. They are classified as 208 certified miners, partners or workers (150 in Colombia and 58 in Peru) and 113 non-certified miners (59 in Colombia and 54 in Peru). The certified miners are from 2 organizations in Colombia out of the 3 certified mining organizations in this country and 4 certified mining organizations in Peru which are all the certified organizations in the country.

Although it might look as a small sample, 208 certified miners, it represents 42% of the approximated total population (Alliance for Responsible Mining, 2020). Besides, I consider it is representative because it covers six out of nine Fairmined certified mining organizations and I get a sample of each organization. Furthermore, I choose and evaluate the well-being in non certified organizations to carry out the matching method. These organizations share the attribute to be formal and to be located in the same countries. The total surveys of non-certified miners is 59 from 5 organizations in Colombia and the total of non-certified miners is 54 from 29 organizations in Peru. Overall, the initial expectation was to collect more surveys. However, due to drastic measures taken by the Colombian and Peruvian governments to reduce the spread of the COVID-19 pandemic stopped the operation of the mining organizations and the challenges encountered with the surveys application and to access to the data. Table 5.1, presents the details of the miners and mining organizations that participate in the survey.

Table 5.1: Interviewed certified and non-certified miners in Colombia and Peru

Organization name	Type	Cert years	Miners (#)	Department
COLOMBIA				
Certified organizations			**150**	
Coop Iquira	Cooperative	6	127	Huila
Chede	Small company	2	23	Cauca
Non-certified organizations			**59**	
Coodmilla	Cooperative	0	45	Nariño
Fortaleza	Association	0	3	Nariño
El Tablon	Small company	0	3	Nariño
Sky minerals	Small company	0	2	Caldas
La Maria SAS	Small company	0	6	Antioquia
PERU				
Certified organizations			**58**	
Cecomip	Cooperatives group	4	23	Puno
Oro Puno	Small company	3	1	Puno
Cruz Pata	Small company	1	4	Puno
Macdesa	Medium company*	3	30	Arequipa
Non-certified organizations			**54**	
Coop.Min. San Franc. De Rinconada	Cooperative	0	1	Puno
Comunidad campesina upina	Cooperative	0	1	Puno
Diasac	Cooperative	0	1	Puno
Carmelitas de chavin	Cooperative	0	1	Puno
Corporación minera de oro	Cooperative	0	1	Puno
Gavilan Rio Pararani	Cooperative	0	1	Puno
Independent	Small company	0	3	Puno
Peña de ore	Cooperative	0	1	Puno
Productores mineros pomasi sac	Cooperative	0	1	Puno
Coop. Independiente	Cooperative	0	1	Puno
San Francisco de Asis	Cooperative	0	2	Puno
Cencomip	Cooperative	0	1	Puno
Tumi de Oro	Small Company	0	2	Puno
Trapiche de oro	Small Company	0	1	Puno
Empresa San Luis	Small company	0	11	Ayacucho
Sancos	Small company	0	1	Ayacucho
Diatomita Ayacucho	Small company	0	1	Ayacucho
San Pedro	Small company	0	1	Ayacucho
Samana	Small company	0	3	Ayacucho
Puquio	Small company	0	1	Ayacucho
Pullo	Small company	0	1	Ayacucho
Las Lomas	Small company	0	3	Ayacucho
Independent	Small company	0	4	Ayacucho
Incapacha	Small company	0	1	Ayacucho
Chillona	Small company	0	1	Ayacucho
Chillacupro	Small company	0	1	Ayacucho
Chilawuito	Small company	0	1	Ayacucho
Coop. Nueva Teresita	Cooperative	0	2	Ayacucho
Nueva Victoria	Small company	0	3	Ayacucho

Note: * Though Macdesa practices artisanal and small scale mining, it has enough employees to be considered "medium company" according the Peruvian law.

6 Methodology

The final goal of this research is to evaluate the impact of the Fairmined Certification on the well-being of its members, partners and workers. This is commonly known in the impact evaluation literature as "*treatment effect*". In this case, the treatment is the Fairmined Certification on the well-being of miners.

To pursue my goal, I follow four steps. Initially, I define the well-being elements to assess these components in the sample of the study. Then, I design the questionnaire to perform phone surveys to the certified and non-certified miners. Afterward, I build an index to measure the well-being. This is the dependent variable that captures the difference between the treated and control group. Since my treated and control samples might not be random, I avoid performing a direct comparison between the well-being of certified and non-certified miners by the usual linear regression methods. Additionally, I point out that my sample has a self-selection problem because the miners who are in the certification have chosen to do so. Doing a direct comparison would result in biased estimates. To eliminate the bias of my results, I need to build a comparable (control group) to measure the impact. I do it using propensity score matching techniques.

I decide to build an index as part of the methodology because my interest is to evaluate one element in the Fairmined theory of change: the well-being of miners. According to the literature revised in section 4.5, the well-being concept implies exploring different dimensions of the livelihoods, including material and physical conditions.

The theory of change in Fairmined Certification is the miners who are beneficiaries of this program have better conditions and well-being. The owners of organizations must guarantee labor rights and decent working conditions. Fairmined miners enjoy being part of formal and legal enterprises (Alliance for Responsible Mining, 2014, p. 30-38) which come with the following benefits:

- Healthy and Safe Conditions in the Workplace
- Social protection
- Freedom of Labor
- Decent conditions of employment
- Freedom from Discrimination
- Freedom of association and collective bargaining
- Elimination of Child labor
- Gender Equality
- Responsible management of toxic substances

All these benefits in labor rights protection must be reflected in the well-being index of the miners who are certified because the non-certified mining organizations might not be guaranteeing the workers rights and a proper working environment. The reasons are

because these non-certified operations might not be fully complying with the national legislation and they are not complying with the demanding requirements of Fairmined Standard which seeks to provide decent working conditions.

Fairmined Standard working conditions are in alignment with international standards such as International Labor Organization (ILO) conventions, Universal Declaration of Human Rights and Minamata Mercury Convention. These better conditions are expected to positively impact the well-being.

6.1 Fairmined miners well-being index

Taking into consideration the multiple possibilities to measure well-being and the complexity of the concept that I point out in the section 4 literature review. Likewise, considering the sector of interest and the limitation for collecting data. I decide to build the Fairmined miners' well-being index with 27 indicators distributed in six well-being dimensions: Education, Health and Safety, Income, Wealth and Housing, Work and Job Quality, Social Connections and Subjective Well-being. The table 6.1 describes the indicators which are listed in the second column. The index combines objective information as well as the perception of the miners in some issues. All the elements are considered desirable attributes for the miners and even workers in other certification schemes. Each dimension has a respective weight which is indicated in the second column. The index goes between 0 to 1, being 0 low well-being and 1 high well-being.

The decision to create an index was under the premise to capture different similar characteristics under the same dimension. I take into account that the data collection was challenging and maybe the miners did not answer correctly all the questions. Then, the existence of an index with sub-indices offer the possibility to compare between the elements of the sub-index and to find correlations and connections. If I would have stayed with only one or a small number of variables to evaluate well-being, the analysis will be less rich and it will have more limitations for the results.

The index dimensions tackle one of the expected impacts of the theory of change of the Fairmined Certification: the well-being of miners. Additionally, these dimensions are in alignment with the literature and particularly with the Organisation for Economic Co-operation and Development (OECD) (2013) approach to measuring current well-being with the variables of the Better life index. On the other hand, I support my research in the definition and measures methods of the subjective well-being (Organisation for Economic Co-operation and Development (OECD), 2013, World Health Organization, 1995) and the material well-being measured by the national quality of life surveys from Colombia (Departamento Administrativo Nacional de Estadística, 2018) and Peru (Instituto Nacional de Estadística e Informatica, 2019).

Overall, the index reflects individual material well-being and the perception of satisfaction with life. The selected elements are composed by material living conditions economic such as income, consumption. Then, the quality of life, this is a set of non-monetary aspects. In this case, subjective well-being includes elements of perception of satisfaction (Organisation for Economic Co-operation and Development (OECD),

2013).

See the following table with indicators per dimension, weight, range of answers, well-being literature dimension and its correspondence with the OECD Better life index.

Table 6.1: Well-being index in the Fairmined certification

Indicators	Weight	Range of answers	Literature dimension	OECD dimension
Level of education	1.00	0-None- 7 university	Mental development	Knowledge and skills
Health status	0.40	0-very bad- 3 very good	Physical health	
Health today satisfaction	0.15	0-Worst -10 best	Physical health	Health
Healthy Physical environment satisfaction	0.15	0-Worst -10 best	Environmental condition	
Type health care	0.30	0 No health care 3- Special	Physical health	
Access electric power	0.05	0 No- 1- Yes		
Access water	0.05	0 No- 1- Yes		
Access sewage	0.05	0 No- 1- Yes		
Access garbage collection	0.05	0 No- 1- Yes	Material wellbeing	Income and Wealth
House property condition	0.20	0 Colective- 5 Own		
Monthly expenses	0.10	0 Min- Data		
Monthly Savings	0.20	0 Min- Data		
Appliances	0.20	0 Min- Data		
Other type of income	0.10	0 No- 1- Yes		
Frequency EPP use	0.20	0-Never- 4- Very frequent	Labor conditions	
Level of job safety	0.10	0-Worst -10 best	Labor conditions	
Job satisfaction	0.10	0-Worst -10 best	Mental development	Work and Job Quality
Training level satisfaction	0.10	0-Worst -10 best	Labor conditions	
Type of contract	0.30	0- Verbal- 2- Associate	Labor conditions	
Accidents in mining last year	0.20	10-Worst -0 best	Labor conditions	
Time to social and community activities	0.50	0-Never- 4- Very frequent	Social well-being	Social connections
Support from relatives and friends	0.50	0-Worst -10 best		
Current income satisfaction	0.20	0-Worst -10 best		
Life today satisfaction	0.20	0-Worst -10 best	Mental well-being	Subjective Well-being
Level of happinness yesterday	0.20	0-Worst -10 best		
Level of worriness yesterday	0.20	10-Worst -0 best		
Level of sadness yesterday	0.20	10-Worst -0 best		

6.2 Propensity Score Matching

As presented in section 4.6, PSM consists of finding two individuals that share the same characteristics except for having or not received a given treatment. To find the matching individuals, I compute a propensity score–denoted by $\mathcal{S}_i$–for each individual accounting for some specific characteristics–denoted by x_i. The propensity score is, in other words, the probability of being treated; as such, it is a number between 0 and 1. I denote by $T_i = 1$ the individual that received the treatment–individuals that belong to a Fairmined certified organization–and by $T_i = 0$ the individuals that did not receive the treatment. Following Rosenbaum and Rubin (1983), I have that the probability of having received the treatment is:

$$\mathcal{S}_i = Pr\left(T_i = 1 \,|\, x_i\right) \tag{6.1}$$

This score $\mathcal{S}$ can be easily estimated using a Logit or Probit model. Because the coefficients of the Logit model can be interpreted as odd-ratios, I am more inclined to use this type of model. Nonetheless, I will perform the estimation using the Probit

model as well to make sure that the propensity score is not sensitive to the selection of the model.

After I estimate a propensity score for each of the individuals in our sample, I find their match using one of the algorithms proposed in the literature: nearest-neighbor, radius, kernel, and stratification matching. Once I have the matched pairs; that is, pairs of individuals with *the same* characteristics but for the treatment, I estimate the Average effect of Treatment on the Treated (ATT). Gertler et al. (2016, p. 145) states that "*for a given propensity score, exposure to treatment is random and therefore treated and control units should be on average observationally identical ... and shows the influence of the observed characteristics on the likelihood of enrolling in the program*".

The average treatment effect on the treated is computed as:

$$\begin{aligned} ATT &= \mathbb{E}\left[y_{1i} - y_{0i} \,|\, T_i = 1\right] \\ &= \mathbb{E}\left\{\mathbb{E}\left[y_{1i} - y_{0i} \,|\, T_i = 1, \mathcal{S}_i\right]\right\} \\ &= \mathbb{E}_{\mathcal{S}_i \,|\, T_i=1}\left\{\mathbb{E}\left[y_{1i} \,|\, T_i = 1, \mathcal{S}_i\right] - \mathbb{E}\left[y_{0i} \,|\, T_i = 0, \mathcal{S}_i\right]\right\} \end{aligned} \tag{6.2}$$

In practical terms, the average treatment on the treated (ATT) is the mean difference between the individuals who received the treatment with those who did not receive it, after controlling for all their other distinctive characteristics.

7 Results

I collect 50 variables in the survey for 321 individuals including their characteristics and observable elements of material and subjective well-being. I use R software for statistical analysis and computation. The total number of observations under analysis are 16.050. Before I analyze the results, the first exercise is to assign a number to the categorical variables such as level of education, position, type of contract, health status, health affiliation, housing's floor and walls materials. Then, I find 115 missing data in some of the individuals' answers. It represents 0.72% of the total population. The majority of missing answers were age and level of monthly expenses, 15 and 14 observations respectively. In order to avoid data loss and preserve the maximum data size, I impute these missing observations using the multivariate imputation by chained equations method. See Azur, Stuart, Frangakis, and Leaf (2011) for further details.

Moreover, I change the saving and expenses figures to Dollars because the original data is in Colombian Pesos and Peruvian Soles. I use the exchange rate of 1 Dollar for 3,700 Colombian Pesos and 1 Dollar for 3.5 Soles. One additional calculation is the building of a score to define the level of wealth with the 21 appliances and goods list. I normalized the goods and appliances with one of the smaller price plus 1. Then, I calculate the logarithm of each good and I sum up each good score to produce the overall score of appliances.

After I have organized the data, the first approach is to evaluate the descriptive statistics and to look at the effect on one variable over another using a linear regression

model. I mean, to compare the index with the variables to be certified or not certified. Moreover, I evaluate the results of the well-being index components. Finally, I create the control group using Propensity Score Matching to reduce the bias of the estimates and to compare the well-being index between treated and controlled groups.

7.1 Descriptive statistics

Table 7.1 describes some of the characteristics of 321 miners including 208 certified and 113 non-certified miners. They are 127 associates and 193 workers. From a gender perspective, there are 273 men (164 workers and 109 partners) and 47 women (29 workers, 18 partners).

Some of the demographic characteristics of the miners under evaluation are that the miners average age, is 42 and 37 years old respectively between non-certified and certified miners. The minimum age in certified miners is 18 years and the maximum is 67 years and the minimum in non-certified miners is 20 and the maximum is 72 years. With respect to the level of education, both types of miners have on average reached complete high school. Finally, on average, the certified miners have 3 people who depend economically on them, instead, the non-certified miners have only 2 people.

The mean of the well-being index for the non-certified partners and associates is 0.61 and 0.64 for certified miners. It is a small difference between means, though it is statistically significant as we will verify later on. Particularly, the certified miners consider their well-being conditions are better because they are part of Fairmined with a score of 8.9 (range of answers is from 0 to 10). Instead, the perception of the non-certified miners, on average 7.7.

Roughly speaking, both certified and non-certified miners, have about the same income level. However, the non-certified miners spend slightly more than the certified miners. The mean of the monthly expenses on certified miners is $328 Dollars while for the non-certified is $332 Dollars. However, the savings level is $96 Dollars in the certified and $120 Dollars in the non-certified. The certified miners have a higher standard deviation and maximum value in the monthly expenses is considerably high in comparison with non-certified miners. On average, certified miners have appliances for 25.19 points while non-certified miners have about 24.47 points. As a reference, the maximum points in the appliances score is 54.4 and the minimum is 0, which implies having none of the items detailed in appendix A numeral 28.

Regarding the characteristics in the artisanal and small-scale mining, the certified miners have been working in ASM, on overage 21 years and their counterparts, non-certified miners have been 19 years in the sector. On average, certified miners have worked 6.7 years in the companies and they work more hours, on average 45.5 hours in the week. Certified miners have more stability in their job that guarantees permanent jobs under better conditions in Fairmined (contracts, decent wages, social protection, etc). More working time may be reflected in more possibilities to spend more, as the results of appliances show. Likewise, certified miners seem to be more satisfied with their lives than their counterparts. As an example, consider the components of health,

life and income satisfaction. According the data, certified miners are on average more satisfied in these three components than the non-certified miners.

Finally, certified miners are on average more aware of environmental and social mining issues than their counterparts. The results reveal a score of 8.7 certified miners and 8 non-certified in environmental concerns. Similarly, certified miners' score for social awareness about mining issues is 8.4 while it is 7.7 for non-certified miners.

Table 7.1: Descriptive statistics: Fairmined and non-Fairmined miners characteristics

Variable	**Fairmined**	**Mean**	**St dev**	**Min**	**P.50%**	**Max**
Wellbeing Index	Non-certified	0.61	0.11	0.38	0.61	0.85
	Certified	0.64	0.08	0.40	0.64	0.90
Age	Non-certified	42.46	13.15	20.00	41.00	72.00
	Certified	37.15	11.31	18.00	35.00	67.00
Monthly Expenses (Dollars)	Non-certified	332.82	330.49	16.22	216.22	2,162.16
	Certified	327.91	448.78	0.00	229.73	4,864.86
Monthly savings (Dollars)	Non-certified	120.33	214.08	0.00	40.54	1,351.35
	Certified	96.52	185.83	0.00	48.65	1,351.35
Appliances	Non-certified	24.47	9.33	7.80	22.80	50.80
	Certified	25.19	9.45	2.80	24.10	54.40
Years in mining	Non-certified	18.96	12.40	0.00	17.00	54.00
	Certified	21.34	9.36	0.00	21.00	55.00
Year in company	Non-certified	8.28	8.49	0.20	5.00	45.00
	Certified	6.71	5.71	0.00	5.00	30.00
Working hours	Non-certified	38.14	12.01	0.00	40.00	60.00
	Certified	45.54	9.14	0.00	48.00	84.00
Level of education	Non-certified	3.22	2.29	0.00	3.00	7.00
	Certified	3.07	2.10	0.00	3.00	7.00
# Dependents	Non-certified	2.49	1.68	0.00	2.00	8.00
	Certified	2.81	1.48	0.00	3.00	7.00
HealthSatisfaction (0-10)	Non-certified	8.15	1.68	3.00	8.00	10.00
	Certified	9.10	1.24	5.00	10.00	10.00
LifeSatisfaction (0-10)	Non-certified	8.41	1.49	5.00	8.00	10.00
	Certified	9.38	1.00	5.00	10.00	10.00
IncomeSatisfaction (0-10)	Non-certified	7.19	1.66	3.00	7.00	10.00
	Certified	7.87	1.89	2.00	8.00	10.00
Environment Awareness (0-10)	Non-certified	8.03	1.90	3.00	9.00	10.00
	Certified	8.73	1.43	4.00	9.00	10.00
SocialAwareness (0 and 10)	Non-certified	7.66	2.00	2.00	8.00	10.00
	Certified	8.44	1.48	0.00	9.00	10.00
BetterFairmined	Non-certified	7.73	1.92	0.00	8.00	10.00
	Certified	8.90	1.69	0.00	9.00	10.00

Note: The level of education is between 0 to 7, being 0 incomplete elementary school and 7 complete university. The variables with possible responses between 0 to 10 indicates 0 as the smaller and 10 as the maximum. The Appliances is a score between 0 and 54.4. The higher the appliances score the more goods and appliances has the individual.

7.2 Well-being index analysis

In this section, I present the results of the well-being index overall and by components. The objective is to identify the impact on well-being index results of all miners and then, I assess the impact on the well-being by dimensions classifying by partners and workers.

7.2.1 Overall Well-being index analysis

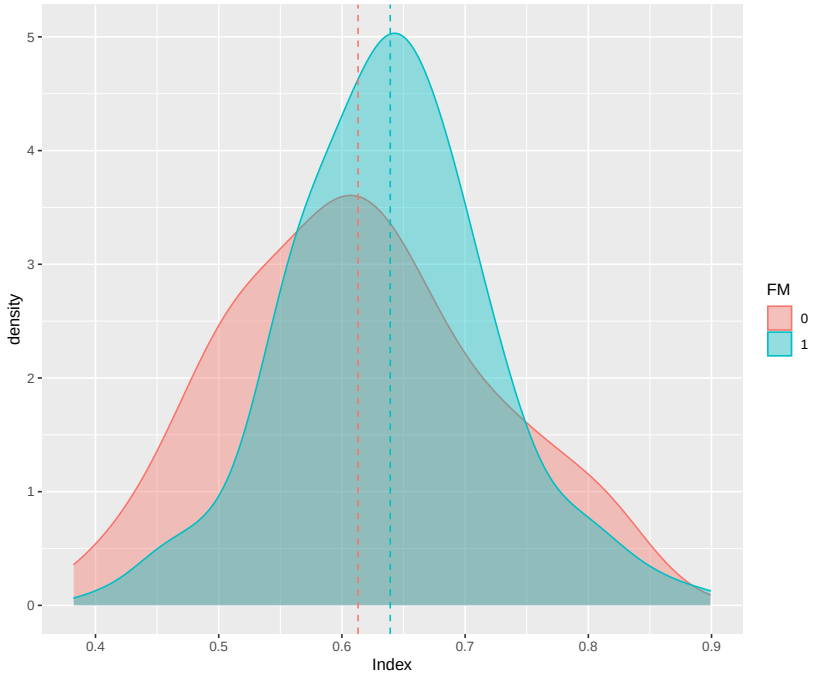
I compare the mean of the well-being index and the empirical densities in a plot between certified (green color) and non-certified miners (red color). See figure 7.1. According to the results, the miners working in a Fairmined certified mining organization have a better quality of life as measured by the well-being index. On average the well-being index for certified miners is 0.639; while for non-certified miners is 0.611. In other words, the difference in the means is 0.027 percentage points. I verify this result with a Welch's test of difference in mean. This test is calculated to identify if two sample means are significantly different. Opposite to the Student's t-test, the Welch test does not require that the variance of the samples be the same. However, it maintains the assumption of normality in the samples.

The Welch's test results indicate that there is a statistically significant difference in the mean in the well-being index of certified miners vs non-certified. The observed t-statistic is -2.3935 with a p-value of 0.01766, hence I reject the null hypothesis of no difference in mean. Furthermore, the well-being index results for certified miners show less dispersion of the data than the non-certified miners. This means that a higher proportion of the certified miners are relatively concentrated around the mean. The non-certified miners, on the other hand, are more disperse. e.g. There are some workers very good in terms of the well-being index but there are also several miners very bad. More precisely, 90% of the certified miners have a well-being index between 0.50 to 0.78. On the contrary, the non-certified miners' well-being index results are more disperse, from 0.45 to 0.81 including a large data proportion in the lower quantile.

Since the Fairmined Certification intends to improve the living conditions of the miners, especially the workers who are exposed to the risks associated with mining. I explore the differences in well-being between partners and workers. The partners are the owners of the companies and the mining rights or titles. Some of them do no work directly in mining sites or processing plants. They are in charge of management and operations. Whereas the workers are employees that can be at the operational level, the miners who work in the tunnels and pits for underground mining executing the extraction and the processing of the mineral and the administrative or professional staff.

From this perspective, I find that the small difference in the well-being of the certified vs the non-certified miners is mainly because of the difference in the well-being index of the workers. See the top plot of figure 7.2. Because of this, I decided to focus my analysis on the workers. The well-being index mean in the non-certified workers is 0.5934 and the certified workers is 0.633. To corroborate the visual result, I perform a

Figure 7.1: Well-being Index density for all miners (workers and partners)



Note: This plot presents the density of the well-being index for all miners for certified (FM=1 and non-certified (FM=0) mining organizations.

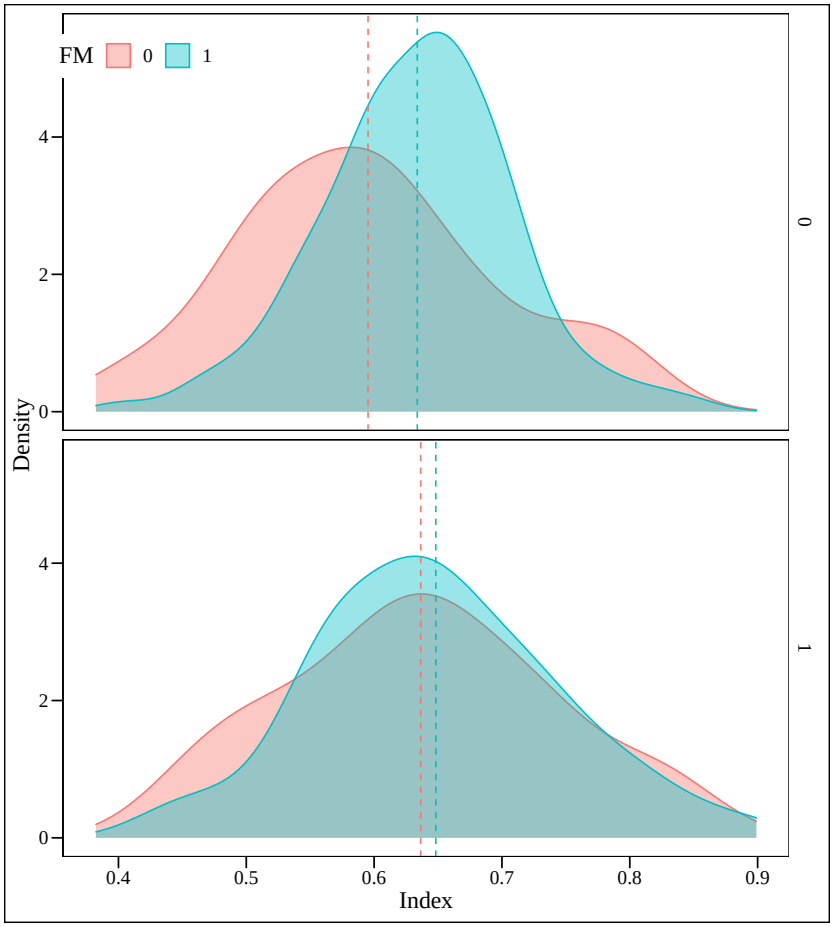
Welch test of difference in mean. The observed t-statistic is -2.8355 with a p-value of 0.005553, hence I reject the null hypothesis of no difference in mean. The result, which is statistically significant, confirms that there is a significant difference in the means in the well-being index of certified workers in comparison with non-certified ones.

Finally, I also compare the well-being index differentiating by country. I find that there is not a significant difference in the well-being index when I compute the Welch's test. The observed t-statistic is 1.1621 and the p-value is 0.2464.

Furthermore, I decide to estimate three models using linear regressions and matched data to verify the above results (see table 7.2). The variables of the models respond to the other relevant variables in the quality of life conditions. These variables are the demographic characteristics, wealth, housing conditions, subjective well-being satisfaction, level of pride with the job and environment and social awareness.

The first model is the linear regression of the well-being index against the binary variable of being or not Fairmined certified. The second model intends to evaluate the well-being index with the variable indicating to be certified or not certified miners, the age, the number of sons and type of house. The last and third model includes the previous variables and sex, country of origin, the house's wall materials, daily leisure hours, pride level for working in the company, job security and environmental and social awareness about mining problems. It is important to mention that other relevant

Figure 7.2: Well-being Index density classified by workers and partners



Note: This plot compares the densities of the well-being index for workers (top) and partners (bottom) for certified (FM = 1) and non-certified (FM = 0) mining organizations.

variables are in the index building or I did not include them in the regression because they are highly correlated with the variables included. For instance, working hours and floor material. The variables included in the regressions are chosen because previous literature finds that they have economical significance.

Model 1 in table 7.2 compares the basic two elements I want to analyze; e.g. the well-being index and the binary variable of belonging, or not, to a Fairmined certified mining organization. According to the results, belonging to a certified mining organization increases the miners' well-being by four percentage points. The result is statistically significant at 1% level. To check the robustness of the results, I include other variables that might affect the well-being index (See Models 2 and 3).

The Model 2 also shows that belonging to a certified mining organization is significant and it increases the miners' well-being by 4.5 percentage points. Moreover, the type of house increases the miners' well-being by 3 percentage points. Conversely,

Table 7.2: Linear regression models

	Model 1	Model 2	Model 3
(Intercept)	0.594***	0.467***	0.139**
	(0.011)	(0.042)	(0.065)
FM1	0.040***	0.045***	0.020
	(0.013)	(0.013)	(0.013)
Age		0.001*	0.002***
		(0.001)	(0.001)
Sons		−0.017***	−0.017***
		(0.006)	(0.006)
House.type		0.027***	0.015*
		(0.009)	(0.009)
Sex			0.005
			(0.015)
CountryPer			0.002
			(0.015)
WallMat			0.012**
			(0.006)
LeisureHrs			−0.002
			(0.001)
Proud			0.010**
			(0.005)
JobSec			0.018***
			(0.005)
EnviAware			0.002
			(0.005)
SocialAware			0.008
			(0.005)
R^2	0.047	0.118	0.338
Adj. R^2	0.042	0.099	0.294
Num. obs.	193	193	193

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

the number of sons reduce the well-being by 2 percentage points. The Model 3, including more variables, presents other significant variables. For instance, job security increases the well-being index by 2 percentage points. According to the results, belonging to Fairmined certified organizations improves the well-being index of miners, even after controlling for other factors that the literature considers relevant, by around 4 percentage points.

Taking into account that my population sample is not random. I estimate the effect again to control for selection bias by self-selection problems. To control for this, I use Propensity Score Matching as presented in section 4.6. The reason to chose this estimation method is that it allows building a valid control group to compare the effect of a given treatment. Though there are other methods like the difference in difference, synthetic control methods, and discontinuity regression; all these require panel data for its proper estimation which is not my case. Then, following Ho, Imai, King, and Stuart (2007) and using its accompanying R package `MatchIt`, I find control units (non-

Table 7.3: Linear regression models with matched data

	Model 1	Model 2	Model 3
(Intercept)	0.594^{***}	0.457^{***}	0.129^{**}
	(0.011)	(0.042)	(0.064)
FM1	0.039^{***}	0.046^{***}	0.020
	(0.013)	(0.013)	(0.013)
Age		0.002^{**}	0.002^{***}
		(0.001)	(0.001)
Sons		-0.020^{***}	-0.019^{***}
		(0.006)	(0.006)
House.type		0.029^{***}	0.015^{*}
		(0.009)	(0.009)
Sex			0.005
			(0.015)
CountryPer			0.000
			(0.016)
WallMat			0.012^{**}
			(0.006)
LeisureHrs			-0.001
			(0.001)
Proud			0.010^{**}
			(0.005)
JobSec			0.018^{***}
			(0.005)
EnviAware			0.002
			(0.005)
SocialAware			0.007
			(0.005)
R^2	0.045	0.127	0.350
Adj. R^2	0.040	0.108	0.306
Num. obs.	191	191	191

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

certified miners) for each of the treated (certified miners) using the "nearest neighbor" algorithm.[1] All in all, for my 129 treated units, I find 62 control units and discarded 2. This is because in the matching algorithm. I allow for replacement within the controls.

After having a data set with the matched treated and control units, I perform the same regressions as before–now with the easy of knowing that the results are not affected by selection bias. Table 7.3 presents the results.

According to the results, being part of a Fairmined certified mining organization has a positive, and statistically significant, effect on the well-being of the miners. After controlling for possible selection bias, the results indicate that the effect is about the same as initially estimated. In total, miners' well-being increases by 4 percentage points by being part of a Fairmined certified organization. This result is consistent with the

[1] As a robustness check, I also used other matching algorithms. The results were consistent and are available upon request.

Welch test of difference in means. The results in the other two models are also consistent between them, though model 2 shows slightly higher results.

One reason for which the results are consistent between the initial regression (table 7.2) and the regressions with the matched data (table 7.3) is that subsetting the data by workers might eliminate the selection bias that I initially thought to be present. This is because workers do not have a saying in the application to be certified. That is a decision of the owners of the mining organization. However, the workers seem to be the ones who perceive more benefits with the certification.

7.2.2 Analysis of the well-being index by dimensions

According to the results, certified miners have on average 0.64 index value and the non-certified miners have 0.61. This is the result I present in figure 7.1. The differences between certified and non-certified partners is subtle but the difference between workers is more considerable, with 0.59 index value for non-certified and 0.63 for certified miners–a difference is 0.0049. This is the result I present in figure 7.2.

As I describe in section 6.1, the index is compound by 27 indicators distributed in six well-being dimensions. The previous result are covering all these six components. To analyze which of the components in the well-being index is more impacted by the Fairmined certification, I compute the Welch difference in mean test for each of the index dimensions; e.g. Education, Health and Safety, Income, Wealth and Housing, Work and Job Quality, Social Connections and Subjective Well-being. Table 7.4 presents the estimated mean and p-value for the test. In this exercise, I present the results for the whole population and for the workers and partners independently.

By dimensions, I find that the education component indicates that on average, the certified and non-certified miners have a well-being education index of around 0.44. Separating by workers and partners, I find that the difference is also negligible and not statistically significant. The health and safety component, on the other hand, is noticeably improved for Fairmined certified workers and partners. On average, the positive effect, for all, is 0.72 in comparison with those in non-certified organization of 0.57. Considering independently the workers, I find a higher improvement–for certified workers is 0.76 while for non-certified is 0.58.

On average, the income, wealth and housing component points out that non-certified miners have a better well-being index than the certified miners. Likewise, the work and job quality index results are on average better in non-certified miners.

Additionally, the well-being index measured with the time to social and community activities and support from relatives has the highest value for certified miners in comparison with other components. The certified miners have an index mean value of 0.82. The non-certified miners have 0.11 points less than the certified miners. From other perspective, the analysis between certified partners and workers shows that workers have a more noticeable index result. The index for certified workers is 0.85 and partners is 0.78.

Finally, the subjective well-being component suggests the certified miners are hap-

Table 7.4: Well-being results by dimensions

	All		Partners		Workers	
	Mean	**p-value**	**Mean**	**p-value**	**Mean**	**p-value**
Well-being index						
Non-certified (0)	0.6121	0.0178	0.6377	0.5494	0.5925	0.0049
Certified (1)	0.6394		0.6487		0.6337	
Education						
Non-certified (0)	0.4488	0.7753	0.4752	0.8051	0.4286	0.9415
Certified (1)	0.4382		0.4597		0.4252	
Health and Safety						
Non-certified (0)	0.5778	<0.0000	0.5740	0.0015	0.5806	<0.0000
Certified (1)	0.7238		0.6644		0.7597	
Income, Wealth and Housing						
Non-certified (0)	0.5041	0.0063	0.5397	0.6381	0.4768	0.0024
Certified (1)	0.4622		0.5281		0.4224	
Work and Job Quality						
Non-certified (0)	0.6949	0.0017	0.6995	0.0349	0.6914	0.0208
Certified (1)	0.6373		0.6372		0.6374	
Social Connections						
Non-certified (0)	0.7143	<0.0000	0.7167	0.0220	0.7125	<0.0000
Certified (1)	0.8297		0.7818		0.8586	
Subjective Well-being						
Non-certified (0)	0.8110	0.0143	0.9139	0.9991	0.7322	<0.0000
Certified (1)	0.8440		0.9139		0.8017	

Note: **Education dimension** is the level of education; **Health and Safety dimension** is the health status, health today satisfaction, healthy physical environment satisfaction and type health care; **Income, Wealth and Housing dimension** includes access to electric power, water, sewage and garbage collection, house property condition, monthly expenses and savings, appliances and other type of income; **Work and Job Quality dimension** is frequency of the EPP use, level of job and training satisfaction, type of contract, number of accidents in mining last year; **Social Connections dimension** is the time to social and community activities and support from relatives and friends and **Subjective Well-being dimension** consists of current income satisfaction, life today satisfaction and level of happiness, worriness and sadness yesterday.

pier and more satisfied than the non-certified miners. The average result is 0.84 in certified miners and 0.81 in non-certified miners. The difference is 0.07 points between certified workers and non-certified workers. Punctually, certified workers have a bigger difference in contrast with certified partners.

Overall, the results are statistically significant for all the components, except the education. Additionally, the certification has a higher effect on the components in the subjective well-being and social connections well-being. On the contrary, the smaller effect is education level indicating that education does not reflect differences in the well-being of the miners.

8 Conclusions

The management of mining resources is a fundamental axis in developing countries since it is an important source of economic resources for the countries. On the one hand, artisanal and small-scale gold mining is sometimes considered problematic due to the existing risks and associated bad practices such as informality, use of mercury, and poor working conditions, among others. On the other hand, artisanal and small-scale gold mining is an engine of development in rural areas where mining is the only source of income, avoiding the rural exodus or the growth of poverty.

Consequently, this research becomes policy-relevant for two reasons. Firstly, the study evaluates one of the sustainability standards for artisanal and small-scale gold mining. Second, it assesses how its Fairmined implementation can not only tackle the formalization of miners but in turn, it becomes a powerful element that leads to improving the conditions of the miners, punctually, their well-being. These impacts can be reflected in the society and the countries because the miners are part of the mining communities.

For the purpose of this research, I use the well-being literature to build a well-being index with six components. The data was collected with primary sources using phone surveys to 321 miners in Colombia and Peru. The result show that miners who are part of Fairmined certified mining organizations have a higher well-being index than the non-certified miners. Furthermore, the results were positive and statistically significant both for the linear regression and when the Propensity Score Matching technique is applied. In conclusion, the results are consistent indicating that Fairmined certified miners are better off than non-certified miners in 4 percentage points.

Furthermore, when I dive into the well-being by components. I find Fairmined certified miners are better off than non-certified miners in their health and safety, social connections and subjective well-being. To respect to education, they have equal conditions to the non-certified miners.

The outcomes of the research also lead to the conclusion that responsible artisanal and small-scale mining framed in the implementation of fair trade standards or responsible mining such as Fairmined may have a greater effect if it is applied on a larger scale. Fairmined certification has incentives for the miners and in turn, it is a guarantee of applicable regulations and also respect for human rights and due diligence practices.

On the other hand, normally, well-being studies are carried out in an aggregate manner in the countries, without carrying out an analysis by economic sector. This research takes a specific sector and also allows evaluating the well-being of people in this sector. Therefore, the replicability of this research can be favorable by expanding the sample of certified and non-certified miners, in order to have broader results.

Policymakers, development agencies and the gold mineral supply chain industry and consumers have a starting point that can serve to promote and develop new fair mining certifications for other minerals, due to their impacts on people who are part of them, and other impacts not measured in this research, but that may be relevant such as the environment and the local economy.

9 Future work

This research project sets a precedent in the evaluation of the effectiveness in minerals sustainability standards, particularly the research starts a discussion about how the sustainability certification for the artisanal and small-scale gold mining can make changes in the well-being conditions of the miners. Consequently, there are several directions for future work.

Although the existing limitations in the conditions under research were carried out, for instance, the need to collect primary data, the COVID 19 Pandemic, the short period of time among others; the research has the potential for application on a larger scale. In other words, to expand the number of observations from certified and non-certified miners even including the characteristics of the family members; to complete the research with qualitative analysis; to analyze the connection between the level of changes in organizational practices and the improvements for the miners and to include Mongolia as the third Fairmined certified country, in addition to Colombia and Peru. For the next steps, researchers will require to seek alternatives to get information with onsite surveys and to consider more time for this process. In a complementary manner, other researchers can shift to use other impact evaluation methods and other statistical techniques for evaluating the same theme. This will give other outcomes for comparative purposes.

One recommendation for ARM, as the certification manager, is to collect the quality of life information for all miners as a baseline for newly certified mining organizations, in addition to requesting the same information each year in order to have comparative results in the medium term that allow providing impact evaluation results more robust and across time. These actions may be beneficial for this standards-setting organization and to transform the current research into long term research.

More broadly, the study can be extended by comparing the results of the Fairmined Certification with other sustainability schemes for artisanal and small-scale mining. Additionally, more in-depth analysis may be carried out. These studies may evaluate the difference in the well-being of certified miners with the people of the communities who are engaged in other economic activities in the same rural areas.

Disclaimer

To subscribe with ethical principles, the survey application included informed consent, confidentiality and non-harm to the participants.

As conflict of interest, I declare that I work for the Alliance for Responsible Mining. Nonetheless, I am carrying out this research as impartially as possible. Besides, I can make publicly available all the data, anonimized, and programs scripts to warranty the replicability of the results. As well as submit the article with my supervisor and peers for evaluation.

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A Questionnaire

Consent: We have obtained your contact information through the representative of the cooperative / company. Mr (s). ——. For which I kindly request if you can answer some questions that will contribute to assess the impact of responsible mining. Your data will be used Anonymous and Confidential. Do you consent and authorize your data to be used in the study? If you do not want to answer any questions, please let me know. When answering the questions, put yourself before the COVID-19 situation, that is, in February.
Please, complete the information or select ONE option by marking an X.

1. Consent:

   Yes: No:

2. Name of the organization:

3. Sex: Man Woman

4. Birth year:

5. What is or was the highest level of education achieved?

   - Some elementary school years
   - All elementary school
   - Some high school years
   - All high school
   - One or more years of the technical or technological program
   - Complete technical or technological program
   - One or more years of university
   - Complete university
   - None
   - Does not know

6. How many people you live with?

7. How many people are financially dependent on you?

8. How many sons/daughters do you have?

9. What is the type of housing where you live?
    - House
    - Apartment
    - Room(s)
    - Indigenous traditional housing
    - Another type of housing (tent, container, wagon, boat, cave, natural refuge, bridge, etc.)
10. The housing occupied by your home is:
    - Own fully paid
    - Own, they are paying it
    - For rent or sublet
    - With the permission of the owner, without any payment (usufructuary)
    - Untitled possession (de facto occupant)
    - Collective ownership
11. What is the main material of the exterior walls of your house?
    - Block, brick, stone, polished wood
    - Tapia tread, adobe
    - Rough wood, board, plank
    - Precast material
    - Guadua, cane, mat, other vegetable
    - Zinc, cloth
12. What is the main material of the floors in your home?
    - Tile, brick, vinyl, tablet, laminate
    - Cement, gravel
    - Polished and lacquered wood, parquet
    - Raw wood, board, plank, other vegetable
    - Sand, land
13. Including living room and dining room, how many rooms or pieces does this home have. Exclude kitchens, bathrooms, garages and rooms for business
14. Which of the following public, private or communal utilities does your home have?

- Electric power Yes No
- Water Yes No
- Sewage Yes No
- Garbage collection Yes No

15. Are you affiliated (contributor or beneficiary) to any health social security entity? (Health-promoting entity [EPS] or subsidized health-promoting entity [EPS-S]). Yes Not Don't know

16. Which of the following social security schemes in health is you affiliated with?

    - Special (Armed Forces, Ecopetrol, public universities, teaching)
    - Contributory (EPS)
    - Subsidized (EPS-S)
    - Don't know, don't report

17. The state of your general health is:

    - Very good
    - Good
    - Bad
    - Very bad

18. How many years have you been in the mining activity?

19. How many years have you been working in this cooperative / company/organization?

20. How proud are you where you work? 0 not at all and 10 very much

    0 1 2 3 4 5 6 7 8 9 10

21. What is your position or main job in the cooperative / company/organization?

22. If you are worker, What type of contract do you have? Verbal Written

23. How many hours, weekly, do you normally work at this job?

24. How many hours daily do you spend per day on leisure or personal care?

25. How often do you spend time in social or community activities?

    - Very frequent
    - Frequent
    - Rarely

- Very rarely
- Never

26. How many accidents in mining have you had in mining during 2019?
    0 1 2 3 4 5 6 7 8 9 10

27. How often do you use personal protection elements to carry out your work?

    - Very frequent
    - Frequent
    - Rarely
    - Very rarely
    - Never

28. How many of the following appliances do you have at home?

    - Washing machine
    - Fridge or refrigerator
    - Electric or gas stove
    - Electric or gas oven
    - Microwave oven
    - Electric or gas water heater or electric shower
    - Tv
    - Iron
    - Blender
    - Video player (DVD, Blue-ray, others)
    - Stereo
    - Air conditioning
    - Video games: Play Station, X-box, Wii, Nintendo, Gameboy, etc.
    - Particular car
    - Motorbike
    - Bicycle
    - Subscription television service cable, satellite
    - Digital or video player (DVD)
    - Computer
    - Tablet

29. Do you have any other type of income other than labor?

    Yes No

30. How much money do you spend on average per month?

31. What percentage of your income do you monthly save?

    The following questions ask about your satisfaction, on a scale of 0 to 10. Where 0 - means that you feel "totally dissatisfied" and 10- means that you feel "totally satisfied".

32. Overall, how safe do you feel doing your job? 0 not safe at all . . . . . 10 very safe

    0 1 2 3 4 5 6 7 8 9 10

33. Overall, how satisfied are you ... with your life?

    0 1 2 3 4 5 6 7 8 9 10

34. Overall, how satisfied are you ... with your current income?

    0 1 2 3 4 5 6 7 8 9 10

35. Overall, how satisfied are you ... with your health?

    0 1 2 3 4 5 6 7 8 9 10

36. Overall, how satisfied are you ... with your current level of security?

    0 1 2 3 4 5 6 7 8 9 10

37. How satisfied are you with your personal relationships (friends and relatives)?

    0 1 2 3 4 5 6 7 8 9 10

38. Overall, how satisfied are you ... with your job/activity currently?

    0 1 2 3 4 5 6 7 8 9 10

39. Overall, how satisfied are you with the training you receive on the job?

    0 1 2 3 4 5 6 7 8 9 10

40. Overall, how healthy is the physical environment where you work? 1 very unhealthy . . . . . .10 very healthy

    0 1 2 3 4 5 6 7 8 9 10

41. How concerned are you about social issues in mining?

    0 1 2 3 4 5 6 7 8 9 10

42. How concerned are you about environmental issues in mining?

    0 1 2 3 4 5 6 7 8 9 10

    The following questions ask about how you felt yesterday on a scale of 0 to 10. Where 0 means that you did NOT experience that feeling "at all" and 10 means that you experienced that feeling "all the time"

43. How happy did you feel ... yesterday? 0 not happy at all ... 10 all the time happy

    0 1 2 3 4 5 6 7 8 9 10

44. How worried did you feel ... yesterday? 0 not at all worried... 10 all the time worried

    0 1 2 3 4 5 6 7 8 9 10

45. How sad did you feel ... yesterday?

    0 not at all sad ... 10 all the time sad

46. Do you know what is Fairmined certification?

    Yes No

47. Are your living conditions better because you are part of a Fairmined certified company?

    0 1 2 3 4 5 6 7 8 9 10