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LONDARI YAMARAK

Papua New Guinea University of Technology, Lae, Papua New Guinea

KEVIN PARTON

Gulbali Institute and School Business, Charles Sturt University, Australia

DO THE INDIGENOUS PEOPLES OF PAPUA NEW GUINEA BENEFIT FROM MINING?

Abstract:

Mining in PNG has had a controversial past with many negative social, political, environmental and health impacts. Our approach is to acknowledge these problems and move on to focus directly on some measurable effects on economic wellbeing of the Indigenous population. This was achieved by using a sustainable livelihood framework with mining-poverty-reduction linkages to assess how livelihoods have been impacted by mining operations. We applied four mining-poverty-reduction linkages: inside capital of households (measured by televisions, VCR/ DVD players, refrigerators, freezers, and cars), human capital (measured by years of schooling), security (measured by food eaten in the last 30 days, square meals in 12 months, and income satisfaction), and empowerment (measured by village participation to help and information volunteering). In addition, we measured overall poverty reduction, the fifth component of the mining-poverty-reduction model, according to position on the rich-pool ladder. The question reads: "please imagine a 9-step ladder where the bottom, the first step, stands for the poorest people, and on the highest step, the ninth, stand the rich. On which step are you today?" It is called the Economic Ladder Question. It does not presume that income is the relevant variable for defining who is poor and who is not but leaves that up to the respondent. At the same time, by using the words poor and rich, the question focuses on a broader concept of economic welfare than income. It is a subjective living standard measure.

In our analysis we compared four types of communities: those in the Ok Tedi region close to mining operations, those in the Ok Tedi region distant from mining, those in the Porgera region close to mining operations and those in the Porgera region distant from mining. A well-known confounding problem of this type of analysis is that there are no observations prior to the arrival of mining, so how do we measure the impact of mining? If you simply compared current data from mining households and non-mining households, it would not be possible to claim that the differences between them are entirely due to mining. The approach is to use a technique called matching, whereby similar households from different regions are first paired with each other. Then, the differences observed can be diagnosed effectively.

We briefly introduce the method of propensity score matching and emphasise the way in which it overcomes the biases of ordinary least squares (OLS) regression and dummy variable regression. The results show that residents of mining villages have received some small improvements in their wellbeing (more at Ok Tedi than Porgera). Two important questions flow from this work: Is the small improvement worth the disruption that has taken place? Are there ways to improve things so that new mining ventures can deliver more substantial improvements in wellbeing for Indigenous people, perhaps with less disruption?

Keywords:

Livelihoods, Mining, Poverty, Indigenous, Papua New Guinea

JEL Classification: I30

Overview of Mining in Papua New Guinea

Mining has affected the people in similar ways in Papua New Guinea (PNG) to those many other third-world countries where mining is a substantial industry. Mining is a major revenue source for any government where mines are located (Aryee, 2001; Christmann & Stolojan, 2001; Connolly & Orsmond, 2011). Gold mining is a major asset of PNG; the largest island known as “*a mountain of gold in a sea of oil*” (Jell-Bahlsen & Jell, 2012). This emphasises that PNG is richly endowed with deposits of gold, silver, copper, oil and gas, with much of it untouched. This has attracted outside investments to develop this industry.

Each of PNG’s mining sites has its own distinct environment, condition, technology and history. Furthermore, the indigenous people and cultures confronted by the different mining projects vary as well because of their distinct tribal practices and cultures. According to Imbun (2008) the advent of large-scale mining operations has largely become a collective affair in the midst of generally receptive and sometimes restless local host communities. The local communities are expected to benefit from any proposed mining development. However, when the socio-environmental impact is taken into account, the benefits of mining and development to the affected people are highly questionable (Fisher, 2016). A United Nations Development Programme report in 2015 highlighted that one of the principal challenges that the country has faced has been in effectively governing the extractive industry sector, which historically has been a source of grievance and conflict for communities living near mine sites (UNDP, 2015).

In many places in PNG today, the ownership of and access to resources are compromised through mining. These activities implicate multi-national mining companies operating in PNG as well as the government. PNG’s economy is now in a precarious shape (Fox, Howes, Nema, Nguyen, & Sum, 2018), even though significant revenues have been generated from mineral exports (Imbun, 2008). Flanagan (2016) described PNG as a resource dependent economy, but with a resource sector that has had limited economic impact on the vast majority of the people.

Four world-class, open pit mines are currently in operation: Ok Tedi and Porgera on the mainland, and Lihir and Misima at island locations. Ok Tedi is the largest mine in PNG, whilst Porgera is the second (PNG Chamber of Mines and Petroleum, 2015). Lihir gold

mining has one of the world's largest known undeveloped gold deposits. According to Chand and Levantis (2000), the mining industry revolves around a small number of projects that are very large by world standards, for example, Ok Tedi rates as the eighth largest copper producer in the world while Porgera is amongst the top five gold producers. Developing the industry poses a number of challenges. Some of the most valuable resources are to be found in the most inaccessible places. Ok Tedi and Porgera and the medium-sized, Kainantu mine and Ramu Nickel mining are all in remote mountainous terrain, while the Lihir mine is located within the rim of an extinct volcano.

There are other mining projects also predicted to come into full operation in the near future. Figure 1 shows the large, medium and small-scale mines in operations, mines under construction and possible future mines still under exploration (PNG Chamber of Mines and Petroleum, 2015). A large-scale mining operation is defined as one that produces mineral commodities with an average value of more than US\$100 million a year for a period of at least ten years (Filer & Le Meur, 2017). As a result of mining project operations throughout PNG, the country has benefitted in terms of taxes and government revenues. However, the environment is degraded, and the indigenous population is reported for the most part to be adversely affected. For example, in Bougainville:

“the mine, and the intractable issues of distribution of benefits and the environmental impact on the community that accompanied its development had created conditions which led to a violent rejection of the company and all the problems it has created for the community” (Banks, 2008, p. 27).

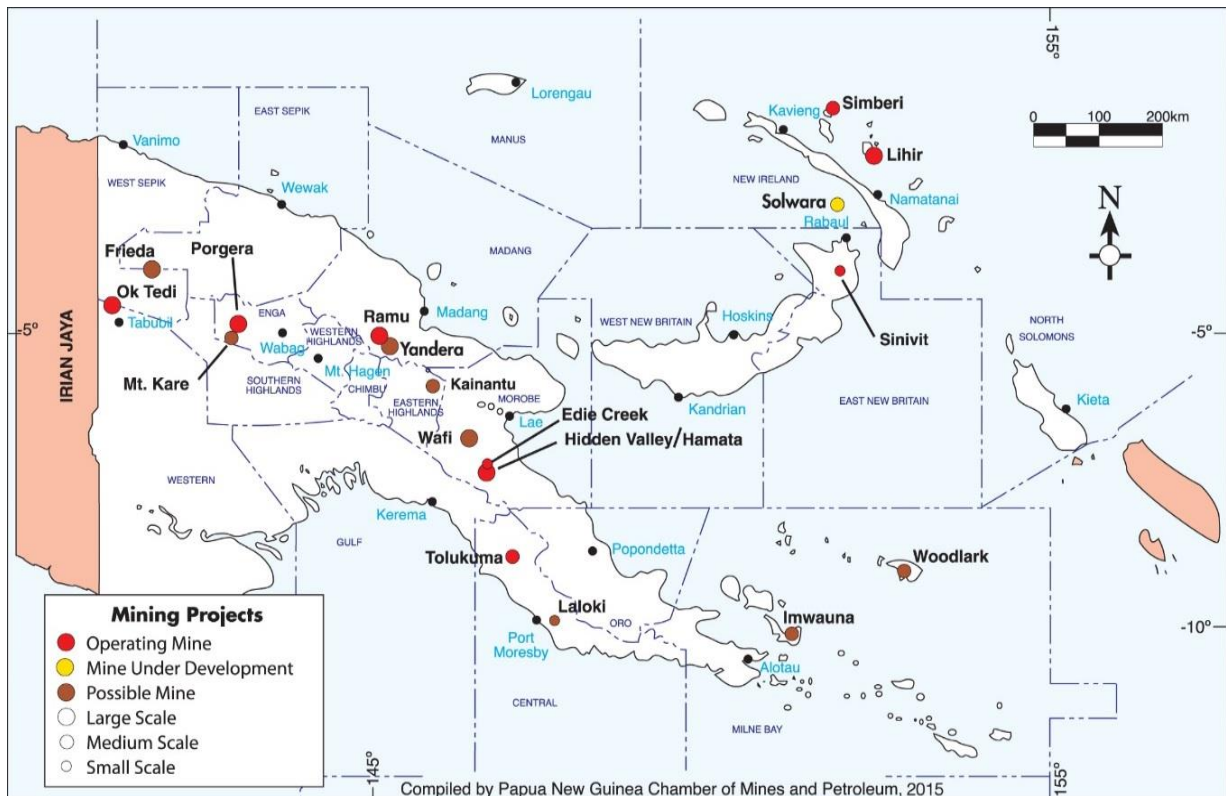


Figure 3.1 Map of Mining Projects in Papua New Guinea. Source: PNG Chamber of Mines and Petroleum (2015)

Macroeconomic Impacts of Mining

Mining and petroleum make a significant contribution to PNG's economy in terms of revenue from taxes and royalties as well as export earnings. PNG is an example of a developing country of moderate size with a significant resource output, but very poor human development indicators, or a resource-rich country with extreme levels of poverty (Filer et al., 2012). Throughout its history as an independent nation, it has been heavily dependent on the resource sector for both export earnings and government revenues. According to the Asian Development Bank (2015, p.1):

“The mining and petroleum sector’s share of gross domestic product (GDP) increased from negligible levels in the 1970s to about 30 percent in the early 1990s, before slipping to between 10 percent -15 percent between 2002 and 2014. From 2014 onwards, this share has increased to around 20 percent of GDP, with the country beginning to export LNG from a US\$19 billion Exxon-Mobil

pipeline built from the Highlands region to the coast. The mining and petroleum sector is overwhelmingly foreign-owned, though the government holds equity in most projects”.

The mining, oil and gas sectors still form the backbone of PNG's economy (Knapton, 2016). Although the mining sector has been in a down cycle, contributions from the mines remain significant in terms of revenue from taxes and royalties as well as export earnings. In 2017, the extractives sector accounted for 86 percent of PNG's total export value. It also comprised 29 percent of PNG's GDP (International Monetary Fund, 2018). However according to Fox et al. (2018) much of the resources sector, which makes up to 30 percent of GDP, is foreign-owned, and a large share of the benefits flow offshore. Therefore, in such an economy, GDP may be a misleading indicator of economic activity. In these circumstances, Gross National Income or non-mining GDP with spill over effects on the resources sector (e.g., taxation and private domestic spending) may be more appropriate (Fox et al., 2018). However, these indicators are not regularly reported.

Fox et al. (2018) also regard the resources boom as having finished in PNG, and revenue received has been squandered through corruption and mismanagement (Howes, 2017 and ADB, 2014). Also, PNG Treasury's predictions on the overall economy have been questioned. For example, PNG Treasury predicted GDP growth of 10.5 percent for 2015, while for the same year the PNG National Statistics Office predicted 5.3 percent (Fox et al., 2018). Variations from predicted levels can occur for many reasons including natural disasters and world economic conditions, but a notable issue highlighted is corruption in PNG's public service (Walton, 2019). According to Walton (2019), the PNG government and international donors have spent millions of kina trying to improve governance in the country's bureaucracy. Despite these efforts, there are few indicators of success: many consider PNG's public service to be rife with corruption (Chevis & Barrum, 2012; Pitts, 2001; Walton, 2019; Warf, 2019).

Governance Issues in the PNG Resources Sector

The World Bank has argued that one of the key factors required for a country to achieve competence in managing mineral wealth is a set of functioning and capable institutions (Weber-Fahr, 2002). Mineral extraction has provided PNG with substantial

opportunities to improve the performance of its economy and governance institutions, yet in many instances this opportunity appears to have been squandered. As an example, the Government of PNG through the 2019 budget statement indicated that it wanted to bring forward reforms to amend the existing Mining and Petroleum Acts to better guide the distributions of benefits to the landowners, State and developers (Deloitte, 2018). Little has so far been achieved.

Moreover, this issue has been observed by many commentators as an ongoing and continuing problem for many years. In 2003, AusAID (2003), on the development perspective of PNG and Pacific, stated that corruption and weak adherence to the rule of law are significant problems facing the Melanesian countries. In the same year, Hughes (2003, p.16) further stated that “both corruption and crime have reached levels that undermine everyday existence and make the conduct of business impossible in PNG and the Pacific Island Countries”. Furthermore, Sir Mekere Morata in 2012 said one of the key challenges facing PNG is that the government statutory institutions have failed to implement the reforms that are already legislated. He further stated that the economy and the government revenues have grown strongly, but this has had little impact on basic services and living standards. His argument was that there is continuing political influence in the mineral sector. Also in 2012, a report from the Lowy Institute said, “successive Australian governments have been in despair about poor governance in Papua New Guinea, worrying about weak institutions, lack of capacity in the public service, corruption, political instability, ineffective leadership, and a thin civil society ill-equipped to hold government to account” (Hayward-Jones, 2012, p. 3). Walton (2014) supports this finding, showing how corruption was tied to a wide variety of activities involving public officials, citizens, and businesspeople. She further mentioned that it reflected the decay and abuse of power, which was considered corrupt, unacceptable, and harmful. Then in 2016, Australian National University academic Dr Flanagan when commenting on the progress of PNG’s economy since independence in 1975, said a combination of corruption, poor politics and poor economic policy means that the resource curse remains the greatest burden hindering real development (Flanagan, 2016). According to Burton (2017), there is widespread corruption within the public service in PNG with the awarding of mining contracts for personal gains. There are also other broad impacts that are not occurring such as stimulating infrastructure development (International Monetary Fund, 2018).

As shown in Figure 2, the Worldwide Governance Indicator assessment of PNG’s performance in controlling corruption showed that it fell below its year 2000 percentile level over the period to 2021, except for a single observation just above the 2000 level in 2020. Figure 2 shows a similar lacklustre performance on the other five governance indicators.

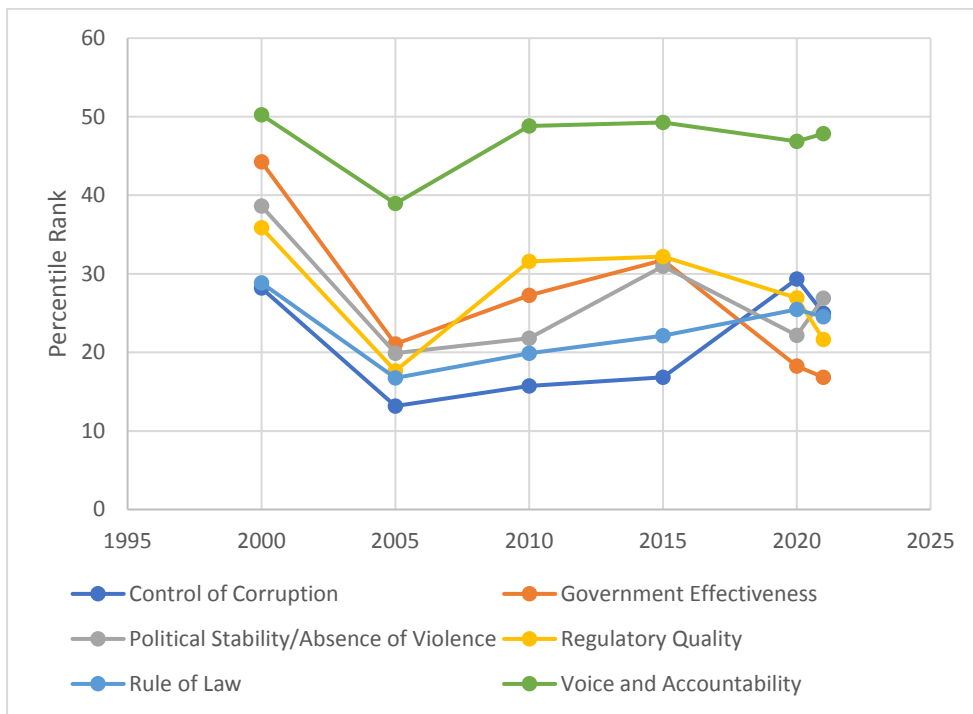


Figure.2 PNG World Governance Indicators. Source: World Bank, Worldwide Governance Indicators (WGI)

<https://databank.worldbank.org/reports.aspx?Report Name=WGI-Table&Id=ccea4d8b>)

Environmental Impact

Throughout PNG in general, mining has negatively affected forests and hunting grounds. This has entailed the extinction of wildlife; the destruction of the flora and fauna, and of cultivated and fallow land; pollution of garden (food-producing) land; pollution of rivers, lakes, ocean bays, and coral gardens; the large-scale poisoning and suffocating of fish, crustaceans, crocodiles, and turtles – otherwise supposedly protected wildlife; and human poisoning from pollution resulting in continuing adverse

health effects (Jacka, 2015; Kirsch, 2001; McKinnon, 2002; Walton & Barnett, 2007). According to Jacka (2015), “Porgera is a massive development failure both socially and environmentally. While proceeds from mining development translate into forms of material improvement in the area, the cost of mining in human lives and the degradation of biodiversity far outweighs the benefits of development” (p. 231).

Ok Tedi Mining’s dump tailings have been deposited into the Fly River and OK Tedi River. It is now felt much further downstream affecting the livelihoods of those who depend on the two rivers. Also from Porgera gold mining, the main concern is with the riverine tailings disposal. The toxicity of the tailings, which contain significant quantities of cyanide, mercury and other heavy elements, are harmful to the environment and its surroundings. The Porgera gold mine has produced significant negative environmental and social impacts, contributing to community concerns about access to clean water (Columbia University, 2019). Many indigenous residents within mining communities express deep fear that their lands, water sources and their bodies are being poisoned by the mining operations at the heart of their traditional lands. For instance, Porgeran residents have often expressed fear and doubt about the availability and quality of water sources, and fear that the water they drink, and with which they bathe, cook, and wash, is a vector of harmful “chemical” emissions from the mine (Columbia University, 2019). Yet many indigenous mining people live in deplorable conditions and feel trapped by the mining activities. The indigenous people feel the earth shake with recurring explosions from the mine operations, and worry about landslides threatening their homes and gardens. They see the rivers change colour with the addition of mine waste and chemicals, smell the strong odor of industrial chemicals permeating their environment, and worry about the impact of these chemicals on their environment and health (Columbia University, 2019). The study also revealed that:

“Porgera Mine discharges tailings waste directly into the river system, effectively converting water sources relied upon by thousands of people into a “mixing zone” of contaminants. Runoff from the solid waste dumps and open pit, and discharge from the underground mines, may also be contributing to the contamination of the major rivers in the area” (Columbia University, 2019, p.4).

The information on the damage to the environment and its social impact are not available to the people (Columbia University, 2019; Fisher, 2016; Roche, 2015). This uncertainty can cause more damage to the indigenous people.

Social Impact

The degradation of the environment produces negative social impacts that take on myriad forms. Mining affects all the people in the mining and adjacent non-mining communities directly or indirectly. Poor working conditions, a high exposure to radiation and injuries, road accidents, toxic spills and the discharge of radioactive tailings into local river systems are just some of the impacts mining can have on the indigenous communities (Roche, 2015). Roche (2015) confirmed that these issues still continue to live on today in almost all mining projects areas in PNG. According to Hyndman (1994, p. 130) as cited by Jell-Bahlsen and Jell (2012):

“The deprivation of their major asset, land, as the source of their subsistence, results in a loss of home; formerly independent farming communities are turned into a proletariat; increasing dependence on wage labour and in its absence on “compensation”, rent and aid; increasing malnutrition, gender inequality”
(p.325).

The occupation and degradation of the land by multi-national mining companies in collaboration with the nation-state has *de facto* robbed PNG’s tribal communities of their existence base. Even with the hard-fought compensation that many communities eventually received, their land has gone or been destroyed, and their waters have been polluted for years to come or even to the point of no return (Ballard & Banks, 2003; Kirsch, 2001). For instance, at Porgera, there is episodic water insecurity, poor sanitary conditions and chronic poverty, and these challenges are magnified by continual in-migration of people from surrounding areas seeking economic opportunities (Fisher, 2016).

Sprague (2015) explored the impact of transnationalism on social monitoring through a Lihir Island case study and identified three main functions that socio-economic monitoring fulfils for mining compliance: (1) to comply with legislation, (2) to demonstrate the project is globally competitive, and (3) to legitimise the existence of the mining project. The mining companies can minimise their negative impacts on the

indigenous people if they can comply with PNG's Environmental Act 2000¹ and the Mining Act 1992². There are six major mining projects operating currently in PNG, their activity towards the environment is monitored by the Environmental Act 2002. It regulates all phases, i.e., exploration stage to the closure of the mine. One of the PNG government's failures was in the implementation and monitoring plan for the Environment Act 2000. As a result, it has far reaching negative impacts on the indigenous people where they have been deprived from farming and fishing. This has further caused health and social issues and these issues live on today. There are also risk to health and safety. This can be related to work injuries, exposure to infectious diseases and environmental hazards. For example, the people of Ok Tedi Mining in PNG are exposed to contagious diseases that directly results from contamination from the nearby Ok Tedi and Fly Rivers. According to Banks (2002, p.44), Ok Tedi Mining's "tailings have been discharged directly to the river system for the last 15 years". The livelihoods of the people that depend on the river system are badly affected. In 2012, Fly River landowners from the South Fly District of Western Province successfully obtained a court order restraining OTML from dumping mine wastes and tailings into the Ok Tedi River catchment (Namorong, 2014). According to the Namorong Report, the court also ordered the payment of K45 million to the landowners to fund independent scientific research into the health and environmental impacts of the Ok Tedi Mine and pay for legal costs. Despite the court order, it is understood that the Ok Tedi mine continued to operate and dump waste long after the order was issued (Namorong, 2014). "Thirty million tonnes of waste rock are still delivered by the Ok Tedi mine to the Fly River system each year" (Banks & Ballard, 2017, p. 10).

In Porgera, the farm lands have been converted into a Mining Township and other infrastructure developments. People living in and nearby the mining communities have to look for other means to survive. Sometimes the survival strategies to cope with the ever-increasing pressure drags them to practicing unsustainable coping strategies. They expose themselves to infectious diseases that can be contagious. The mine tailings

¹ PNG's Environmental Act 2000, section (a), (b), (c), and (d) calls for protection of the environment and to promote sustainable development so that air, water, soil and the ecosystem is preserved for the present and for the future generations. This act provides for the protection of the environment from harm so that present and future generations are saved from any damage

² The Mining Act 1992 regulates licences, leases, rents, fees and royalties, mining development contracts and compensation for land owners and occupants of affected landowners.

spew out the end of a pipe, which the local landowners have been panning for gold. The panners used the most primitive technology thus exposing themselves to risk. It was discovered that, most people living along the Porgera River ('red wara' as it is referred to by most people) got sick and some have died (information supplied by a gold panner, 15th April 2018).

The landowners at Porgera suffer from poverty and a dearth of basic government services. Even to the extreme, the villagers and others who came to dig gold were attacked by security personnel hired by Porgera Joint Venture. The Human Rights report stated that security personnel carried out extrajudicial killings and other violent abuses against illegal miners and other local residents (Human Rights Watch, 2010). In the same report, there were cases of rape by the security personnel (Human Rights Watch, 2010). Food security is threatened, and the mine people were also affected by loss of the agricultural land, water pollution, restricted water supply, dust, noise, and stone waste. These present potential threats to the health and livelihoods of the poor and the vulnerable groups (Weber-Fahr et al., 2002), particularly those who are less mobile.

If such issues could be strictly controlled and monitored by the government agencies, sustainable, environmental friendly and less socially disadvantaged mining communities around PNG can be promoted. Yamarak (2020) considers many other examples of corruption, weak governance, environmental impact and social impact (including various human rights issues) in relation to the mining industry in PNG.

Method

Following similar mining industry analyses of Ticci and Estoban (2015) and Loayza and Rigolini (2016), we applied the propensity score matching (PSM) method. This enabled us to achieve the precision of regression analysis and, at the same time, largely overcome the selection bias problem that is typically associated with studies that compare groups in two locations. We collected a sample of 800 households divided into four groups: mining and non-mining villagers at Ok Tedi, and mining and non-mining villagers at Porgera. We then compared the mining with the non-mining households in each region.

The outcome variable of interest that we focused on was the rich-poor ladder. This is a variable elicited in the survey questionnaire to measure overall poverty levels within the mining and non-mining communities. The question reads: – “please imagine a 9-step ladder where the bottom, the first step, stands for the poorest people, and on the highest step, the ninth, stand the rich. On which step are you today?” It is called the –Economic Ladder Question. It does not presume that income is the relevant variable for defining who is poor and who is not, but leaves that up to the respondent (Ravallion and Lokshin 1999). At the same time, by using the words poor and rich the question focuses on a broader concept of economic welfare. It is a subjective living standard measure. By definition, this instrument should be related to underlying living standards and poverty levels among local people. Further details of the method are contained in Yamarak and Parton (2021).

Results: Impact on Poverty

PSM measures the average treatment effect on the treated (ATT) (Austin, 2011), which in this instance is the effect of mining in mining villagers, where the effect is measured by the impact on the rich-poor ladder. Table 1 shows differences between mining and non-mining households in their rich-poor ladder scores. For Ok Tedi, there are significant and positive effects of mining on the rich-poor ladder assessments of mining households. The observed values of 0.86 for radius matching and 1.18 for kernel matching on a 9-point scale are relatively small. For Porgera, and for the combined Ok Tedi and Porgera dataset, there are positive and significant effects for radius matching, but insignificant results for kernel matching. As well as the level of statistical significance, the value of the estimated coefficients is also of importance. Of the six coefficients estimated, two are not significantly different from zero, two are less than 1.0 on a 9-point scale, and two are between 1.0 and 1.7. So, even in the cases where there is a positive impact, it remains relatively small. The overall assessment is that there are small positive effects at Ok Tedi and inconclusive effects at Porgera. In other words, even though there has been some improvement, the indigenous peoples affected by mining consider that they have experienced only a small positive impact from mining.

Table 1 Average treatment effects on the treated (ATT) and t-statistics for different matching methods, with the rich-poor ladder as the performance index

| Model 1: Regional OK Tedi | | |
|---|------------|----------|
| Mining | ATT | t |
| Radius | 0.862** | 2.384 |
| Kernel | 1.184** | 2.623 |
| Model 2: Regional Porgera | | |
| Mining | ATT | t |
| Radius | 1.561** | 2.352 |
| Kernel | -0.703 | -0.549 |
| Model 3: Combined OK Tedi and Porgera Mining | | |
| Mining | ATT | t |
| Radius | 0.890*** | 5.365 |
| Kernel | 0.138 | 0.431 |

Note 1: *** and ** indicate 1 %, 5%, and 10% level of significance, respectively

Adapted from: Yamarak and Parton (2021)

We also examined in the PSM analysis many other target variables. Important among these were human capital (years of schooling), food eaten in last 30 days (food security), income satisfaction and rich-poor ladder. These are shown in Table 2 for the combined Ok Tedi and Porgera dataset. The significant and positive coefficients for human capital and food eaten in the last 30 days indicate that the level of schooling and food security are both higher in mining village. However, once again the coefficients are small in value, suggesting that in the case of schooling, for example, that the difference between mining and non-mining households is less than a year on average.

| Variables | Matching | ATT | Standard Error | t |
|---------------------------------------|-----------------|------------|-----------------------|----------|
| Human Capital | Radius | 0.262 | 0.056 | 4.715 |
| Food eaten in the last 30 days | Radius | 0.264 | 0.063 | 4.218 |
| Income Satisfaction | Radius | -0.201 | 0.047 | -4.242 |
| Rich-Poor Ladder | Radius | 0.890 | 0.166 | 5.365 |

Adapted from: Yamarak (2020)

The differences in the rich-poor ladder are similar to those discussed above, while for income satisfaction, the negative coefficient suggests that a higher level of income is needed in mining households compared with non-mining households to reach a given level of satisfaction. The key factor that this probably indicates is that mining communities have a more monetised economy and a higher level of expenditure is required to obtain a given level of consumption there.

Discussion

As well as the microeconomic impacts on the affected indigenous peoples that we measured in our analysis, in the introductory component of the paper we have shown that previous studies have demonstrated that there have been impacts of mining, many negative, on the macroeconomy of PNG, on governance of the resources sector, on the environment, and on social aspects. The underlying questions become: (1) are the small microeconomic benefits for indigenous people of PNG worth the macroeconomic, governance, environmental and social costs? and (2) what else can the mining industry do to continue to produce the microeconomic benefits and at the same time reduce the other costs?

Mining in Papua New Guinea has often been associated with adverse environmental, social and economic outcomes for the indigenous peoples. From this background, we set out to estimate the impact of mining on indigenous communities in two significant mining locations at Ok Tedi and Porgera. Various indicators of poverty were employed within the sustainable livelihood framework. Extended into a mining–poverty reduction linkage approach, the SLF provided the theoretical foundation for the study. This foundation supported the use of the propensity score matching method by focusing on economic opportunities, capabilities, security and empowerment, as drivers reducing poverty. Our results indicate that at Ok Tedi and Porgera mining has reduced poverty when measured using the variables human capital, inside capital, village participation to help, food eaten in the last 30 days and square meals in 12 months. There is more income for the mining households as indicated particularly by an increase in investment in human capital, but the food quality and security of food supply have also improved. However, there is less information sharing compared to non-mining households. Also, crucial ATT estimates from the propensity score matching indicate only a small and unconvincing impact of mining on poverty, as measured by mean position on the rich–poor ladder. In other words, even though there has been improvement in the key drivers of the sustainable livelihood framework: economic opportunities, capabilities, security and (partly) empowerment, the indigenous peoples affected by mining consider that they have experienced only a small positive impact from mining. With respect to methods, propensity score matching was employed to correct for the non-randomness in the selection process of alternative methods. This was seen to be essential because the results are different from methods that do not correct for this bias. In the analysis presented, propensity score matching produces smaller coefficient estimates for the impact of mining on the rich–poor ladder (and for most of the other key variables measuring opportunities in relation to poverty) that are less significant than for methods that do not apply the correction. Hence, the correction to overcome non-randomness bias using propensity score matching was warranted.