Balanay et al., Journal of International and Global Economic Studies, 7(1), June 2014, 20-31

Analyzing the Income Effects of Mining with Instrumental Variables for Poverty Reduction Implications in Caraga Region, Philippines

Raquel M. Balanay[1] Jose M. Yorobe, Jr.[2] Sheila G. Reyes[3] Adrilene Mae J. Castaños[4] Ordem K. Maglente[5] Jocelyn B. Panduyos[6] and Charry C. Cuenca[7]

Caraga State University, UPLB, College, ASSCAT, Caraga State University, Caraga State University, SDSSU, and Caraga State University

Abstract: The study has analyzed the income effects of mining in Caraga Region with the use of survey data and IV approach, so that inferences for poverty reduction would be drawn for the region. The IV approach used is a two-stage least squares (2SLS) estimation procedure where mining exposure has yielded a positive influence on income. Access to health facilities and potable water sources have proven to be good instruments for mining exposure through probit analysis and over-identification test. Age of the household head, loans, years in school and food and education expenditures are the covariates that have positive influence on income as well, which are associated with lifelong experience/learning and investments for the development of human resources and enterprises in the area. The findings of the study are suggestive of strengthening measures towards human capital buildup to catalyze sustainable development in the mining areas of Caraga Region. These measures when built around the economics of environmental protection provides a more advantageous optimization strategy for the mining benefits in Caraga Region, which may help institute responsible mining or "mining with a conscience." The use of IV in this study is justified by the significance of endogeneity problem in the empirical analysis.

Keywords: income effects, IV, probit, endogeneity, 2SLS, responsible mining
JEL Classification:

1. Introduction

Caraga Region is a mining destination in Northeastern Mindanao, Philippines. In 2009, the Mines and Geosciences Bureau (MGB) of the Department of Environment and Natural Resources (DENR) in the country had reported the iron ore deposit in the region as the biggest in the world and the nickel and gold deposits as the largest in the country. Besides this, copper, chromite and coal are among the rich deposits for mining in Caraga Region, with coal as the major lignite reserve in the Philippines located in three of the region's four provinces – Agusan del Sur, Surigao del Norte and Surigao del Sur (Caraga Watch, 2009). Approved mineral production sharing agreements as of the latest record have reached a total of 51 in Caraga Region, which cover an area of 129,369.49 hectares (DENR-MGB-Caraga, 2014). In 2012, an estimate of US$ 12 million had been raised by the mining sector as royalty payment, which had benefited the local government units of the mining areas in the region (DENR-MGB-Caraga, 2013).

With multi-million dollars earned continuously from ore exports from Caraga Region (DENR-MGB-Caraga, 2013), it can be posited that such mining benefit could have been translated into high employment and bustling economy, which can be a source of pride in Northeastern Mindanao, Philippines. However, earlier years of the region had shown a history of difficult struggle among its people to be able to get out of the bounds of poverty. Even the special assessment report from the Department of Social Welfare and Development (DSWD) in April 2013 for Caraga Region had shown that poverty is still an issue in spite of the multi-million dollar contributions of the mining sector (Panganiban, 2013). Over the years, the debate on mining contributions and impacts has been centered and embattled on the grounds of poverty, because people's welfare is of utmost importance in the development agenda of the Philippine government, as enunciated in the Social Contract for the Filipino People in the Official Gazette of the Philippines in 2010.

Thus, in 2005, pressures were built on the mining sector and on some government agencies for the strict compliance on the provisions concerning social welfare in the Philippine Mining Act of 1995, as part of the reforms that would be led by the mining sector. Responsible Mining has become the byword that embodies that noble intention of the Philippine government in partnership with the mining sector on optimizing mining benefits for social welfare. These reform strategies are coursed through the Mines and Geosciences Bureau (MGB) of the Department of Environment and Natural Resources (DENR) for strict implementation and monitoring of outcomes. Prelude to the desired outcomes with the said reforms in mining is mining's stepped-up participation in the improvement of the economic performance of the region, which has helped ease poverty incidence on a regional scale, enough to declare Caraga Region no more the poorest region in the Philippines in 2013 (Panganiban, 2013). Although there are yet reforms to do on this matter and on the optimization of mining benefits in Caraga Region, intensified efforts are still going about to obtain further insights for responsible mining to become more perceptible in the future.

In particular, this study is aimed to analyze the income effects that mining is able to induce in the mining areas through an estimating procedure that has the capability of ridding off endogeneity and selection bias. The method used in the verification process of this study has considered its non-experimental nature and that involves survey data from randomly-selected respondents in the mining areas. The past data from which the economic impacts of mining over time could be determined are yet inadequate to use for a time-series analysis, with which the difference that mining has induced in the purview of social welfare and economic development could be exhibited suitably. The deterministic approach in this study utilizes the unbiased procedure of instrumental variable (IV) method to emphasize the influence of mining for proper attribution of effects/impacts and drawing of insights. Because the optimization of mining benefits is a shared responsibility of the Philippine government, the mining sector, and the local communities, there is a need to develop an operational definition for responsible mining so that these entities can pursue a mining-led sustainable development in Caraga Region.

2. Literature Review

Mining has long been studied, practically in terms of impacts on economies and social welfare. Specifically, mining impacts have been broached for insightful empirical investigation, as in the studies of Kitula (2005) for mining impacts on the local livelihoods in the Geita District of Tanzania, Gurrib (2011) for the mining-induced structural change in Australia, Apostolides (2012) for the link of mining with the rapid growth of the Cypriot economy, Khaliq and Noy (2007) for mining on foreign direct investments, Fatah (2007) for the environmental impacts of coal mining, and Malsyuk and Dharmaratna (2012) for the influence of coal mining on the general macroeconomic condition of Australia. Similar concerns have been also the point of analysis for the cautious use of propensity score matching in the studies of Ticci (2011) and Ticci and Escobal (2012). Ticci (2011) in particular has dwelt on the comprehensive evaluation of mining impacts on migration, access to basic services, labor market, and occupational distribution across sectors. Propensity score matching (PSM) as applied in Ticci's study (2011) is aimed to resolve the issues on selection bias and endogeneity for robust estimation results and sound inferences.

Ticci and Escobal (2012) had PSM also applied in their investigation on the extractive industries in the Peruvian Highlands. Their study had dealt with the parameters interlinked with the income effects of mining similar to the earlier study of Ticci (2011), as PSM is used to seek the changes that mining has made on access to basic services (e.g. electricity, water services, and sanitation services), labor market and occupational distribution, poverty and welfare status, agriculture and education. Migration and child labor are concerns also tackled in the study, which has yielded results that mining expansion had induced in-migration to the mining areas, had made a change in labor sectoral composition favorable to mining and had reduced the labor share of agriculture and non-primary sector in the Peruvian Highlands. Implications for income effects of mining are stated with the possibility of mining having "a propulsive role for local economies." The risk of this is with "mining specialization having little links with other industries," according to Ticci and Escobal (2012). The use of PSM in the study is paired with difference-in-difference approach to improve the robustness of results, which has proved useful in inferring about the socioeconomic impacts of mining in the Peruvian Highlands that had received the highest mining investment inflow in Peru in the earlier decades (Ticci and Escobal, 2012).
PSM in the study of Ticci (2011) and Ticci and Escobal (2012) had purged the issues of selection bias and endogeneity through the provision of suitable counterfactuals. Such issues are elaborated cogently in the explanation of Caliendo and Kopienig (2005) regarding the inferential weaknesses associated with selection bias and endogeneity in the analysis, which is as follows:

> "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 particularly concerned with the same estimation issues in the determination of income effects of mining, because it is of non-experimental nature prone to the possibility of having those biases to affect the estimation results for insightful inferences. However, besides PSM, the other approach used to resolve the concern on selection bias and endogeneity is instrumental variable models (Heckman, Urzua and Vytlacil, 2006 and Andrews and Ebbes, 2013). According to Khandker, Koolwal and Samad (2010), "instrumental variable (IV) methods allow for endogeneity in individual participation, program placement, or both. Measurement error that results in attenuation bias can be resolved through this procedure whose attribute relaxes the exogeneity assumption of ordinary least squares or propensity score matching and is capable of obtaining robustness to time-varying selection bias, unlike the difference-in-difference method. "

Specific applications of IV methods are exhibited in the studies of Yorobe, Rejesus and Hammig (2011), Angrist (2005) and Clarke, Palmer and Windmeijer (2011) for various concerns. The study of Yorobe, Rejesus and Hammig (2011) is concerned on estimating the impact of Farmer Field Schools (FFS) on insecticide use by onion farmers in the province of Nueva Ecija, Philippines. This study has made use of IV technique to enhance the predictive ability of the impact model for FFS on insecticide use, in which after correcting the endogeneity and selection bias through IV methods the parameter of interest (FFS impact) had exhibited significant influence on insecticide use.
Angrist (2005) has applied the IV procedure on quantitative criminology particularly in the case of Minneapolis Domestic Violence Experiment, with the contention that the said procedure can be used to solve the major statistical problems arising from imperfect criminological experiments. As was used originally in health studies, IV method was applied by Clarke, Palmer and Wingmeijer (2011) in the analysis of the relationship between adiposity and hypertension using structural mean models (SMMs) with two genetic markers as instruments for adiposity. In the case of mining impacts, the application of IV is highly recognized for various discourses, as in the recent study of von der Goltz and Barnwal (2014), the studies of Zhu (2012), Glaeser and Kerr (2010) and Marvasti (2013).

Interesting health-wealth tradeoffs due to mining is discussed in the study of von der Goltz and Barnwal (2014), where the parameters for income effects have been noted. As reported, higher wealth is associated more in mining communities than in non-mining communities or in areas closer than farther to mining. But the study had yielded results that imply higher health costs in mining districts than in non-mining districts, which had spelled the tradeoff (von der Goltz and Barnwal, 2014). The study of Glaeser and Kerr (2010) has mining as an instrument in the link between entrepreneurship and local employment growth, in which in the analysis persistence of this link is observed "when instrumenting initial entrepreneurship with historical mines." In the honors thesis of Zhu (2012), IV was used with joint estimation "to construct efficiently identified estimates of supply and demand equations for the world iron ore market under the assumption of perfect competition."

Results of Zhu's (2012) research had found efficient and consistent coefficient estimators for the supply and demand of iron ore, although there are shortcomings that would be addressed by enhancing understanding on the iron ore market behavior and dynamics. Similar to the reviewed studies, IV is also explored on the case of analyzing the income effects of mining in Caraga Region for implications on poverty reduction as an aspect of Responsible Mining program, in which insights for catalysts of sustainable development are hoped to be obtained in the process. The use of IV is aimed to rid out endogeneity and selection bias in the analytical procedure to produce robust estimates worthy for inferences about the management of the income effects of mining to set in place the policy mechanisms for poverty reduction and sustainable development in Caraga Region, Philippines.

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 income effects 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 or untreated group with binary representation 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 nearby or in close proximity.

Reliability of estimates forms the strongest reason for the choice of IV method in this study. Although the method can purge selection bias and endogeneity, it still has to be taken with caution because of the possibility of having weak instruments that would have even worse estimation issues. There are concerns in IV that could mar the process of attaining robustness and sound inference, which are taken with prudence in the estimation process. One challenge is with finding a good instrument, because weak instruments would give a drawback where biased estimates on effect or impact are obtained in the event "the chosen instrument is correlated with the unobserved characteristics affecting the outcome. If the "instrument is weakly correlated with the treatment variable, the standard error of the IV estimate is likely to increase because the predicted impact of the outcome will be measured less precisely," according to Khandker, Koolwal and Samad (2010). A good instrument is characterized to meet the three requirements, which are as follows (Goldberger, 1991; Manski, 1995, and Stock and Watson, 2003 as cited by Zhu (2012):

- The instrument must be correlated with the endogenous variable, conditional to the other covariates;
- The instrument cannot be correlated with the error terms in the explanatory equation, and
- The instrument satisfies the exclusion criterion, which means the instrument affects selection but is not correlated with factors affecting the outcomes (Khandker, Koolwal and Samad, 2010).

Over-identification tests had been used in this study to facilitate the identification of good instrumental variables (Khandker, Koolwal and Samad, 2010 and Yorobe and Smale, 2012). The IV model for this study follows the specification of the two-stage least squares (2SLS) estimation model as specified in the handbook for impact evaluation by Khandker, Koolwal and Samad (2010). In this study, the treatment is the exposure to mining M_i, assigned with a binary code of 1 for mining area and 0 for non-mining area.

The specification for the first-stage of estimation has the treatment M_i for the mining exposure or influence instrumented by access to health facilities (AH_i) and access to potable water sources (AW_i). Both instruments are measured in meters and are used in generating the predicted values of M_i through probit estimation (see Equation 1). Endogeneity (Hausman) test and over-identification test are used to know the suitability of these instruments for the mining exposure. The predicted values for the treatment variable (M_i) are incorporated in the second stage of estimation, which is specified in equation 2.

$$M_i = \Upsilon AH_i + \phi AW_i + u_i \quad (1)$$

The second stage of estimation as specified in Equation 2 shows the predicted values for mining exposure (represented by M with a hat to mean predicted value from equation 1) generated in Equation 1 incorporated as part of covariates of household income. Equation 2 is the predictive equation to show the impact of mining on household income represented in the specification below as Y_i. The other covariates represent the factors that would have influence on income, which in the analysis would facilitate in obtaining insights for optimizing the income effects of mining to reduce poverty in Caraga Region. Equation 2 shows the predictive equation for the second-stage of estimation:

$$Y_i = \propto + \beta \hat{M}_i + \delta_1 HS_i + \delta_2 A_i + \delta_3 As_i + \delta_4 L_i + \delta_5 FE_i + \delta_6 EE_i + \delta_7 SY_i + \delta_8 CY_i + \varepsilon_i \quad (2)$$

where Y_i is the monthly household income, $\hat{M}$ is the predicted value for the mining exposure, HS_i household size, A_i age of the household head measured in number of years, As_i asset in terms of Philippine peso, L_i loans in terms of Philippine peso, FE_i monthly food expenditure of the household in terms of Philippine peso, EE_i average monthly educational expenses of the household in terms of Philippine peso, SY_i years in school of the household head, and CY_i years in the community of the household. The regression coefficients are signified by β, δ_1 , δ_2 , δ_3, δ_4, δ_5, δ_6, δ_7 and δ_8, while $\propto$ is the intercept and ε_i is the error term. Robustness is ensured with resolving the heteroscedasticity issue and bootstrapping of errors with replications up to 100 draws.

4. Results and Discussion

4.1 The Covariates in the Testing for Income Effects of Mining

The list of covariates for the testing of income effects of mining is shown in Table 1. These have been selected with respect to priori expectations of their effects on household income. Particularly, age, years in school, years in the community and asset are posited to have positive effects on income. Loans and expenditures on food and education are assumed to have negative effects on income; however, positive effects of loans and expenditures on food and education on income may represent the returns on investment for human welfare. The instruments of mining or mining exposure as the treatment variable are comprised of access to health facilities and access to potable water sources in the table, which are measured in meters. These instruments are subjected to over-identification test to evaluate their merit relative to the three requirements for good instruments. The said test have shown the appropriateness of these selected instruments where they are highly correlated with mining or mining exposure (Table 2) but not correlated with error in the explanatory equation (coefficient of accesshealth = 0.0688122 insignificant at p value = 0.499 and coefficient of accesswater = 0.6484767 insignificant at p value = 0.223 relative to the error term of the explanatory equation).

4.2 The Income Effects of Mining in Caraga Region

The results of the two-stage least squares (2SLS) estimation as shown in Table 3 exhibit the evidence associated with the income effects of mining in Caraga Region. Income effects of mining imply that mining in Caraga Region has the capability of bringing in opportunities that tend to improve income and consumption in the region. The coefficient of mining as instrumented by access to health facilities and access to potable water sources in the IV estimation procedure has yielded a significant value, which signifies mining's capability to improve the incomes of households in the mining areas. It also demonstrates the potential of mining to spur economic gyrations, especially with proper management of economic opportunities in the region. The coefficient of mining is suggestive of mining able to enhance the capability of the households in the mining areas to improve their living standards by means of the opportunities brought about by mining operations and benefits. The result (coefficient of mining (m_nm) = 5619.065) has shown that mining can bring an increase in household income by more than PhP 5,000 or US$ 125 per month. Thus, this also broaches an implication for poverty reduction in Caraga Region.

Besides the positive effect of mining on household income, age of the household head, loans, food expenditures, educational expenses and years in school exhibit positive effects on household income on a highly-significant level of confidence. These results corroborate the priori expectations held for each of the significant variables relative to their effects on income. Age is associated with gaining experience since it enhances experience actually, which accounts for most of the reason of the positive effect of age on income. Increasing food expenditures and education expenses manifest the investments for human welfare or well-being, whose outcomes could drive up the capability of households to earn higher income, as indicated in the estimation results. Incurring loans to improve income has to be taken with caution here, because proper management of borrowed funds is needed to translate the said funds to economic opportunities and incentives. Borrowed funds or loans infuse financial capital that creates the goods and services for profit generation or generation of additional income. Meanwhile, the results also imply that education is a good investment, because its outcome would improve the capability of households to improve living standards by earning higher incomes.

The results of 2SLS are consistent with the results of the ordinary least squares (OLS), both having their heteroscedasticities held in check. However, with mining exhibiting endogeneity based on Hausman test (p value = 0.0494), the use of IV and 2SLS in this study has added confidence in making the inferences for insights and implications on poverty reduction from the results. Thus, for income effects to be optimized relative to poverty reduction in the region, mining stakeholders could focus on crafting policies and programs that would increase investment on human capital. This entails courses of actions intended to improve the quality of human capital through education, training programs and emphasis on entrepreneurship. Specifically, mining benefits would likely redound to poverty reduction in mining areas and across Caraga Region, if those programs and courses of action would capitalize on the skills requirements and science and technology (S&T) support for the mining industry to reduce pollution and adverse environmental impacts of mining operations. Thus, future interventions on education, entrepreneurship and human capital buildup in general can be taken to the direction where mining companies and entities have much of the challenge in the region, which is on the aspects of quality of human capital, structural change and environmental protection. Meanwhile, the instruments for mining in the first stage of estimation (access to health facilities and access to potable water sources measured in meters) have exhibited high relevance to mining as a treatment covariate for household income (Table 2). Their coefficients have signified that mining has caused greater access through shortened distances to health facilities and potable water sources. Their negatively-signed coefficients indicate that the increasing probability that the area is with mining is associated with shortened distances to health facilities and potable water sources.

5. Conclusion and Recommendations

The use of IV in this study has been able to add confidence to the purpose of making inferences relative to the income effects of mining on household income for poverty reduction, more importantly on optimizing these effects for welfare improvement. The approach has ensured the robustness of the estimation results based on the three requirements for good instruments. The use of IV has been justified with the presence of endogeneity problem as detected through Hausman test. Thus, mining can clearly bring in opportunities that would spur sustainable economic development through the proper management of its associated income effects. The impact of mining on income is positive, so mining can help in strengthening local economies as in Caraga Region for poverty reduction and nation-building. However, mining needs to be supported with good insights in the management of mining benefits to direct these benefits and future efforts to the right context of human and socioeconomic development. As implied in this study, the capability of households to increase incomes and improve living standards is closely associated with mining with proper investments on human capital buildup and entrepreneurship. Thus, future efforts are recommended to put premium interest on those aspects and to put special attention on addressing the concern on environmental health and sustainable development in the optimization of mining benefits in the region. Aiding mining entrepreneurially with support services and enterprises towards environmental protection would not only produce more income effects for Caraga Region, but would also redound to having inclusive growth in a healthy and safe environment.

Endnotes

[1]Assistant Professor, Department of Agricultural Sciences, College of Agricultural Sciences and Natural Resources, Caraga State University, Butuan City,Philippines 8600.
Email: raquel_balanay@yahoo.com.
[2]Associate Professor, Department of Agricultural Economics, College of Economics and Management, University of the Philippines, Los Baños, Laguna, Philippines 4030.
[3]Assistant Professor, Agusan del Sur State College of Agriculture and Technology, Bunawan, Agusan del Sur, Philippines 8506.
[4]Instructor, College of Arts and Sciences, Caraga State University, Ampayon, Butuan City, Philippines 8600.
[5]Instructor, College of Arts and Sciences, Caraga State University, Ampayon, Butuan City, Philippines 8600.

[6] Instructor,Surigao del Sur State University, Tandag City, Philippines 8300.
[7]Research Assistant, Caraga State University, Butuan City, Philippines 8600.

Acknowledgment

The Commission on Higher Education (CHED) of the Philippines is acknowledged in this work for funding the implementation of this study in the mining areas of Caraga Region. 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 likewise given due credit for doing the data collection and encoding for the IV analysis. Insightful comments from the referees and editor are appreciated. Any errors are the authors' sole responsibility.

References

Andrews, R.L. and Ebbes, P. (2013), "Properties of Instrumental Variables Estimation in Logit-Based Demand Models: Finite Sample Results", Working Paper, available at http://ssrn.com/abstract=2251772 (accessed 15 March 2014).

Angrist, J. (2005), "Instrumental Variables Methods in Experimental Criminological Research: What, Why and How?", Technical Working Paper 314, 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).

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).

Clarke, P.S., Palmer, T.M. and Windmeijer, F. (2011), "Estimating Structural Mean Models with Multiple Instrumental Variables using the Generalised Method of Moments", Working Paper No. 11/266, Center for Market and Public Organization, Bristol Institute of Public Affairs, University of Bristol, 2 Priory Road, Bristol BS8 1TX.

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

DENR-MGB-Caraga Region (2014). "Mining Tenements Statistics Report", available at www.mgb13.ph/images/pdf files/tenement/mpsa-approved.pdf (accessed 20 March 2014).

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.

Glaeser, E.L. and Kerr, W.R. (2010), "Entrepreneurship, Mines and Urban Growth", available at www.aeaweb.org/aea/2011conference/program/retrieve.php?pdfid=623 (accessed 20 March 2014).

Gurrib, I. (2011),"The impact of mining and services industries on the structural change of Australia", *International Journal of Economic Sciences and Applied Research,* Volume 4 Number 2, pp.35-51.

Heckman, J.J., Urzua, S. and Vytlacil, E. (2006). "Understanding Instrumental Variables in Models with Essential Heterogeneity", Discussion Paper, UCD Geary Institute, Dublin, Ireland.

Khaliq, A. and 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).

Khandker, S.R., Koolwal, G.B. and Samad, H.A. (2010), *Handbook on Impact Evaluation: Quantitative Methods and Practices,* The International Bank for Reconstruction and Development/The World Bank, Washington, DC.

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*, Volume 14(2006), pp. 405-414.

Malsyuk, S. and 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).

Marvasti, A. (2013), "The Role of Price Expectations and Legal Uncertainties in Ocean Mineral Exploration Activities", *Resource Policy*, Volume 38, Issue 1, pp. 68-74.

Panganiban, C.V. (2013). "Despite Growth, Caraga Folk Among Poorest", available at www.newsinfo.inquirer.net/391323/despite-growth-caraga-folk-among-poorest (accessed 20 March 2014).

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. and 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).

Von der Goltz, J. and Barnwal, P. (2014), "Mines: The Local Welfare Effects of Mineral Mining in Developing Countries", Discussion Paper No.: 1314-19, Department of Economics, Columbia University, New York, NY 10027.

Yorobe, J.M., Rejesus, R.M. and Hammig, M.D. (2011). "Insecticide Use Impacts of Integrated Pest Management (IPM) Farmer Field Schools: Evidence from Onion Farmers in the Philippines", *Agricultural Systems*, Volume 104(2011), pp. 580-587.

Yorobe, J.M. and Smale, M. (2012), "Impacts of Bt Maize on Smallholder Income in the Philippines", *AgBioForum*, Volume 15, Issue 2, pp. 152-162.

Zhu, Z. (2012), "Identifying Supply and Demand Elasticities of Iron Ore", Honors Thesis, Duke University, Durham, North Carolina.

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

Variable Name	Definition
Mining* (m_nm)	Location of the household (1 if within mining area; 0 if outside mining area or non-mining)
Household Size	Number of household members
Age	Age of the household head in terms of number of years
Years in school (schoolyrs)	Number of years spent by the household head in formal education
Years in the community	Number of years of the household in the community
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
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
Household income	Average monthly household income in Philippine peso

*denotes the treatment variable

Table 2. First-stage Probit Model for Mining

Variable	Coefficient	p value
access to health facilities	-0.0000193	0.000
access to potable water sources	-0.0001289	0.000
Log likelihood	-1102.6364	
Pseudo R-squared	0.0468	
Akaike information criterion	2211.273	
Bayesian information criterion	2227.632	

Table 3. OLS and IV Estimations for the Effect of Mining on Household Income

Variable	OLS			IV		
	Coefficient	Robust Std. Err.	p value	Coefficient	Robust Std. Err.	p value
Mining (m_nm)	2064.013	504.3172	0.0000	5619.065	1669.429	0.0010
Household size	117.1371	138.1659	0.3970	116.966	135.9894	0.3900
Age of the household head	64.87523	20.36667	0.0010	64.26097	20.83376	0.0020
Asset	0.0055358	0.0036004	0.1240	0.0055941	0.0035777	0.1180
Loans	0.057422	0.0232768	0.0140	0.0623886	0.0231993	0.0070
Food expenditures	1.805253	0.1717952	0.0000	1.865708	0.1643427	0.0000
Education expenditures	1.656893	0.4265871	0.0000	1.656181	0.4191692	0.0000
Years in school	322.5645	93.28606	0.0010	296.7491	91.05272	0.0010
Years in the community	6.912975	14.69446	0.6380	-3.032708	14.69836	0.8370
Intercept	-5110.657	1416.971	0.0000	-7120.149	1729.837	0.0000
Number of observations		1725			1725	
R-squared		0.3056			0.302	
Prob>F		0.0000			0.0000	