A Review of "The economic impact of ferrous and non-ferrous mining on the State of Minnesota and the Arrowhead Region"[1]

Evan Hjerpe, Ph.D.[†] and Spencer Phillips, Ph.D.[‡]

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Brief Summary: Regional economic impact analyses can be helpful in illustrating potential changes in output, income, and employment that might result from new development. Economic impact analysis (EIA) is, however, subject to stringent methods that must be adhered to in order to provide credible estimates of impacts. Additionally, EIA is based on an underlying set of restrictive technical assumptions that may apply only in rare instances. Thus, great care must be taken in conducting and using the results of economic analysis if it is to have any value at all. The proliferation of turn-key economic impact models, such as IMPLAN, has made it extremely easy to produce estimates of economic impacts by non-economists or economists with little training in this area. Impacts can be generated with little consideration for the underlying methods and technical assumptions. This has resulted in a wide range of quality in economic impact analyses.

After examining "The economic impact of ferrous and non-ferrous mining on the State of Minnesota and the Arrowhead Region, including Douglas County, Wisconsin," (hereafter "the UMD report") we conclude that the University of Minnesota, Duluth's economic impact analysis falls squarely at the "low-quality" end of the spectrum. In brief (and as detailed below), the reasons for this conclusion include the following:

- The authors of the UMD report failed to adhere to a number of the most critical EIA methods. Multiple violations of standard EIA methodology undermine all generated IMPLAN results.
- The underlying technical assumptions of input-output modeling, the core tenet of IMPLAN, lead to an unrealistic picture of the regional economy, because they inflate induced effects and multiplier effects. As such, researchers generally take a deliberately conservative approach and/or perform sensitivity analysis. The UMD report incorporates neither.
- The authors of the UMD report provide no comparison of potential mining multiplier effects to multipliers for other industries within the regional economy. Without comparison, the reader has no context with which to judge the impacts.
- The authors do not acknowledge the limited role and application that EIA results have in the overall environmental assessment of mining impacts. Apart from a brief note in Appendix B that "a detailed cost-benefit analysis is beyond the scope of this report," the UMD study does

[1] Skurla, James A. et al., *The Economic Impact of Ferrous and Non-Ferrous Mining on the State of Minnesota and the Arrowhead Region, Including Douglas County, Wisconsin* (University of Minnesota, Duluth: Labovitz School of Business and Economics, November 2012), http://www.d.umn.edu/lsbe/bber.php.

[†] Conservation Economics Institute, Boise, Idaho

[‡] Key-Log Economics, Charlottesville, Virginia

nothing to place the modeled (short-term) economic impacts in the context of what are reported elsewhere to be significant, long- and short-term negative environmental, economic and fiscal impacts of non-ferrous mining in Northeast Minnesota.[2]

1. Introduction

New, non-ferrous mines are being proposed in northeastern Minnesota, but need to undergo an environmental planning process to help determine if the new mines are in the public interest of Minnesotans. The primary component of determining public interest is assessing the overall environmental impacts of proposed projects to determine if the public benefits outweigh the public costs. Part of this process has also typically included an assessment of potential economic impacts that might be generated by the proposed mining. A recent study, "Economic Impacts of Ferrous and Non-Ferrous Mining on the State of Minnesota and the Arrowhead Region, and Douglas County, Wisconsin," was conducted by The Labovitz School of Business and Economics at the University of Minnesota Duluth (hereafter, "UMD report"). In this paper, we review UMD's economic impact analysis, so as to provide an objective perspective on the associated economic impacts of proposed mining expansion, with particular attention to new non-ferrous mining. Because proposed non-ferrous (sulfide) mining is new to the region and has the greatest environmental impact, we review the report with an eye on the implications for non-ferrous mining.

The UMD report suffers from multiple technical and methodological flaws and does not address any associated costs of non-ferrous mining. These flaws include: inappropriate study area delineation, a lack of rigor in data collection, and inappropriate inclusion of past economic activities related to existing mining production. Additional problems, and technical errors, were also found throughout the report that led to consistently inflated economic impacts. The presented economic impacts are therefore not credible estimates and require an entirely new analysis to correct these fatal flaws.

2. Economic Impact Analysis (EIA) and Environmental Planning

To provide greater understanding of the role of the UMD report, it is helpful to first frame the scope of EIA in terms of its value in determining overall public costs and benefits. In the broad picture of net public interest, EIA is narrowly focused on short-term changes in regional economic indicators. As such, EIA does not shed light on any associated costs to society that might result from the proposed development (e.g., environmental impacts, damages to other industries, or long-term viability of the industry or the region). Furthermore, economic impacts, even if positive, are rarely considered as economic benefits for the regional economy.[3] This is because regional economies are dynamic, but gravitate towards equilibrium in terms of economic indicators. That is, losses in one sector of the economy are generally offset by gains in other sectors; and gains in one sector are generally offset by

[2] Marcotty, Josephine, "Iron Range Mine Could Pollute Water for up to 500 Years," accessed December 3, 2013, http://www.startribune.com/local/226548091.html; Dunbar, Elizabeth, "State's Top Elected Officials Approve Mineral Leases, with Reservations," *MPR News*, accessed November 25, 2013, http://minnesota.publicradio.org/display/web/2013/10/25/elected-officials-vote-on-mineral-leases.

[3] Consumer surplus is the appropriate measure for economic benefits.

losses in others, despite the tendency for regional economies to attain overall growth or restriction in the long run.[4]

Thus, the results of economic impact studies provide only a portion of the overall economic effects associated with proposed development, for a very limited amount of time, and virtually none of the overall societal costs and benefits over time. This is important to consider when exploring regional economic development strategies.

Another consideration for the scope of economic impacts is that most are presented in isolation. While generated multipliers and impacts may appear large or small, the public and decision-makers have no context for the results if they are not compared to multipliers and impacts from other industries for a similar regional economy. What do these numbers mean? Depending on geographic, demographic, and other variables, regional economies and individual entrepreneurs have choices in the form of economic development they would like to pursue. Without a comparison to the impacts and multipliers associated with other types of industrial development in a particular region, the public and decision-makers do not have a proper context for framing results.

3. Disregard for Critical Economic Impact Analysis (EIA) Methods

We present the most critical EIA methods in detail below to provide the reader with their importance in determining all the subsequent results and economic impacts provided by models such as IMPLAN. Failure to adhere to these methods produces unreliable and inaccurate estimates of economic impacts, often leading to double, triple, and quadruple counting of unique economic impacts of income, employment, or industry purchases.

3.1 Defining initial changes in final demand

The driver of economic impact analysis is the *change in final demand* (via output, value-added, or employment) in the defined region that will be spurred by a new development. This change in final demand, or "shock" to the regional economy, is estimated by the researcher based on surveys of businesses and individuals, or in the case of the UMD report, getting input from mining companies and other groups to ascertain "employment estimates, local purchases, and operations dollar value of sales or output production (p. 3)." The change in final demand is entered into IMPLAN software and applied to the predictive I-O model for the particular region being studied. Once changes in final demand are entered into IMPLAN for the affected industry sectors, the software provides the *direct effect* to the region (subsequent analysis options allow for estimating *indirect and induced effects*).

All changes in final demand result in direct effects, but based on regional purchasing coefficients (RPCs) and location quotients as defined by the size and structure of the regional economy, IMPLAN software categorizes these direct effects by industry sector, domestic trade, and foreign trade. That is, direct effects are the initial estimate of how much of the regional final demand changes impact regional

[4] These economic trends are perhaps easiest to understand from the individual laborer perspective. Regional economies typically have a limited labor supply. When an individual loses their job, they typically seek and find work at another company, as opposed to staying unemployed and representing a permanent loss to the economy.

industry sectors, how much leaves the defined region as domestic trade, and how much leaves the country as foreign trade.

Critically, data collection for changes in final demand is concerned only with economic activity that occurs in the defined study area. For example, if a mining company owns a mine in one part of the state, has state headquarters in another part of the state, and has international headquarters outside of the U.S., different changes in final demand will occur in all three areas based on new mineral sales. The location and impact of final demand changes based on mineral sales is different for each particular region. Given this, the proper delineation of the study area for regional economic impact analysis, and capturing final demand changes that occur within that region, are critical first steps in determining accurate direct effects and subsequent multiplier effects.

Multipliers represent the amount and number of times economic activity (e.g., output, value added, or employment) re-circulates within the defined study area. Specifically, multipliers are the ratio of total effects (direct + indirect + induced) to direct effects. All economic activity that is not captured by the local economy due to imports and purchases elsewhere is considered leakage. *The size of the defined study is a major determinant of the resulting multiplier effect, with larger study areas capturing more of the economic activity.*

Researchers have illustrated that study areas for regional EIAs should be restricted to the region most affected, not only in terms of economic impacts, but also in terms of costs incurred.[5] The reasons for this are twofold. First, increasing the study area for localized economic development projects (such as for a few counties) beyond its primary economic influence (e.g., to the state-level) results in inflated multipliers and impacts. Secondly, and perhaps more importantly, an EIA should compare local economic impacts to local costs of such development including the need for greater public services and costs associated with environmental degradation.

As such, changes in final demand are strictly the purchases, sales, and employment that will occur within the study area. On p. 6, the UMD report correctly defines direct effects as "*Initial spending in the study area resulting from the project.*" On the same page, the UMD report also correctly defines value added and output in terms of "contribution to the local economy" and "the value of local production." But, throughout the UMD report, two dramatically different study areas are used (the Arrowhead Region and the State of Minnesota), yet the majority of direct effects remain the same for both. This indicates that only one set of final demand changes were used for both study areas. This is a fatal flaw that undermines the credibility of the entire report.

- The authors of the UMD report utilize and present results for two different study areas: 1) the Arrowhead Region of Northeast Minnesota, which includes seven adjacent Minnesota counties and one adjacent Wisconsin county; and 2) the entire state of Minnesota, which includes 87 counties. The proposed mining expansion will all occur in the Arrowhead Region, making this the more appropriate study area. The only reason we can see for also utilizing an additional

[5] Hjerpe, E.E. and Y. Kim. 2007. Regional economic impacts of Grand Canyon river runners. *Journal of Environmental Management* 85(1): 137-149.

study area of the entire state of Minnesota is to boost reported economic impacts. Indeed the first and primary comprehensive Table provided in the executive summary shows only the inflated impacts resulting in the entire state (p. viii). Utilizing two separate study areas is inappropriate and reflects a poor understanding of economic impact analysis. *If using multiple study areas, each study area must have its own survey (or data collection) of changes in final demand*.

- For these different study areas, most of the reported direct effects are identical. (Compare Tables 4 and 5 (p. 11); Tables 8 and 11 and Tables 9 and 12 (pages 14-15); Tables 18 and 19 (p. 20); Tables 22 and 25 (pp. 22-23); Tables 23 and 26 (pp. 23-24); Tables 33 and 35 (pp. 28-29), and Tables 34 and 36 (pp. 28 and 29). This illustrates that the researchers did not collect economic data specific to each defined study area, but rather utilized one set of final demand changes for both study areas. This is problematic for a number of reasons. First, Douglas County is in Wisconsin, and changes in final demand (and resulting direct effects) for construction, operation and output sales that occur in Wisconsin should not be counted in Minnesota. So even if 100 percent of the direct spending associated with the proposed new mining were to occur in the smaller study region, at least some of that effect would have to accrue to Minnesota's neighbor to the east.

  Second, it is extremely unlikely that 100 percent of the direct spending would occur in the Arrowhead region in the first place. At least some of the increase in employment required to support the new and expanded mining would occur in the company's down-state and/or out-of-state / out-of-country offices (i.e., PolyMet state headquarters in St. Paul and international headquarters in Toronto). Wages and salaries earned by managers in the Twin Cities should not be confused with (or counted the same as) wages and salaries earned by mine workers in the Arrowhead region.

  Third, it is likely that the sale of ore itself would be transacted in places far from the mine, and large portions of those sale proceeds (e.g., profits) would be part of the direct effect in those distant places, not in the Arrowhead Region. As is often the case with multinational mining companies, only the value-added portions of mineral sales would accrue as economic impacts in the Arrowhead Region.

  Without seeing the precise assumptions and numbers that went into the estimation of the initial changes in final demand, it is not possible to say how much smaller the direct effect in the Arrowhead region should be. One can be certain, however, that those effects would be different, and smaller in the region than in Minnesota as a whole.

  Interestingly, there are a couple exceptions in the presented Non-Ferrous Mining direct effects (Tables 22 and 25, and Tables 23 and 26) where only the value-added components are actually slightly different and are carried over to the summary tables in the combined totals at the end of the report. However, the value-added direct effects in these tables are actually higher in the

smaller, Region Operations tables. We presume these are typos, as it suggests that value-added impacts that occur in seven Minnesota counties somehow got lost on their way to the State of Minnesota. (The only way this would make sense is if the effects are so much larger in Douglas County, Wisconsin that they overwhelm the difference between Minnesota-wide effects and those occurring in the Minnesota portion of the Arrowhead region. But of course if this is true, then it further calls into question the estimates of direct value-added effects that are identical for the entire Arrowhead region and the entire State of Minnesota. (See, for example, Tables 9 and 11.))

- There is very little detail presented in the UMD report concerning their data collection and their construction of initial changes in final demand, yet this critically determines the direct effects and additional indirect and induced effects. The reader is only told that mining companies and other mining associated groups provided input to the authors to ascertain "employment estimates, local purchases, and operations dollar value of sales or output production (p. 3)." Accuracy and consistency in data collection is the first fundamental step in sound science. How were data collected? Did the author's provide respondents with a written survey? In-person interviews? What regional economic study area was used? This information should be noted in the text and surveys and data collection instruments should be provided in an appendix.

- Many of the estimated jobs may be filled by transient workers, who will earn wages in the area and spend them elsewhere. It is not clear if this was taken into consideration for the initial estimates of changes in final demand. If not, employment effects will be overestimated for the regional economy.

3.2 Defining economic impacts

EIA, and its technical assumptions, are predicated on forecasting the impacts of *new* changes, or a "shock," in final demand for a regional economy, most often from a proposed policy change or development plan. Economic impact analysis is defined in the IMPLAN Analysis Guide[6] as:

> "An assessment of change in overall economic activity as a result of *some change* in one or several economic activities [emphasis added]."

Despite this, the UMD report includes all *on-going* ferrous and non-ferrous mining operations in the impact study, combined with estimates of new construction and operation. The first summary table in the Executive Summary (p. viii), and likely the most important take home message from the report, claims that the total economic impacts are a "…Value Added total of almost $5 billion, and Output of almost $7.8 billion, and an Employment total of more than 27,300 (p. viii)."

Existing operations are supposed to be used to understand the current economic relationships between industry sectors that will be used to estimate potential economic impacts from the "shock" of new final demand changes in that industry. *These impacts have already been absorbed by the regional economy*

[6] IMPLAN Professional Analysis Guide. 1999. Technical Report. Minnesota IMPLAN Group, Inc.

and should therefore not be counted among the impact of the new changes in the economy. Inclusion of existing operations indicates a lack of understanding economic impact analysis and grossly exaggerates impacts. In reality, such rapid mining expansion would come at the loss of existing mining industry due to increased cost of supply inputs and decreased market prices of final products from flooded local markets.[7]

4. Critiques of I-O Modeling and Implications for the UMD Report

There are numerous technical assumptions required for input-output (I-O) modeling, a core tool of economic impact analysis. I-O modeling is the balancing of all industrial sector sales and purchases, and exogenous sectors such as households,[8] government, and foreign trade. That is, increases or decreases in one sector will yield a cascading effect on many other sectors that will ultimately balance out. The primary technical assumptions include linearity among production functions, fixed technical coefficients, homogenous sector output, and no supply constraints.[9] The resulting implications of these assumptions yield a static regional economy, with no economies of scale, no technological advances, and an unlimited supply of resources and labor. In short, this is far from a realistic portrayal of any regional economy, but necessary for the mathematical balancing conducted within I-O models. These assumptions traditionally lead to inflated economic impacts. For example:

- Due to the unrealistic technical assumptions necessary for input-output modeling, all multipliers, and especially employment multipliers, are inflated and should be viewed with extreme caution. For example, the linear production functions lead to the presumption that businesses and households will spend and consume at the same rate. In reality, once a certain threshold in income is achieved, more saving and investing occurs (and often these savings are invested outside the region).

- Another example comes from the hypothetical economic assumption of fixed technical coefficients. Forecasting mining impacts in the year 2016 neglects improvements in technology. Labor-displacing technology is significant in the mining industry.

- The employment impacts in the UMD report are presented in terms of full and part-time jobs, not Full-Time Equivalents. Because of the seasonal and temporary nature of mining jobs, especially for all construction impacts, the reporting of employment impacts is suspect. The UMD report imparts no information of the typical percentages of seasonal and temporary workers in the mining industry. Without this context, the public and decision-makers are left wondering what the real impact will be. Likewise, the UMD report provides no comparison to potential employment impacts that might result from investments in other forms of economic

[7] Stacking new impacts on top of on-going operations also illustrates the problems associated with unrealistic I-O modeling assumptions of linear production functions and unconstrained supply pools.
[8] Households and other previously exogenous sectors have been "endogenized" in the structural accounting matrices used for most modern multiplier effects, such as in IMPLAN.
[9] Miller, R.E. and P. Blair. 1985. Input-output analysis: foundations and extensions. New Jersey: Prentice-Hall, Inc.

development. How do these numbers compare to other industries that communities might want to pursue?

Given that the UMD report acknowledges how these assumptions can lead to overestimates, and given that information about the critical relationship between output and employment was provided by mining project managers without additional information taken from independent sources (p. 8), it would be reasonable to expect the UMD report to take a more conservative approach.

5. Tax impacts

The tax impacts from existing and proposed mining in Minnesota are presented in the UMD report in detail. At first glance, they appear impressive. Upon a closer examination, however, it becomes clear that the mining industry is afforded minimal taxation by the State of Minnesota.

- A calculation of overall taxes presented in the UMD report illustrate that the mining industry is afforded an *effective regional tax rate of less than one percent of calculated direct output* .

  $17.6 million in 2010 from Table 38, divided by $1.85 billion of estimated direct output for both ferrous and non-ferrous 2010 baseline from Table 41 = 0.95%.

  As direct output in the region is necessarily smaller than overall sales of final mining products, this effective regional tax rate is miniscule and represents major tax breaks provided to the mining industry. The more important question is how do these tax rates compare to other sectors in the economy? Given the normal regional rates of taxation on most industries (e.g. tourism), a comparison within the UMD report would provide substantial context for the public and decision-makers.

- No costs associated with mining are presented in the UMD report. Yet, we know from recent history that mining is a boom and bust industry, susceptible to volatile, global mineral pricing. We also know this type of development will require increased infrastructure, health, and emergency services that are needed with such rapid development. Additionally, ample public taxes will be needed in the future to pay for future rehabilitation and reclamation of degraded mining lands, as well as continual monitoring of water quality and active treatment for hundreds of years, at least.[10] With such a miniscule effective tax rate for the mining industry, it seems prudent to question whether current annual taxes can keep up with the public service needs stemming from rapid development, much less provide for future clean-up costs.

  But, the less than one percent effective regional tax rate per direct output is not the only exceptional characteristic of Minnesota mining taxation. A deeper look at the collected taxes

[10] Karnowski, Steve, "New Environmental Review Due for PolyMet's Copper-Nickel Mine," *Associated Press*, accessed December 5, 2013, http://www.twincities.com/localnews/ci_24634015/minnesota-copper-nickel-mine-new-environmental-review.

shows that of 13 tax accounts, six are funneled back into minerals management (Table 38). While we do not know the exact distribution of each tax account,[11] the appearance is that a substantial portion of the taxes collected are reinvested back into the mining industry. This represents further tax breaks and kick-backs to the mining industry in Minnesota.

6. Other Problems with the UMD Report

The UMD report is deficient in many areas, leading to consistent inflation of actual economic impacts stemming from mining in the region. Other issues from the UMD report include:

- Table 1 and the discussion on Gross Regional Product (GRP) on page 4 are incorrectly presented, and very misleading. First, GRP is equivalent to a state's gross domestic product (GDP) and represents the market value of *final* goods and services. Including indirect and induced effects in GRP calculations (as noted beneath Table 1) is inaccurate and a poor use of multipliers and leads to substantial overestimates. In fact, intermediate inputs from other industries should be subtracted, not added (see BEA definition for state GDP).[12]

  Secondly, the UMD report states that, "Note that the GRP for the State of Minnesota was $281.1 billion. When compared to the State, mining GRP totals approximately 5.3% for 2010" (p. 4). At 5.3%, mining GRP for Minnesota in 2010 is presented as $14.9 billion. However, when we looked at the source presented in Table 1 (BEA Regional data), we find that for 2010, mining as a whole represented only $724 million of Minnesota GDP, or 0.3% of Minnesota GDP for that year ($268.6 billion). It is unclear how the numbers in the UMD report were derived. *This is a major discrepancy and leads to vast inflation of mining's importance*.

- The comparisons to the tourism industry GRP in Table 1 are also misleading, as they vastly under-represent the industrial sectors that combine to make up the tourism industry. The tourism industry is comprised of portions of multiple industries, making it difficult to assign a GRP value. The notes for Table 1, state that tourism was estimated from two IMPLAN sectors, "amusements, gambling, and recreation," and "accommodation and food services." This, however, does not capture all tourism products. A number of researchers have illustrated that additional sectors combine to make up the tourism industry.[13]

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[11] Some taxes may in fact be used to help clean up mine sites. But, the appearance is that a significant portion of mining taxes are spent on increasing mining development (e.g., funding university advocacy).

[12] The BEA defines gross domestic product by state as: "GDP by state is the value added in production by the labor and capital located in a state. GDP for a state is derived as the sum of the gross domestic product by state originating in all industries in a state. In concept, an industry's GDP by state, referred to as its "value added", is equivalent to its gross output (sales or receipts and other operating income, commodity taxes, and inventory change) *minus its intermediate inputs* (consumption of goods and services purchased from other U.S. industries or imported). Thus, GDP by state is the state counterpart of the nation's gross domestic product (GDP), BEA's featured measure of U.S. output." Italics ours.

[13] For example, Marcouiller, D.W. and X. Xia (2008. Distribution of Income from Tourism-Sensitive Employment. Tourism Economics. 14(3): 545-565), include those sectors listed as well as portions from the Retail Trade and Passenger Transportation sectors.

- The UMD report gathered all necessary inputs from mining companies and mining-associated organizations and agencies. Given that the report was prepared for these same groups, we believe that a more objective approach would include input from other perspectives, particularly those of sectors (industries, households) likely to be harmed by non-ferrous mining in the study region.
- An earlier version of the 2012 UMD report was released by UMD in 2009. The 2009 version appears to suffer from the same methodological failures detailed above. However, one note of interest is the major decrease in economic impact for both existing and proposed non-ferrous mining expansions. The direct employment in the region for non-ferrous on-going operations decreases from 531 in baseline 2007 (in the 2009 UMD report, p. 30) to 175 in baseline 2010 (in the 2012 UMD report, p. 20), or a 67% decline. While we question the accuracy of all estimates in the reports, this is a precipitous decline if taken at face value[14]. It is also emblematic of the lack of accuracy in UMD's projected economic impacts. Instead of gaining more than 2,000 direct jobs in the region that were supposed to be operational by 2013 (as projected in the 2009 UMD report, p. 32), the non-ferrous industry has been losing jobs. This issue also highlights the inability of I-O models, such as IMPLAN, to account for changes in production functions and technical coefficients.

7. Conclusion

After thoroughly reviewing the UMD report, we conclude that the study is deficient in a number of areas and suffers from fundamental flaws. We also conclude that even if accurate economic impacts were presented for potential mining expansion, they should be viewed as a small component of the overall costs and benefits to society. The public interest should be most concerned with the long-term consequences of mining development, the costs incurred, and opportunities that will be lost.

Finally, communities in Northeastern Minnesota should be very cautious in pursuing a particular economic development strategy. "If some is good, then more is better," is not always applicable. To wit, economic diversification increases community resilience in times of recessions and when exposed to the "bust" cycle of an important industry sector. If mining is indeed already 30% of gross regional product in Northeastern Minnesota (p. 4), a virtual doubling of direct mining jobs will render the region utterly dependent on a known boom and bust industry, decreasing its overall economic diversification. This is not a wise economic development strategy.

[14] We recognize a recession occurred during this time. However, baseline contribution of ferrous mining increased during this period.