Analyzing the Socio-economic Impacts of Mining with Propensity Score Matching (PSM): Insights for Responsible Mining in Caraga Region, Philippines

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Abstract

Propensity-score matching (PSM) is an estimation procedure used in this study to address selection bias and endogeneity to obtain robust results in determining the impacts of mining on the socio-economic condition of the people in the mining areas of Caraga Region, Philippines. This study has used it with three matching methods (nearest neighbor, kernel and radius matching) to come up with implications on the socio-economic underpinnings of responsible mining for the region. The impacts of mining in this study are signified by the significance of average treatment effects on the treated (ATT) for each of the socio-economic parameters of the households under study. Consistently, the results demonstrate increased borrowing in the mining areas of the region. Results of radius matching have indicated increase in investment for human capital buildup, as implied by the increase in food and education expenditures. There are also manifestations of in-migration and efforts on the part of mining to participate in the improvement of accessibility condition through the provision of paved roads. Yet, the results signify that there is yet a need to work for the improvement of the quality of life as perceived by the households in the mining areas. This study has recommended intensified efforts towards human development, entrepreneurship and pollution control, especially that responsible mining is to build the resilience of people to natural hazards for sustainable development in Caraga Region, Philippines.

Keywords: propensity-score matching, nearest neighbor, kernel and radius matching, ATT

1. Introduction

Mining is still a moot point in the discourse of sustainable socio-economic development in the Philippines. Although it is highly recognized by World Bank for its substantial contribution to poverty reduction (Pegg 2005), it is however questioned in a number of controversies where biodiversity loss, environmental degradation and exposure to natural hazards are oft-cited. It is usually put under heavy censure and strict scrutiny when disasters strike and heavy losses on human lives and properties are claimed. Particularly, this encumbers mining's social acceptability to become a lead growth driver in the Philippine economy; especially with the growing consciousness of communities and civil societies on the comprehensive impacts of mining. Opposing sides continue to contend on the pros and cons of mining in the Philippines, in which heated discussions go back to the bottom line on the distribution of mining benefits, whether or not the people at the grassroots have benefited with the introduction of new income streams, as part of the strategies for building resilience against frequenting typhoons and prolonged rain incidence in the country. This study is prompted with the issue and the need to institute an unbiased analysis to determine the difference that mining has made on the socio-economic condition of the locals in the key mining areas of the country, in which Caraga Region is a part.

Caraga Region is a mining destination in Mindanao, Philippines where a number of large-scale mining industries are in operation. The Mines and Geosciences Bureau (MGB) of the Department of Environment and Natural Resources (DENR)-Caraga Region has long been reporting the rich deposits of nickel, iron, gold, silver and chromite for the area, particularly in the Surigao Mineral Reservation (SMR) site and Agusan del Sur. In the first quarter of 2013, the region has hosted 16 large mining companies for nickel, which had made 40 shipments or 2.2 million MWT of nickel ore to China and Japan at an estimated value of US$ 45.545 million. In similar period, gold bullion is pegged at a volume of 22, 738 oz at US$ 36.967 million in worth (MGB-DENR-Caraga

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2013). As of September 30, 2012, the region had sealed 55 mineral production sharing agreements (MPSAs) with large- and medium-scale mining companies. From these companies, around US$ 12 million has been raised from royalty payments for the yearend of 2012 alone, in which the beneficiaries are the local government units of Caraga Region (MGB-DENR-Caraga 2013).

Given this scenario, the statement of Pegg (2005) about mining making sense as a positive contributor to economic development and poverty reduction sounds right. However, there are still doubts on the capability of mining to make such uplifting impacts discernible up to the grassroots in the key mining districts of Caraga Region, Philippines. This means the growth that mining has brought about is in question if inclusive of the locals in the key mining communities. Downing (2002) had reported that new poverty could be developed because of mining-induced displacement and resettlement (MIDR). This condition may not be farfetched to Caraga Region. The MIDR concept, according to Downing (2002), fosters the "risks to societal sustainability as rich mineral deposits are found in areas with relatively low land acquisition costs (in the global market) that are being exploited with open-cast mining and are located in regions of high population density-especially on fertile and urban lands-with poor definitions of land tenure and politically weak and powerless populations, especially the indigenous peoples." Meanwhile, the accompanying resettlement effect of MIDR is defined as the loss of physical and non-physical assets, including homes, communities, productive land, income-earning assets and sources, subsistence, resources, cultural sites, social structures, networks and ties, cultural identity and mutual help mechanisms (Downing 2002).

Not only that mining can induce poverty through MIDR, but the seemingly-irreversible destruction to the vegetation covers of the mined areas has engendered apprehensions among the local communities because of increased vulnerability to natural hazards and calamities that have become more frequent in Mindanao and in the Philippines (DOST-PAGASA 2013). Increased vulnerability to disasters has triggered the need to fast track the improvement of resilience of people and communities to prevent further casualties, poverty and economic stagnation. The mining development in Caraga Region, Philippines could provide the leverage sought for a more resilient condition due to boosts in income and other socio-economic opportunities, which the study seeks to verify. The difference that mining has been able to induce is important to be determined unbiasedly so that support to further mining development would reflect "mining with a conscience" as embodied in the responsible mining strategy that Philippines has been trying to build. Thus, this study has aimed to analyze the socio-economic impacts that mining has created on the locals in the key mining areas of Caraga Region to identify the socio-economic underpinnings of responsible mining in the light of increasing resilience of people and communities for sustainable development.

2. Literature Review

For impacts, mining has long been studied. As in many other countries endowed with rich mineral deposits, Tanzania's Geita district has been investigated by Kitula (2005) for environmental and socio-economic impacts of mining on the local livelihoods. His research had used local people's perceptions in the assessment of socioeconomic activities as influenced by mining and the impacts of mining to the environment of Geita district. Pairwise ranking was used in the identification of mining-related problems as experienced by the study's respondents and in the ranking of mining-influenced socio-economic activities in the area. Analysis of variance (ANOVA) and cross tabulations had been utilized to determine the differences of socio-economic characteristics between mining and non-mining communities in Tanzania's Geita district. This study had yielded results purporting serious social and environmental impacts of mining practices to include land degradation, damage to water quality, pollution and harm to livestock and wildlife biodiversity (Kitula 2005).

Mining impacts have been also the central point in the study of Gurrib (2011) where the link between mining influences and structural change in Australia is being established. The study has a framework based upon the extension of a three-sector hypothesis involving primary (e.g. agriculture and mining), secondary (e.g. manufacturing and construction) and tertiary sectors (private services), measured in terms of employment or output. This three-sector hypothesis is extended to cover four sectors (agriculture, mining, market and nonmarket service industries), which is based on the United Nations (UN) International Standard Industrial Classification (ISIC). VAR model has been used to analyze with robust estimates the trend in interstate activity flows while noting the forecasting ability of the activity in the mining and service industries. Results of this research have pointed out that mining has caused structural shifts in Australia and that mining booms have increased the rate of structural change in the same country (Gurrib 2011).

Similar points for evaluation are raised in the study of Apostolides (2012) where the mining impacts are investigated in view of the rapid growth of Cypriot economy with the use of primary information and a simple

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counterfactual exercise. Khaliq and Noy (2007) had arrived at robust results for the negative impacts of mining on foreign direct investment (FDI) flows with the use of an augmented Cobb-Douglas production function framework with FDI as one of the factor inputs. Fatah (2007) on the other hand had indicated the growth of the coal mining industry in South Kalimantan Province in Indonesia with lesser environmental impacts for small-scale mining operations than for large-scale through the use of Social Accounting Matrix (SAM) and mixed multiplier analysis. Noting the importance of coal mining in Australia given that it is the second largest exporting industry in the said country, Maslyuk and Dharmaratna (2012) had predicted for it to affect Australia's general macroeconomic condition. The said industry was found to be sensitive to large international events such as financial crisis and shocks in the international oil market and oil prices (Maslyuk and Dharmaratna 2012).

However, new developments in the analysis of impacts have emphasized the importance of resolving attribution concerns, particularly when impacts are tried to be linked with certain conditions of great political and social relevance as in socio-economic and environmental conditions. This is because there is a need to institute minimal bias in accounting for such impacts, which is the purview of the discourse on making causal inferences. Propensity score matching (PSM) has been the method that has the facility of "showing the difference in outcome as attributable to the difference in treatment especially under nonrandomized conditions" (Kaltenbach 2008) or "estimating the effect of an event on those who do and do not experience it in the observational data" (Blanchard 2013). According to Coca-Perallion (2006), it is capable to attribute the differences after treatment between subjects not randomly assigned to treatment and control groups (treated and untreated) through treatment effects in observational studies.

Applications of propensity score matching can be observed in the studies of Mensah, Oppong and Schmidt (2009) in the evaluation of Ghana's National Health Insurance Scheme; Muehler, Beckmann and Schauenberg (2007) in the analysis of returns to continuous training in Germany, and Palangkaraya (2013) in determining the propensities to innovate among Australia's economic sectors and the effects of innovation in exportation, among others. The application of which in mining can be seen in the studies of Ticci (2011), Ticci and Escobal (2012) and also Palangkaraya (2013). The 2011 paper of Ticci is a comprehensive evaluation of mining impacts, which has looked into the local impacts of mining boom on migration, on access to basic services, on labor market, and on occupational distribution across sectors. Specifically, it has paired difference-in-difference (DD) with propensity score matching (PSM) with the treated and untreated groups comprising of mining and non-mining districts, respectively (Ticci 2011). Her paper has stressed the importance of having "suitable counterfactuals" for proper accounting and attribution of treatment effects or impacts.

In relation to PSM, discussions in the research of Ticci and Escobal (2012) are in similar context, which seeks the reliability of attribution through the establishment of suitable counterfactuals in the comparison of the estimated treatment effects due to mining exposure. The choice of propensity score matching in the analysis of this study serves the same concern on ensuring proper impact evaluation specifically that this study is non-experimental. The following is a cogent explanation for the choice of PSM, which is adopted from Caliendo and Kopienig (2005):

> "A problem arises when there is need to know the difference between the participants' outcome with and without treatment. Clearly, both outcomes for the same individual cannot be observed at the same time. Taking the mean outcome of non-participants as an approximation is not advisable, since participants and non-participants usually differ even in the absence of treatment. This problem is known as selection bias and a good example is the case where motivated individuals have a higher probability of entering a training programme and have also a higher probability of finding a job. The matching approach is a possible solution to the selection problem. It originated from the statistical literature and shows a close link to the experimental context. Its basic idea is to find in a large group of non-participants those individuals who are similar to the participants in all relevant pre-treatment characteristics X. That being done, differences in outcomes of this well selected and thus adequate control group and of participants can be attributed to the programme."

This study is confronted with the basic question of whether or not mining has made a difference in the socio-economic condition of the locals in the key mining areas of Caraga Region, Philippines. Mining has been accommodated in the region at the cost of other industries such as fishing, agriculture and forestry. Thus, an unbiased study on this aspect would facilitate the identification of measures that would strengthen the socio-economic underpinnings of instituting responsible mining or mining with a conscience in support also to the development of other industries in Caraga Region. With the caveats and observations of Abadie and Imbens (2009) and Dehejia and Wahba (1998) in the use of PSM, this study adheres with the view of Ticci (2011) that

PSM is a means of generating reliably the socio-economic impacts of mining in the region through "balancing observable characteristics and creating groups as similar as possible in terms of confounding variables."

3. Methodology

Primary data gathered from direct interviews of 1,725 respondents in the four provinces of Caraga Region – Agusan del Norte, Agusan del Sur, Surigao del Norte and Surigao del Sur – had been used in the analysis of the socio-economic impacts of mining in the area. The respondents were selected through a multi-stage systematic random sampling in 17 barangays across the four provinces of the region. Four of these barangays are non-mining areas where 680 respondents have been selected for direct interviews. These barangays belong mostly to the province of Agusan del Norte, in which the respondents constitute the control group for the analysis. The rest of the barangays from which the 1, 045 respondents have been selected constitute the treated group, because these are the areas where mining tenements and establishments are in close proximity. The role of the control group in the analysis is explained in the later part where PSM specification is tackled.

Reliability in the testing procedure provides the strongest reason for adopting the propensity score matching for this impact study, where in most impact analysis, selection bias based on observable characteristics poses an enormous challenge in the need of making proper attributions for the impacts. Similar with Rejesus *et al*. (2011), PSM is used in this study as a matching procedure that would provide the right counterfactuals for the determination of impacts, as it can "control selection bias based on observable characteristics by finding control observations having observable characteristics as similar as possible to the treatment group, to serve as surrogates for the missing counterfactuals" (Rejesus *et al*. 2011). The procedure of determining the impacts of mining for this study would have been following a before-and-after-mining analysis, because such would reflect better testable mining contributions. However, with the infeasibility of that procedure today due to the insufficiency of past records, with-or-without is decided upon, in which ensuring the reliability of matching procedure must be established to account the impacts properly – thus, the consciousness of selection bias in this study.

The theoretical explanation of PSM can be found in Wooldridge (2002) as cited in the paper of Rejesus *et al*. (2011). On PSM, Ticci (2011) had elaborated the specific terms on when and how to use it to produce the measures for the impacts generated by mining. Similar with Ticci (2011), the impacts of exposure to mining among the respondents in the selected barangays across the four provinces of Caraga Region would be determined by the estimation of an Average Treatment Effect on the Treated (ATT). Thus, ATT would indicate the effect of mining on certain outcome variables purporting the socio-economic condition of the locals in the mining areas of the region, which is to be construed as "the average change of an outcome variable for treated districts due to the event of mining, whose functional form is exhibited below based on the paper of Ticci (2011):

$$ATT = E(Y_i^1 - Y_i^0 / D=1) = E(Y_i^1 / D=1) - E(Y_i^0 / D=1) \qquad (1)$$

where ATT is the measure of the change caused by mining on an outcome, Y_i^1 the estimate of an outcome value of district i if i is treated (mining district), Y_i^0 the estimate of an outcome value of district i if i is not treated, and D=1 the participation status in case of treatment. The participation status where the treatment is zero is D=0.

Furthermore, Ticci (2011) had explained for each i to have only one outcome and $E(Y_i^0 / D=1)$ to be not observable. The latter being so would create "the problem of causal inference" (Holland 1986 as cited by Ticci 2011) which then needs information from the control group or the respondents from the non-mining area to replace the missing counterfactual data for the treatment. However, $E(Y_i^0/Z_i,D_i=0)$ that represents the expected value of Y_i^0 for the untreated districts or areas can be estimated with the strong ignorability assumption in mind, where two conditions are involved: unconfoundedness and overlap or common support condition. Unconfoundedness implies the independence of potential outcomes to treatment assignments given a set of observable covariates, as exhibited below:

$$E(Y_i^0/Z_i,D_i=1) = E(Y_i^0/Z_i,D_i=0) \qquad (2)$$

Overlap or common support condition is specified as $0<Pr(D_i=1/Z_i)<1$, which ensures that there are both treated and untreated districts or areas for each covariate to be compared. Particularly, the issue of selection bias due to the approximation of $E(Y_i^0 / D=1)$ is solved with the use of data from the control group (Ticci, 2011). To control further any bias and to help ensure robustness of results, the characteristics of the mining and the non-mining

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districts of the study from which the respondents are selected had been chosen based on similar attributes or profile, besides the bootstrapping of errors, the establishment of the ideal bandwidth, and the imposition of a common support restriction in the estimation process (Becker and Ichino 2002 as cited by Rejesus *et al*. 2011). Also, the three methods of matching, namely: radius matching (with default radius of 0.1), kernel matching (with epanovich bandwidth of 0.06) and nearest neighbor matching procedures are performed to check for consistency of findings. The impacts of mining on the locals in the mining areas of Caraga Region for this study are thus examined on the basis of the outcome variables indicated in Table 1 and the impacts are signified in the values of the significant average treatment effects on the treated (ATTs) for each outcome variable. PSM has the capability to identify incomparability of outcome variables in the estimation process, and normally drops the variable that does not meet the balancing property criterion inherent in the estimation.

4. Results and Discussions

The impacts of mining in Caraga Region have been examined with propensity score matching, which uses a probit model in the estimation of propensity scores similar to Rejesus *et al*. (2011) to ensure verifiable and unbiased findings on the impacts of mining on the socio-economic condition of the locals in the key mining areas of the region. Table 1 presents the original list and definition of the socio-economic variables with which the outcomes of mining are evaluated. Mining exposure as the causal agent of the outcomes is represented by m_nm, which is associated with the location of the household residence as either mining or non-mining with binary equivalent of 1 and 0 in the model, respectively. In similar table, the socio-economic variables included in the model specification for the estimation of the propensity scores are likewise shown. These variables are identified based on the results of the balancing property test for propensity score matching. The variables with asterisks in Table 1 are the variables that are dropped in the final specification of the model for propensity score estimation. Household income and four access indicators (health facilities, potable water, wet market and banks) are particularly dropped because of failure to meet the balancing property requisite for estimation. Thus, no generalization could be made with these variables in this study on the basis of mining impacts, since propensity score matching fails to find the required matches for proper comparison.

4.1 Socio-economic Correlates of Mining: Probit Estimation

The probit estimation of propensity scores for each observation to be matched using all of the matching processes (nearest neighbor, kernel and radius) has yielded both the socio-economic correlates of mining and the socio-economic variables that have complied with the balancing requirement of propensity score matching (PSM). Table 2 shows the abridged version of the original list of socio-economic variables used in PSM. The variables with asterisks shown in Table 1 are the ones discarded for the subsequent matching procedures based on propensity scores. Of the variables in Table 2, age, loans, access to paved roads, food expenditure, years in formal education, and years in the community are considered as the socio-economic correlates of mining, because of their significant coefficients. Of these variables, loans and food expenditure are the socio-economic correlates that have positive relationships with mining. Based on their estimates, they are likely to increase with the increasing probability that the location of household residence is within the mining area.

4.2 The Socio-economic Impacts of Mining

In determining the impacts of mining on the socio-economic condition of the people in the key mining areas of the region, the significance of the average treatment effects on the treated (ATT) is used as basis. The estimation of the ATT values has applied the three matching procedures mentioned for robustness and consistency check, which are the nearest neighbor matching, the kernel matching, and the radius matching procedures. The matching procedures have observed common support constraints, bootstrapping of errors and replications of 100, besides the epanovich bandwidth set at 0.06 for kernel and the default radius at 0.1 for radius matching. The results of the analysis demonstrate the stringency of the nearest neighbor method as a matching procedure, where the parameter on loans has emerged as the only variable with a significant impact from mining (Table 3). The rest have more than that with radius method of matching having the highest number of significant impacts attributable to mining. In terms of consistency of results, all of the matching methods have shown that borrowing would increase with mining in Caraga Region. The ATT estimates in the three methods are positive and significant at 5%-1% levels of confidence. This finding may imply the socio-economic confidence that accompanies with mining, which means that with mining in active or full operation, people would have an increased capacity to earn a living – thus, the increased borrowing.

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The significant ATT estimates of food and education expenditures under the radius method of matching may support the finding on loans or increased borrowing in this analysis. ATT estimates of both variables purport the possible uses of the borrowed funds, as both signify investments on well-being and education. These ATTs show the positive contribution of mining, as these are necessary inputs to economic reconstruction and nation-building, especially that occurrence of natural hazards (typhoons, floods and quakes) is getting more frequent in Caraga Region. However, on perception-based quality of life, consistency of findings is exhibited by the three methods despite their various considerations in matching. Although ATT on quality of life is significant under the kernel method of matching, it is however negatively signed, which may indicate the feeling of discontent among the people on mining in the mining areas of the region. This discontent may spring from something other than earning income. It may be brought about by pollution issues such as dust and noise pollution and peace-and-order-related problems as some areas have predicaments associated with insurgency (Caraga Watch 2009). The other methods (nearest neighbor and radius) have yielded results that mining has not made significant improvements in the employment of locals in the mining areas. This is somewhat supported by the ATT result on the number of working household members where mining is implied to have done a slight disservice to the people in the mining areas of the region, because of a negatively signed ATT estimate of less than 1 significant at 5% level of confidence.

Such result on the number of working household members means that mining has not yet made a significant contribution on employment of people in the mining areas. The years spent on formal education and the years in the community have similar results with the number of working household members. Both are negatively signed and significant at 1% level of confidence under the radius method of matching. Their corresponding ATTs imply shorter years in formal education among the household heads perhaps due to early drop-out cases and lower number of years in the community indicative of in-migration, respectively. The possibility of in-migration in the mining areas can be also construed in the ATT for age being significant under the radius method of matching. The result for the ATT of age signifies younger population in the mining areas by more than 4 years, wherein most households have spent lesser number of years in the community. In terms of gender, the ATT where the estimate is positive and significant implies that female-headed households are common in the mining areas. However, the differences of ATT results between kernel and radius methods on the access to paved roads are noticeable, because both are significant but with different signs. Under the kernel matching procedure, the result can be interpreted that paved roads would be distant in the mining areas, while under the radius matching procedure, it is the opposite – paved roads would be nearer. This can be attributed to the differences in considerations between the two methods as applied in the analysis together with the imposition of their corresponding constraints in the estimation. However, it means that even if mining is carried out in the highlands and people in these areas may find it difficult to find paved roads, mining is doing something along the aspect of improving accessibility condition by providing paved roads in its own pace, which due to budget considerations, the coverage of paved roads would yet be a bit limited. On the other hand, income being an important economic parameter would have to be analyzed with the use of other analytical methods (e.g. instrumental variables) to check mining's influence on it and to elicit insights from these alternative analyses.

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Table 1. Definition of Variables for the Socio-economic Impact Evaluation

Variable Name	Definition
m_nm	Location of the household (1 if within mining area; 0 if outside mining area or non-mining)
Social Indicators	
Household Size	Number of household members
Age	Age of the household head in terms of number of years
Gender	Gender of the household head (1 if male; 0 if female)
Years in school	Number of years spent by the household head in formal education
Years in the community	Number of years of the household in the community
Number of working household members	Number of household members on active employment
Quality of life	Perception of the household on its living condition (1 if the response is positive; 0 if the response is negative)
Accessibility of Social Infrastructures	
Access to health facilities*	Distance of the household to the nearest health facility (e.g. rural health units, clinics, etc.) measured in meters
Access to potable water*	Distance of the household to the nearest source of potable water measured in meters
Access to paved roads	Distance of the household to the nearest paved road measured in meters
Access to wet market*	Distance of the household to the nearest wet market measured in meters
Access to banks*	Distance of the household to the nearest bank measured in meters
Economic Indicators	
Asset	Value of anything owned by the household in terms of Philippine peso
Loans	Value of anything owed by the household in terms of Philippine peso
Food expenditures	Average monthly expenditures of the household on food in Philippine peso
Education expenditures	Average monthly expenditures of the household on education in Philippine peso
Health expenditures	Average monthly expenditures on medicines and other health-related expenses in Philippine peso
Household income*	Average household income in Philippine peso

*indicate the variables that are dropped from the model specification for the estimation of propensity scores based on the balancing property test results

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Table 2. Probit Estimates on the Socio-economic Correlates of Mining

Variable	Coefficient	p-Value
Intercept	1.124187	0.0000
Household size	-0.0230454	0.167
Age	-0.007536	0.008
Gender	-0.0161001	0.888
Asset	-6.92E-08	0.507
Loans	0.00000766	0.0000
Access to paved roads	-0.0000423	0.0000
Quality of life	-0.982653	0.142
Food expenditures	0.0001201	0.0000
Education expenses	0.00000348	0.918
Health expenditures	0.0000495	0.540
Years in formal education	-0.0499456	0.0000
Number of working household members	-0.0550204	0.157
Years in the community	-0.0150047	0.0000
Log likelihood	-1038.5562	
Number of observations	1725	
Prob>chi2(13)	0.000	
Pseudo R2	0.1022	

Table 3. ATT Estimates of the Socio-economic Variables for Mining Impacts

VARIABLE	NEAREST NEIGHBOR MATCHING		KERNEL MATCHING		RADIUS MATCHING	
	ATT	t	ATT	t	ATT	t
Household size	0.129	0.72	0.166	1.202	0.145	1.226
Age	0.551	0.578	-0.073	-0.095	-4.727***	-7.516
Gender	-0.009	-0.513	0.006	0.403	0.035***	2.313
Asset	-0.000186	-0.907	-0.00013	-0.547	15186.875	0.844
Loans	2825.976**	1.67	2928.863***	2.017	7170.556***	6.52
Access to paved roads	128.118	0.827	280.409***	2.42	-588.892***	-3.076
Quality of life	-0.032	-1.045	-0.048**	-1.529	0.00	0.007
Food expenditures	-157.721	-1.042	3.154	0.023	888.857***	8.604
Education expenses	-74.37	-0.84	-38.399	-0.613	82.426**	1.579
Health expenditures	-7.898	-0.231	-0.731	-0.029	14.592	0.695
Years in formal education	0.003	0.015	-0.024	-0.118	-0.292***	-2.359
Number of working household members	-0.01	-0.158	-0.007	-0.148	-0.062**	-1.672
Years in the community	-0.498	-0.501	0.033	0.049	-9.231***	-10.716

** significant at 5% level of confidence

*** significant at 1% level of confidence

5. Conclusion

PSM is a strict procedure for the evaluation of impacts as far as non-experimental studies such as this study are concerned in order to get rid of selection bias and endogeneity in the estimation process. The results of this study

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have accounted the influences of mining on the parameters of the socio-economic condition of people in the key mining areas in Caraga Region. Although the analysis of this study could not yet indicate whether the local people in the mining areas get poorer or richer, due to the disqualification of income from PSM, the effects of mining on the local people have evidently induced increased borrowing and spending specifically on food for wellbeing and on education among the households in the mining areas. Increased borrowing in these areas is a crucial matter of welfare, which could be harnessed with the proper management of borrowed funds. Borrowings could be a growth driver or a catalyst of socioeconomic development if utilized wisely (e.g. investment purposes); vicious trap of poverty if not. Thus, special attention should be given to the households that have incurred these funds to guide them on proper utilization to avoid the poverty trap and be able to spur entrepreneurial activities and employment opportunities in the mining areas. Caraga Region has large mining corporations that have community relations offices, instituted to look into the welfare of people in the mining areas. These offices have functioning operational frameworks in the delivery of socio-economic interventions with the strict implementation of the Social Development and Management Program (SDMP) by their companies, which is pursuant to the Administrative Order issued by the Department of Environment and Natural Resources (DENR) in the Philippines. Entrepreneurship and finance- or investment-related education is an area that these offices in the large mining companies in Caraga Region could explore gainfully with the other stakeholders of mining. Related efforts for such education would be much appreciated if consequent entrepreneurial outcomes would capitalize on restoring the environment to help retard, if not reverse, the ill-effects of mining.

Increased expenditures on food and education in the results indicate a good impact of mining as it contributes to human capital buildup, which is necessary for economic reconstruction and nation-building in Caraga Region and the country as a whole. Support from mining companies to keep it up is sought, so that human development would redound to resilience of communities in the mining areas. Exposure of school-age youth to skills development and career orientation are examples of support activities that direct human potential to productive endeavors. This is for inclusive growth to effect fully in the mining areas, so that the mining companies would utilize the human resources in the areas where mining is in full operation, instead of getting the manpower from other places. However, there is so much to do with the quality of life being not improved yet with mining based on the perception of the local people in the mining areas. Fathoming what has caused this would address properly the shortfalls in mining contributions. Further study on this aspect such as the technologies that would control effectively dust pollution and other pollutions arising from mining activities is among the aspects that must be given importance, so that quality of life brought about by mining would be appreciated. With the influx of people in the mining areas (due to in-migration), there is also a need to fast track population management to avoid thinning out of benefits as it causes interruptions in entrepreneurial activities and social unrest due to feeling of discontent among the people. Suppressing such eventualities while mining is in operation may generate the full potential of mining, which is important for building the resilience of communities in the mining areas in support to poverty and disaster risk reduction in the Philippines.

Acknowledgment

The Commission on Higher Education (CHED) of the Philippines is credited in this work for providing the funds for the implementation of this study in the mining areas of Caraga Region. Likewise, the Mindanao University of Science and Technology (MUST) and the University of Southern Mindanao (USM) are also acknowledged as partner-agencies of Caraga State University (CSU) in the implementation of responsible mining research program in Mindanao, in which this study is a part. Finally, Ms. Corazon Dumanat, Ms. Christian Joy Gegone, Ms. Janeth Quico, Ms. Josie P. Lomoljo, Ms. Evsyl Ybanez, Ms. Shahaneh de Asis, Ms. Mary Ann Gonzales, Ms. Jean Lovely Rose Erat and Ms. Jessiel Babia are acknowledged in this study for doing the data collection and organization for the PSM analysis of this study.

References

Abadie, A. & Imbens, G.W. (2009), "Matching on the Estimated Propensity Score", NBER Working Paper Series 15301, National Bureau of Economic Research, Cambridge, Massachusetts.

Apostolides, A. (2012), "Copper and Foreign Investment: The Development of the Mining Industry in Cyprus during the Great Depression", MPRA Paper No. 43211, available at http://mpra.ub.uni-muenchen.de/43211/ (accessed 5 February 2014).

Blanchard, S. (2013), "An Introduction to Propensity Score Matching", available at www.utexas.edu/cola/center/prc/_files/cs/Spring2013_Blanchard_Propensity_Score_Mtaching.pdf (accessed 12 February 2014).

Caliendo, M. & Kopeinig, S. (2005), "Some Practical Guidance for the Implementation of Propensity Score Matching", Discussion Paper, DP No. 1588, IZA, P.O. 7240, 53072 Bonn, Germany.

Caraga Watch (2009), "Mining Caraga", available at www.insidemindanao.com/february_2010/Mining Caraga.pdf (accessed 17 February 2014).

Coca-Perallion, M. (2006), "Matching with Propensity Scores to Reduce Bias in Observational Studies", available at www.nesug.org/proceedings/nesug06/an/da13.pdf (accessed 12 February 2014).

Dehejia, R.H. & Wahba, S. (1998),"Propensity-Score Matching Methods for Non-experimental Causal Studies", NBER Working Paper Series 6829, National Bureau of Economic Research, Cambridge, Massachusetts.

Downing, T.E. (2002), "Avoiding New Poverty: Mining-induced Displacement and Resettlement", Report No. 58, Mining, Minerals and Sustainable Development Project, International Institute for Environment and Development, England.

Fatah, L. (2007), "The Impact of Coal Mining on the Economy and Environment of South Kalimantan Province, Indonesia", Research Report No. 2007-RR2, Economy and Environment Program for Southeast Asia, South Bridge Court, Singapore.

Gurrib, I. (2011),"The Impact of Mining and Services Industries on the Structural Change of Australia", *International Journal of Economic Sciences and Applied Research,* 4(2), 35-51.

Kaltenbach, L. (2008), "How to Use Propensity Score Analysis", available at www.mc.vanderbilt.edu/gcrc/workshop_files/2008-04-11.pdf (accessed 12 February 2014).

Khaliq, A. & Noy, I. (2007), "Foreign Direct Investment and Economic Growth: Empirical Evidence from Sectoral Data in Indonesia", available at http://www.economics.hawaii.edu/research/working_papers/WP_07-26.pdf. (accessed 12 February 2014).

Kitula, A.G.N. (2005), "The Environmental and Socio-economic Impacts of Mining on Local Livelihoods in Tanzania: A Case Study of Geita district", *Journal of Cleaner Production*, 14(2006), 405-414.

Malsyuk, S. & Dharmaratna, D. (2012), "Impact of Shocks on Australian Coal Mining", available at http://www. Buseco.monash.edu.au/eco/research/papermalsyukdharmaratna.pdf (accessed 10 February 2014).

Mensah, J., Oppong, J.R. & Schidmt, C.M. (2009), "Ghana's National Health Insurance Scheme in the Context of the Health MDGs-An Empirical Evaluation Using Propensity Score Matching", available at http://repec.rwi-essen.de/files/REP_09_157.pdf (accessed 10 February 2014).

MGB-DENR-Caraga Region (2013), "Economic Benefits in Mining", paper presented at the MRFC-MMT-CTWG Conference, February 20, 2013, Gateway Hotel, Surigao City,Philippines.

Muehler, G., Beckmann, M. & Schauenberg, B. (2007), "The Returns to Continuous Training in Germany: New Evidence from Propensity Score Matching Estimators", ZEW Discussion Paper No. 07-048, available at http://hdl.handle.net/10419/24615 (accessed 10 February 2014).

Palangkaraya, A. (2013), "On the Relationship between Innovation and Export: The Case of Australian SMEs", available at http://www.melbourneinstitute.com/downloads/working_paper_series/wp2013n04.pdf (accessed 16 February 2014).

Pegg, S. (2005), "Mining and Poverty Reduction: Transforming Rhetoric into Reality", *Journal of Cleaner Production*, 14(2006), pp. 376-387.

Rejesus, R., Palis, F., Rodriguez, D.G.P., Lampayan, R.M. & Bouman, A.A.M. (2011), "Impact of the Alternate Wetting and Drying (AWD) Water-saving Irrigation Technique: Evidence from Rice Producers in the Philippines", *Food Policy*, 36 (2011), 280-288.

Ticci, E. (2011), "Extractive Industries and Local Development in the Peruvian Highlands: Socio-economic Impacts of the mid 1990's Mining Boom", EUI Working Paper RSCAS 2011/4, Robert Schuman Center for Advanced Studies, European University Institute.

Ticci, E. & Escobal, J.A. (2012),"Extractive Industries and Local Development in the Peruvian Highlands", available at http://www.disei.unifi.it/upload/sub/publicazioni/repec/pdf/wp-22_2012.pdf (accessed 18 February 2014).