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Validating policy prescription from benefit-cost assessments of mining through comparative analysis and test of hypotheses

A contribution to method and case study paper (26 November 2007)

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I. Introduction

According to advocates, corporate mining has the potential to bring at least US\$800 billion of benefits.¹ Although cost figures are oftentimes lacking, what advocates imply is that benefits more than compensate for the environmental damage or risks posed by corporate mining. In an earlier work with the title “Valuation of Benguet Biodiversity and Environmental Cost of Mining,”² the author articulated that large-scale or corporate mining in Benguet produces an economic loss of Php92.7 billion at current level of operation. He

¹ Peter Wallace, an economic analyst, who attended the session of the Philippine Economic Society Annual Meeting during which an initial version of this paper was presented, declared or clarified during the open forum following the presentation of this paper that advocates of mining cite a figure of only US\$8 billion of benefits from mining. The author, however, saw estimates on supposed benefits from mining as high as US\$800 billion from powerpoint slides of advocates.

² This work is a sequel to the work mentioned. “Valuation of Benguet Biodiversity and Environmental Cost of Mining” was a work commissioned to the author by the Haribon Foundation in 2005 (edited 2006, the views expressed may or may not necessarily reflect those of Haribon). The 105-page work is available in the website of Haribon and can also be accessed through www.geocities.com/haribonartboquirenreport/benguetmining2006.htm. Another unpublished work of the author related to b/c analysis of mining is “Towards a basic methodology in the benefit-cost assessment of mining” and is available through www.geocities.com/artboquirenpaperone/bcminingjan07.pdf. Although this work is self-financed by the author, the author acknowledges with deep and sincere thanks the various types of assistance provided by Action for Economic Reforms through Men Sta. Ana and the Foundation for Philippine Environment (FPE) through Sylvia Mesina and FPE Executive Director Christine Reyes. I am also thankful for the kind comments of Dr. Michael Alba, my former teacher in economic statistics and econometrics, an expert in economic statistics and econometrics, incumbent President of the Philippine Economic Society as of 14 November 2007, and former Dean of the College of Business and Economics of the De La Salle University. Dr. Michael brought me honor when he attended the session wherein I presented my paper. However, it must be emphasized that the author alone is responsible for the views and methodology articulated in this paper and the persons mentioned in this work may want to make critical comments on this paper in the immediate or distant future. The author seizes this opportunity to also express his gratitude to Haribon Foundation Director Annabelle Plantilla as well as the incumbent (effective 16 November 2007) Philippine Economic Society President Fernando Aldaba, who is also the head of the Economics Department of the Ateneo de Manila University, for welcoming his paper to the 45th annual meeting of the Philippine Economic Society. The author may produce an improved version of this work in January 2008 and this may come out in www.geocities.com/arturoboquiren/selectworks.htm where some of the works of the author are available. In the improved version for January 2008 being planned today, the technical discussion or references will be placed in a technical appendix and endnotes rather than footnotes will be available. Further, I also intend to improve both the methodology and substance of this work.

argued further that monetary value of costs overshadow the monetary value of benefits until at least when the price of gold shoots up by 55% from its price of US\$634.05 an ounce in May 2006.

The higher yet arguably valid estimate of economic costs can be partly attributed to the assumption of potable water (similar to that used by Dr. Marcelino Dalmacio for the Samar Island National Park in 2003) without mining as well as possible environmental or geohazard risks with mining. In the computation, many intangible costs were not yet even monetized.

B/C or benefit-cost analyses of mining and conclusions adopted can vary based on the b/c analysis perspective adopted, valuation methodology employed, and values used for proxies and valuation of intangibles. This implies a need for developing techniques to validate the policy implications suggested by various b/c analyses of mining.

If mining is indeed good then this fact should show in the income, poverty, and health figures. In this attempt at validation, mining and non-mining localities are compared with regard to local government income growth rate, local government income per hectare, local government (LGU) income per capita with regard to the population covered by the LGU jurisdiction, and nutrition status of children 71 months and below.

At the same time, test of hypotheses for means and proportions were used. The test statistic employed for the tests of hypotheses on means is $t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}}$ which I consider to be most applicable given the data set at hand. On the other hand, the test statistic utilized for test of hypotheses on proportion or

percentage is $z = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\hat{p}\hat{q}[(1/n_1) + (1/n_2)]}}$. The tests of hypotheses on means and

proportions and rules for application are typically found in all statistics reference books, including in a book considered as a classic in statistics or Walpole 1983 as well as the book of Freund and Simon 1997. In this work, the mining communities or localities refer to the municipalities of Itogon, Mankayan, and Tuba where large-scale corporate mining operates. The corporate or large-scale mining companies operating in these municipalities are Lepanto Mining, Benguet Consolidated, and Philex Mines.

II. Comparison and test of hypotheses on income

Advocacy for mining is strongly premised on the argument that benefits from mining are so large and, therefore, environmental issues concerns can be sacrificed. If benefits from mining are indeed so large then this matter should be significantly reflected in the incomes of local government units hosting corporate mining. Is this the case? Are the local government units hosting corporate mining really earning large revenues compared to those not hosting large-scale or corporate mining? Table 1 is illustrative.

Table 1. Municipal income in 1996 and 2002, growth rate, and rank of growth rate

Municipality	1996 (in thousand pesos)	2006 (in thousand pesos)	Annual Municipal Income Growth Rate 1996-2006 (%)	Rank
Atok	10,819	32,728	11.71	13
Baguio City	281,110	781,329	10.76	11
Bakun	11,624	47,611	15.14	2
Bokod	13,159	34,564	10.14	14
Buguias	13,192	43,784	12.75	10
Itogon	33,410	82,126	9.41	12
Kabayan	8,675	31,022	13.59	7
Kapangan	9,408	32,044	13.04	9
Kibungan	9,434	34,110	13.72	5
La Trinidad	29,066	113,090	14.55	3
Mankayan	19,928	90,121	16.29	1
Sablan	7,678	27,985	13.81	4
Tuba	22,402	80,655	13.67	6
Tublay	7,624	26,671	13.34	8

Source: Benguet Profile 2003 (latest provincial profile available) and Commission on Audit (COA)

Doing a one-tail hypotheses test of means on $H_0: \mu_{non-mining} = \mu_{mining}$ versus $H_1: \mu_{non-mining} < \mu_{mining}$ where μ refers to the mean annual income growth rate of local government units that may or may not have corporate mining for 1996-2006, we find that the null hypotheses of equality of means cannot be rejected given that the value of the applicable test statistics is -0.3546 . The value of the test statistics suggests that the local government unit income growth rate of non-mining communities from mining communities are not significantly different from each other and, thus, based on the theories of statistics, it is valid to say that mining, particularly large-scale mining, will not increase nor will not lead to a significant increase in the income of local government units.

Beyond the test of hypotheses on means, however, one can note that municipalities perceived to be poor like Bakun, Buguias, Kabayan, Kibungan, and Sablan exceeded the LGU income growth rates of municipalities hosting corporate or large-scale mining even if gold price approximately tripled during the period 1996 to 2006. This indicates that hosting large-scale mining companies need not be the source of income growth for Benguet municipalities. Equally beneficial municipal income growth trend can be obtained if municipalities focus on agriculture, manufacture, educational centers, and other sources of livelihood.

Table 2 divides the LGU income by the land area in hectares covered by the LGU. A pattern similar to the earlier observation can be noted. Table 2 shows that equally respectable LGU income per hectare can be derived from livelihoods other than large-scale or corporate mining. Among such livelihoods, for example, are vegetable, banana, and broom production. This is a surprise considering that multi-million pesos are invested in mining while other sources of livelihood like banana and broom production are not even big enough in Benguet municipalities.

Table 2. Estimate of municipal income per hectare and rank of Benguet municipalities in 2006

Municipality	Area in Hectares	Municipal Income in 2006 (in thousands)	Income per Hectare (pesos)	Rank in Income per Hectare
Atok	13,700	32,728	2,389	7
Baguio City	5,749	781,329	135,907	1
Bakun	23,740	47,611	2,006	10
Bokod	43,530	34,564	794	14
Buguias	19,310	43,784	2,267	9
Itogon	42,370	82,126	1,938	11
Kabayan	17,750	31,022	1,748	13
Kapangan	13,640	32,044	2,349	8
Kibungan	19,210	34,110	1,776	12
La Trinidad	6,140	113,090	18,419	2
Mankayan	13,170	90,121	6,843	3
Sablan	9,160	27,985	3,055	5
Tuba	31,438	80,655	2,566	6
Tublay	8,490	26,671	3,141	4

Executing a one-tail hypotheses test of means for $H_0: \mu_{non-mining} = \mu_{mining}$ versus $H_1: \mu_{non-mining} > \mu_{mining}$ where μ refers to the mean annual income per hectare of jurisdiction of local government units that may or may not have corporate mining for 1996-2006, we find that the null hypotheses of equality of means cannot be rejected given that the value of the applicable test statistic is 0.9935. In this analysis, we are very fair because the mean local government

income per hectare of jurisdiction of non-mining communities is actually very large at P15,805 per hectare compared to that for mining communities at P3,782. However, the value of the test statistic for the hypothesis test was influenced to a very large degree by the high value of the sample standard deviation at P40,136. Based on the theories of statistics, what we are only allowed to say is that the null hypotheses of equality of income per hectare between local governments hosting large-scale or corporate mining and LGUs not hosting large scale or corporate mining cannot be rejected.

For the next discussion, we construct table 3. We derive the population growth rate by comparing population figures in 1990 with 2000. Notice that we have decreasing population growth figures for Mankayan, Itogon, and Tuba or the municipalities hosting large-scale or corporate mining activities. This data alone can be interpreted as indicative of the limited opportunities in the mining areas during the period. The data possibly reflect the vulnerabilities of local governments hosting large-scale or corporate mining (but of course, a deeper study is in order). In particular, table 3 most likely indicate that when mining is not doing good in the international market, the municipalities can become out migration areas with possible consequences on economic and income figures.

Table 3. Projected population of Benguet municipalities in 2006

Municipality	2000 Population	Annual Growth Rate in %	Projected Population in 2006
Atok	16,657	2.33	19,126
Baguio City	252,386	3.26	305,955
Bakun	12,213	-0.82	11,624
Bokod	11,705	2.2	13,338
Buguias	33,177	3.43	40,618
Itogon	46,705	-0.43	45,513
Kabayan	12,344	3.25	14,955
Kapangan	18,137	3.59	22,412
Kibungan	15,036	1.23	16,180
La Trinidad	67,963	1.95	76,313
Mankayan	34,502	-0.08	34,337
Sablan	9,652	1.1	10,307
Tuba	38,366	-0.47	37,297
Tublay	13,672	1.02	14,530

Based on table 3 and earlier tables, we can construct table 4. In particular, we are able to derive from table 3 and earlier tables the LGU income per capita population of the Benguet LGUs. Again the same pattern in earlier tables can be observed in table 4 next page.

In particular, table 4 of the next page again indicates that even vegetable, banana, and broom production can beat LGUs hosting large-scale or corporate mining in terms of LGU income per capita population. Bakun is considered or widely known as a poor municipality and yet it defeated Mankayan, a gold producer, in terms of LGU income per capita population!

Table 4. Estimate of municipal income per capita and rank of Benguet municipalities in 2006

Municipality	Projected Population in 2006	Municipal Income in 2006 (in thousands)	Municipal Income per Capita	Rank in Municipal Income per Capita
Atok	19,126	32,728	1,711	11
Baguio City	305,955	781,329	2,554	5
Bakun	11,624	47,611	4,096	1
Bokod	13,338	34,564	2,591	4
Buguias	40,618	43,784	1,078	14
Itogon	45,513	82,126	1,804	10
Kabayan	14,955	31,022	2,074	8
Kapangan	22,412	32,044	1,430	13
Kibungan	16,180	34,110	2,108	7
La Trinidad	76,313	113,090	1,482	12
Mankayan	34,337	90,121	2,625	3
Sablan	10,307	27,985	2,715	2
Tuba	37,297	80,655	2,163	6
Tublay	14,530	26,671	1,836	9

Implementing a one-tail hypotheses test of means for $H_0: \mu_{non-mining} = \mu_{mining}$ versus $H_1: \mu_{non-mining} < \mu_{mining}$ where μ refers to the mean annual LGU income per capita population of the local government units that may or may not have corporate mining for 1996-2006, we find that the null hypotheses of equality of means cannot be rejected given that the value of the applicable test statistic is -0.1797 . The value of the test statistics implies that even if the mean LGU income per capita population of the LGU with corporate mining is slightly higher than LGUs without mining, the null hypothesis of equality of means cannot be rejected. Thus, based on statistical theory, we have a good basis to argue that corporate mining will not result to higher LGU income per capita population among local government units.

III. Comparison and test of hypotheses on poverty incidence

The National Statistical Coordination Board or NSCB religiously tabulates poverty incidence data. However, as of November 2007, the latest available data

for poverty incidence at the municipal level are the poverty incidence for 2000. National poverty incidence data on specific sectors but not for the total population are available for 2003. Similarly, official 2003 poverty incidence data at the municipal level are still not available as of November 2007. Table 5 next page reflects the poverty incidence per municipality while table 6 aggregates the data for mining versus non-mining (non-large scale mining) LGUs.

Table 5. Poverty incidence in Benguet and rank in terms of lowest poverty of areas

Municipality	Population in 2000	Poverty Incidence in 2000	Rank in having the lowest poverty incidence
Atok	16,657	54.35	10
Baguio City	252,386	6.73	1
Bakun	12,213	60.72	13
Bokod	11,705	46.44	7
Buguias	33,177	48.91	8
Itogon	46,705	30.13	3
Kabayan	12,344	57.87	12
Kapangan	18,137	57.16	11
Kibungan	15,036	68.55	14
La Trinidad	67,963	14.41	2
Mankayan	34,502	42.53	6
Sablan	9,652	49.10	9
Tuba	38,366	36.88	5
Tublay	13,672	35.86	4

Table 6. Mining and non-mining communities of Benguet and poverty incidence, 2000

Mining Localities of Benguet		
	Total Population	119,573
	Poverty Incidence	35.87%
Non-mining localities of Benguet		
	Total Population	462,942
	Poverty Incidence	22.11%

If corporate or large-scale mining is indeed good for Benguet municipalities then poverty incidence should be very low in corporate mining municipalities of Mankayan, Tuba, and Itogon. After all, large scale or corporate mining has been in Mankayan for at least 71 years, in Tuba for at least around 49 years, and in Itogon for around 91 years. Let us see the poverty incidence figures in Benguet in table 5.

Table 5 appears to suggest that the elimination of poverty appears to be correlated with urbanization because the LGUs that have lower poverty rates compared to the mining communities are those associated with urbanization: Baguio City, La Trinidad, and Tublay. In turn, urbanization in these

municipalities is the result of a focus on the establishment of manufacture, schools, and service industries.

Nevertheless, testing $H_0: p_{\text{mining}}=p_{\text{non-mining}}$ or that poverty rate in mining communities are not different from poverty rate in non-mining communities versus $H_1:$ or that poverty rates in mining communities are higher compared to poverty rates in non-mining communities, we obtain a value of 98.0461 for the applicable test statistic. The value of the applicable test statistic strongly suggests that poverty rates in communities with corporate mining are significantly higher than poverty rates without significant corporate mining. The probability of committing a type I error or error committed in accepting the alternate hypotheses when the null hypothesis is in fact true is low at less than one in a trillion or, more precisely, less than one out of 1×10^{30} with 30 as the maximum number of zeros that Excel 2000 can cover to the right of the decimal point.

The result come as a surprise but a possible explanation for the phenomenon can be found in the Leontieff Input-Output Table for the Philippines (National Statistical Coordination Board or NSCB: 2006). Analyzing the input-output table, the NSCB produced a table which is captured this work as table 7.

Table 7. Backward-Forward Linkage Based on Latest Leontief Input-Output Table for Philippines

Sector	Backward Linkage		Forward Linkage	
	Index of Dispersion	Rank	Index of Sensitivity	Rank
1. Agriculture, Fishery, and Forestry	0.8616	10	1.0307	3
2. Mining and Quarrying	1.0003	5	0.8162	7
3. Manufacturing	1.2648	1	2.8780	1
4. Construction	1.1382	3	0.6292	10
5. Electricity, Gas, and Water	0.9208	8	0.8237	6
6. Transportation, Communication, and Storage	1.1383	2	0.8859	4
7. Trade	0.9745	6	0.8800	5
8. Finance	0.9697	7	0.7624	8
9. Real Estate and Ownership of Dwellings	0.7034	11	0.6482	9
10. Private Services	1.1275	4	1.0581	2
11. Government Services	0.9009	9	0.5875	11

Source: NSCB 2006: 17

Tables 5, 6, and 7 imply that several alternatives other than large-scale mining are available towards lowering the incidence of poverty and these alternatives are far better alternatives. For instance if a little urbanization or diversification of livelihood can be better in lowering the incidence of poverty then a review is in order if corporate or large-scale mining is in fact an obstacle

against diversification because once an area is converted as a mining site, its conversion to other uses can become difficult.

IV. Comparison and test of hypotheses on nutrition status

Table 8 examines the nutrition status of children 71 months and below in Benguet. What is scandalous in table 8 is that Mankayan that is hosting a company engaged in the production of gold is among the municipalities that have the lowest rank in terms of having children 71 months and below that are not underweight. Baguio City is not included because its data are not comparable with other municipalities. Baguio City weighs children 72 months and below instead of 71 months and below adopted by the Benguet municipalities.

Nevertheless, doing a test of proportion similar to that for poverty, a test statistic equal to 1.0088 is obtained. This implies that even if mining communities have a slightly higher percentage of children 71 months and below who are underweight, it is not significantly different from the rate of communities not that are not hosting large-scale or corporate mining. The proportion of underweight in mining communities is 3.84% while those for non-mining communities is 3.66%.

Table 8. Nutrition status of children 71 months and below in Benguet

Municipality	Children 71 months and below	Count of Underweighted (including severely underweight)	%Underweight (including severely underweight)	Low Malnutrition Rank
Atok	2,047	86	4.20	6
Bakun	1,608	126	7.84	13
Bokod	1,339	94	7.02	10
Buguias	4,869	78	1.60	1
Itogon	7,916	325	4.11	5
Kabayan	1,390	99	7.12	11
Kapangan	1,758	133	7.57	12
Kibungan	2,066	81	3.92	4
La Trinidad	11,682	251	2.15	3
Mankayan	5,189	292	5.63	9
Sablan	1,315	59	4.49	7
Tuba	5,107	82	1.61	2
Tublay	1,910	90	4.71	8
Benguet	48,196	1,796	3.73	n.a.

Source: Benguet Provincial Health Office. The "Operation Timbang" covered 46,061 children 71 months and below out of 52,055 or 88.5% of target

V. Conclusion and postscripts

The overall conclusion that can be constructed from this exposition is that non-mining areas perform at least just as “good” as mining areas and, thus, communities or local government units that want their cities or municipalities to take off and take a higher growth path need not embrace large-scale mining. There is a strong basis therefore to explore more environment-friendly alternatives to development and, given the threats posed by mining on the environment, mining need not be an option for municipalities and cities to have a higher growth path.

Meanwhile, based on figures cited in this work, it is also valid to conclude that where corporate mining operate in Benguet, poverty incidence is in fact higher and not lower. Related to this, I anticipate that advocates of mining would interpret the data set as a case where sharing of benefits between mining companies and local government units can be explored. Against this, I would like to reiterate the point I made earlier that a better interpretation is that the data highlight the need to explore alternative paths to development other than the one proposed by large-scale or corporate mining. Development can be on a higher growth path and more environment-friendly at the same time.

It will be interesting to replicate or do a study similar to this work in many mining municipalities nationwide and all over the world. My guess is that the results will not be radically different from the one I have for Benguet Province, Philippines.

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