Analyzing the Implications of a Change in Mining Regulations on a Small City Economy

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ABSTRACT

There is wide agreement that sustainability has multiple dimensions, but substantially less agreement on the appropriate balance among those dimensions. This occurs because peoples' vision of a sustainable future, their goals for sustainable development, and their objectives for resource management are reflections of their values, culture, and life experiences. Even assuming agreement about the objectives of sustainable resource management can be reached; there is still a need for policy and decision makers to choose from among alternative courses of action, each of which has its own set of impacts and outcomes. One of several tools used to compare the consequences of alternative actions is the Computable General Equilibrium (CGE) model. This paper uses CGE modeling to demonstrate how policy decisions do not take place in a vacuum and how policy-makers must be aware that there are trade-offs involved in any decision.

INTRODUCTION

Sustainable development, according to a common definition, strives to improve the economy, environment, and quality of life for the current generation, without compromising the ability of future generations to meet their needs. The foundation of sustainable development is reconciliation of a society's development goals with the earth's environmental limits (National Research Council [1]) There is broad consensus that we need to deal with the problems of persistent and widespread poverty, as well as a limit the intensity and spatial extent of human impacts on the environment (Lubchenco [2] and World's Academies of Science 2000 [3]). There is also recognition of the need to integrate human development for the present generation with development for future generations (Anand and Sen [4].)

These issues are urgent and complex, and in addition display a high degree of uncertainty (Moldan and Billharz [5]; Funtowicz and Ravetz [6]). Gunderson and Hollings [7] use the term panarchy to describe the evolving nature of complex and adaptive systems. They argue that systems exhibit endless cycles of growth, adaptation, restructuring, and renewal, and define sustainability as the capacity to create, test, and maintain adaptive capability. Panarchy acknowledges that sustainable development is not a process directed towards a simple, clearly articulated, permanent goal and that as a result, no single adaptation can guarantee sustainability because each is a temporary solution to changing selective conditions (Rammel and van den Bergh [8]). Rather, sustainable development is a process that must include new discoveries and deal with changing social values in an ongoing process of goal reformulation and response (TAB [9]).

At its core sustainability is value-based, and a stated desire for simultaneous equity, prosperity, and environmental protection represents an ethical position (Shields et al. [10]) Human values are context-dependent and there are multiple perspectives on what should be sustained, how, when, where, and for whom. Because we cannot sustain everything, everywhere, for everyone, across all of history and into the future, sustainable development requires choices and tradeoffs. As Lehtonen [11] notes, the key challenges of sustainable development are the synergies and trade-offs that occur at the interfaces within and between socioeconomic and biophysical dimensions.

Normative choices about the kind of society we want to live in and what we want to leave behind for future generations are made through open, public debate and political processes in democratic societies. Policies are then implemented to achieve the agreed-upon societal goals. The purpose of policy is to codify objectives in a manner consistent with the social and political system and also representative of the public's social value set (Shields et al. [10]). It is a connecting of desired ends with practical means, i.e., a course of action calculated to achieve a desired objective (Fenna [12]).

The overarching design requirements for sustainable development policies are to (Spangenberg [13]):

1. Integrate the environmental, social, economic and institutional objectives of society so as to exploit synergies and minimize trade-offs:
2. Coordinate between sectors of the economic and across levels of government;
3. Create policy processes, institutional settings and organizational structures that advance integration and coordination;
4. Introduce a normative orientation to policies on trade, development, social issues, and health so as to limit the transfer of externalities; and
5. Extend the policy perspective to include distant peoples and future generations.

Unfortunately, "introduction of the term sustainable development has by no means always been accompanied by an actual change in policy or that policy has failed to embrace the [above] approach in its full dimension" (TAB [9]). Rather than incorporating the characteristics listed above, existing policies tend to reflect the problems, objectives, issues, and interests of prior eras. They also exhibit what has been called path dependence, i.e., policy choices are extensions of existing modes of thought; what optimization and innovation that exists takes place within the existing development trajectory (Rammel and van den Bergh [8]). Moreover, most are focused on single issues and were designed using the tools of economic efficiency analysis.

This has clearly been the case for minerals. Looking back it can be seen that the U.S. government has pursued five general strategies to manage the nation's resources: conservation of natural material resources, protection of strategic resources, development of a comprehensive materials policy, regulation of minerals as environmental pollutants, and the management of materials markets (Geiser [14]).

The result has been a history of individual initiatives to promote resource development, stockpiling, and environmental regulation, limited attention to materials conservation, recycling, or detoxification, and "no such thing as an integrated national policy." (Geiser [14], p.161) Many of the policies were specific responses to spatially and temporally discrete problems (Dovers [15]). Sustainability includes such problems, but also is defined by problems that are multi-faceted, complex, spatially and temporally diffuse, highly interconnected with other issues, and capable of posing serious threats to production and consumption (Dovers [16]). Thus, sustainability will require new policies and policy instruments that respond to complex and broad scale issues of the present, while at the same time taking a long-term rather than short-term perspective. Individual policies will need to be consistent with sustainable development goals, as well as coherent and integrated across sectors (OECD [17]).

One conceptual tool for framing complex relationships is the social practices model. The social practices model is based on the idea that personal behaviors, including consumption practices, are not simply outgrowths of attitudes, but rather are the result of both lifestyle and the existing structure of the provisioning system. When viewed this way, sustainability goals such as minimizing the environmental impacts of daily activities ceases to be the sole the responsibility of either the individual consumer or the industry providing the goods and services to society. Using a social practices approach, it can be seen that shifting a lifestyle segment (clothing, food, transport, shelter) to a more sustainable path is feasible only when systems of provision offer consumers enabling choices (Spaargaren [18]).

There is widespread interest in developing policy responses to a variety of minerals sector sustainability issues, including waste disposal, resource recycling and reuse, detoxification, dematerialization, impacts of new materials and composites, energy intensity, pollutant emissions, land use, resource depletion, and visual impacts. At the same time societal issues such as poverty, unemployment, public investment, public participation, community resilience and social satisfaction cannot be ignored. Thus, prior to enacting legislation to implement policy, it is essential to know how the proposed change will affect the social economic and environmental sustainability goals.

In the next section of this paper we place aggregates supply in the context of a social practices model and then identify a possible policy to address one of the sustainability issues associated with the aggregates transport. We investigate the local economic impacts of the proposed policy using the results of a computable general equilibrium (CGE) model. We conclude with a few comments about the strengths and limitations of using economic models to test policy options.

PROBLEM CONTEXT

Societies require stable supplies of natural resources, including aggregates. Individuals, households, industry and governments have [derived] demand for aggregates because of their direct demand for shelter, economic development, and infrastructure. Aggregates are essential in construction, but their provision is controversial. Quarrying is often unpopular with the general public due to dust, vibrations, the unsightly nature of quarries, and the infrastructure wear, increased truck traffic, and pollution associated with aggregates transportation (Šolar et al. [19]).

In a social practices context, life style drives demand for things constructed using aggregates, but consumption choices are constrained by the system providing the resource. Either side of the model can be the focus of policy responses to sustainability issues associated with aggregates such as dematerialization and recycling, energy intensity, pollution prevention, resource depletion and land use. Assume the desire is to address concerns about the environmental affects of quarrying. Multiple responses are possible. The number permits for new quarries could be limited, potentially leading to more extraction at existing quarries or importation of construction materials. Alternatively, new regulations could be enacted that require a specified percentage of recycled aggregate in new construction.

We look at another aspect, the emissions and infrastructure impacts of aggregates transportation. Aggregates are most often transported by truck and, given the high volume to value ratio, large haul trucks are often used. Over time, the operation of these large haul vehicles can do significant damage to the transportation infrastructure, while the emissions from these vehicles produce negative health effects and reduce the aesthetic value of the surrounding environment. We are going to use a computable general equilibrium model as a predictive tool to analyze the effects of implementing a policy designed to diminish the infrastructure and environmental damage done to communities. The policy to be implemented will restrict the mining and transportation of aggregate materials to the local community.

THE COMPUTABLE GENERAL EQUILIBRIUM (CGE) MODEL

CGE models have been used to capture the inter-linkages that exist between the economic, social, and environmental aspects of a society for over four decades (O'Ryan, et al. [20]), with emphasis on the national and large regional issues, including trade, taxation, and income distribution. A lack of reliable and consistent data has prevented a thorough use of CGE analysis in smaller entities, such as cities (Partridge and Rickman [21]). However, through the use of available state and federal wage and tax data (ES202), input-output analysis, census estimates, county assessor's data, and local tax data, many of the obstacles previously have been overcome to a significant extent. Byers, et al [22] developed a CGE model to analyze proposed tax incentives in a middle sized city in northern Colorado, while and Cutler and Davies [23] used the city data to investigate the sectoral impacts of migration on income distribution. For this paper we have used the model developed by those mentioned above and augmented the mining sector to reflect a more mining-dependent community. We then used the CGE model to analyze the implications of imposing a local policy intended to promote one set of sustainable development goals (improved infrastructure and lowered air-borne emissions).

THE SOCIAL ACCOUNTING MATRIX (SAM)

	Expenditures								
		Productive Sectors	Housing Services	Factors of Production	Commuting	Households	Taxes	Gov't	ROW
REVENUES	Productive Sectors								
	Housing Services								
	Factors of Production								
	Commuting								
	Households								
	Taxes								
	Gov't								
	ROW								

Table 1: Social Accounting Matrix

The data for the CGE is first arranged in a Social Accounting Matrix (SAM) from which the GAMS software extracts it for use by the CGE model. The SAM is a double entry accounting system, in which revenue and expenditure flows in the economy are recorded. It is a static picture, or "snapshot", of the economy at a given point in time. The SAM in Table 1 records the monetary flows into and out of eight designated components or segments within the economy. The second row in the table presents these components of the economy that pay for goods and services (expenditures for products, transfers for taxation, and transactions in the financial components), while the second column in the table details the revenues received by the economy's components. In general, money flows from the components of the economy in the second row to components in the second column. Although no component of the economy will transact with other component, each will pay for goods and services produced in some other component(s) and each will receive payment for the goods or services they provide.

The productive sectors component of the SAM presents the purchases of intermediate and final goods in the product markets. There are twenty sectors within the productive sectors component, including sectors for agriculture, construction, manufacturing, mining, utilities, and finance, among others. Each sector may pay for goods and services received from any of the productive sectors (including itself). Every sector also needs to pay for factors of production (land, labor, and capital), transfers to social security, local, state and federal taxes, and for any imported goods or services. On the other side of the ledger, the individual productive sectors receive income from households, investment operations, state and local government activities, productive sectors (including themselves), and from those outside of the economy (exports). The construction and finance, insurance, and real estate (FIRE) industries also receive payment for the goods and services they provide to the Housing Services components of the economy.

The Housing Services component concerns the provision of residential dwellings. There are four Housing Services sectors - single family residences valued at less than $120,000, single family residences valued between $120,001 and $200,000, single family residences valued at more than $250,000, and multi unit housing (such as apartments). In addition to the previously mentioned expenditures for construction and FIRE, payments need to be made for value added contributions of land and capital. Payments made to Housing Services come from the six individual sectors within the Households component of the SAM.

The factors of production are land, labor, and capital. In this SAM, there are three sectors for labor, one for land, and one for capital. Each factor of production produces income for the six household sectors. Salaries and wages from the labor sectors provide some of the income to the households, while returns from land and capital result in the additional household income. Additionally, the three categories of labor make payments into the social security trust fund. All three of the factors receive payments from each of the productive sectors, while land and capital receive revenues for the contribution to housing services. The state and local government sectors provide wages (labor), but do not own land or capital so they do not provide payment to those factors.

The Commuting component of the SAM tracks income that originates outside of the economy and is paid to the households in the form of wages.

Taxes are transfers of funds from one entity (individuals or businesses) to another entity (governments). Social security taxes are paid by all employers in the private and public sectors and by each labor group. Personal income taxes come from the wages earned in the six household groups. The other taxes are paid by employers (private and public) and by the households. City sales taxes are received from the retail, eating, lodging, low services, and utilities production services. Received taxes are paid out for city, county, and state operations, including city general funds, police, fire, parks and recreation, and administration. Social security is paid to the individual household occupants and to STFED operations.

As mentioned above, household income comes mostly from the factors of production (wages from labor, rents from land and capital). Social security payments also contribute to household incomes (as mentioned above). In addition to these sources, those who commute out of Fort Collins to other areas for employment bring income back into the city. This money counts as a source of income.

The major sources of household expenditures are for goods and services from the productive sectors (purchases) and for taxes (personal income taxes, federal taxes, property taxes, and other city revenues). Also the households have expenditures for any investments they make (only the top two household income categories).

The various government operations make payments for the goods and services they purchase from the productive sector businesses. They also make payments for labor (wages) and social security taxes. The majority of the local government operations are financed through taxes that are collected by the city general fund and are then redistributed to the various governmental operations (police, fire, parks and recreation, etc.).

ROW – Rest of the World. This is the part of the economy where imports and exports are introduced. When the economy imports goods and services, money leaves the economy and when goods or services are exported additional money is introduced into the economy. All of the productive sectors import goods and services, while goods and services are exported from all sectors except housing services, taxes and local government operations.

THE DATA

The data compiled for this paper is for Fort Collins, Colorado, a medium sized city with a population of about 110,000 inhabitants. The city is located along the Front Range corridor about seventy miles to the north of Denver. Data gathered for the model came from a variety of sources. IMPLAN, an input-output analysis program was used to help determine household purchases and intermediate goods purchased by the productive sectors. ES-202 data and the unemployment insurance database are used to determine the number of workers in each sector and the wages paid to each worker. The identity of the workers cannot be identified using this data. Land data, including the zone and tax rates are kept by the Larimer County Assessor's Office. This data includes the acreage on each property and the value off the property. Additional income data is found at in the Regional Economic Accounts of the Bureau of Economic Analysis. Distribution of labor income is determined by the Colorado State Demographer's Office. Financial data on Fort Collins governmental agencies were found in the Consolidated Annual Report (CAFR) for the city.

THE RESULTS

We have prepared and run two simulations. The first simulation is a reference case, where the city has not imposed a restriction on local mining operations. The second simulation is when a mining restriction policy is implemented. The policy prohibits the exportation of most aggregates mined in Fort Collins, in effect eliminating a portion of the available demand from the local mining industry. The goal is to reduce damage to the city's transportation infrastructure and also reduce the pollutants that are emitted into the environment.

Effects on Employment and Wages

The most immediate effects of the implementation of regulations requiring local production of aggregates are the changes in employment and wages in the community. The loss of export markets for aggregates necessitates a reduction in local production of the commodity, which in turn results in the loss of local mining jobs. Under the reference case scenario, there are a total of 1300 people employed in the aggregate-dominated mining industry. When confronted with the lower demand for its product the mining industry loses 920 jobs. However, the community as a whole loses only 635 jobs, with the remaining 285 being absorbed back in the local workforce. This result is contrary to those seen in other sectors of the economy, where employment losses in a particular sector most often lead to additional losses throughout the city's other sectors. As an example, with a similar loss in the number of manufacturing jobs (920), the city's employment sectors are unable to assimilate those workers. The end result is that, unlike the mining sector, when manufacturing's demand for labor declines, the city loses not only those jobs, but the ensuing economic conditions dictate the loss of additional employment. The difference in the ability to absorb the unemployed personnel into the local economy may be the result of the relative wages and skill sets required to work in each sector. The majority of the lost mining jobs (530 jobs or 58%) are held by low skill, lower wage workers, those making less than $20,000 per year (designated as L1). 284 of the eliminated jobs (31%) are lost to those earning between $20,000 and $50,000 (L2), with the remaining 106 lost jobs (11%) belonging to those earning a salary in excess of $70,000 (L3). The percentage of the manufacturing workers in wage group L1 (48%) are much smaller than seen in the mining sector, while the percentage of the manufacturing workforce in labor group L2 is ten-percent higher than in the mining sector. Low wage, low-skilled workers are relatively easier to find than those with higher wages and more specialized skill sets. This combination makes it more difficult for many of the unemployed mine workers to relocate to similar positions elsewhere, whereas the higher wage and presumably higher-skilled workers in manufacturing are in greater demand and may relocate more easily.

As a consequence of the former mine worker being less willing or unable to find comparable work elsewhere, they may elect to stay in the community. One impact of these additional workers on the general workforce is to create a downward pressure on wages community-wide. As the former mine workers enter the market for other jobs in the community employers may find increased competition for many jobs. The increased supply of labor combined with a relatively unchanged demand for workers may enable existing businesses to offer lower wages or delay increases in wages. Throughout the community, wages in each of the labor groups falls, with the most significant decline (approximately 2%) occurring among the lowest paid workers (L1). When the lower wages are considered along with the 635 jobs lost throughout the community the economy loses approximately $19 million in labor wages.

With the decline in the work opportunities in the city 98 more workers are forced to commute out to find employment, while 41 fewer workers commute in from outlying areas. These changes also contribute to the total amount of lost wages in the community and to lost income for businesses that no longer have the commuters spending locally. Additionally, the increased number of residents commuting out of the city to find acceptable employment contributes to increased costs to society and the individual. These costs include greater levels of pollution, increased infrastructure deterioration, and productivity and leisure losses due to workers spending a greater amount of time in transit. The workers are also faced with increased monetary costs and psychological costs associated with driving more. Among those costs are increased amounts of money for operation and "wear and tear" on the vehicles being driven, psychological well-being, and the lack of leisure time.

Effects on Households and Housing

As the employment base in the community declined, the number of households in the community also dropped from the 40,119 (in the reference case) to 39,970, a net loss of 149 households. The resulting loss of wages, land, and capital income generated by these 149 households results in a decrease in community income of $13.8 million, with almost half of the losses ($6.4 million) coming from the highest income housing group - those whose incomes exceed $70,000 annually. The drop in the number of households may also create a surplus of housing in the area, which may depress housing values. The decline in housing values may adversely affect the social and financial well-being of the remaining residents in the community. Housing values are used to determine the amount of property taxes to be collected from city residents. Among other uses, property taxes are a significant source of revenues for public schools in the community. If the taxes collected do not meet the necessary levels of funding for schools then city officials would be forced to raise the property tax rates, find some other source of funding the schools, or reduce school services. Any of these alternatives will lead to the diminishing of community well-being. Additionally, there is a cost to the homeowners in the community, as a decline in housing values will decrease their wealth and negatively impact personal and community financial well-being.

The decline in the number of households and the ensuing financial impact on the homeowners and educational services is only one part of the changing dynamics of the community. The other element to be considered is the increase in the number of non-working households versus the number of working households. A non-working household is one in which no individual in the household is employed, either a full-time or part-time. Members of non-working households may be retired, students, or unemployed. While there was a net decline of 149 households in the community as a result of the policy changes, there was a decline of 263 working households and an increase of 115 non-working households. The overall drop in households, coupled with the increase of 115 non-working households creates additional stresses on the community and state support systems. Not only are there more households that may be in need of assistance, there are now fewer working households available to support them.

Effects on Demand and Supply

The demand by local businesses, residents, and governments for goods and services produced in the community would fall by over $16 million if a policy limiting the majority of sales of the mining industry commodities to the local community is implemented. Despite not having any restrictions placed on the ability to market its product locally, the mining industry would experience the greatest loss of sales, falling by approximately $5 million, from $86.6 million to $81.6 million.

Under this scenario, out of the twenty productive sectors, only the agricultural production, agricultural services, and computer manufacturing would experience an increased demand for their products. Overall, for the productive sectors, the demand for locally produced intermediate goods and services would be expected to decline by $4.0 million. The expenditures by households (local residents) for locally produced goods and services would fall by $7.1 million dollars under the policy change, with the 63% of the decline seen by those earning more than $70,000 ($2.80 million) and those earning between $20,000 and $40,000 ($1.65 million). Local government expenditures would decrease by $129,000, with purchases by the city transportation and city administration sectors accounting for over two-thirds of the decline. However, expenditures by state and federal government agencies on locally produced commodities would fall by over $4.8 million under the policy. The limitations imposed on spending by these agencies may in turn limit the services they can provide.

The supply of locally produced goods and services would be expected to decline by $18.7 million under the policy change. However, the local mining sector supply would fall by about $31.5 million, meaning that the other twenty-three sectors combined would see a net increase of $12.8 million in their outputs. Besides mining, the only sectors that should anticipate supply reductions are those less likely to have a strong export outlet for their goods and services (restaurants, housing services, and elementary and secondary education). The increase in supply of goods and services is driven by increased demand for exports from the productive sectors. The lower wages and lower land costs translate into lower production costs and lower prices for potential customers, making the goods and services produced in the community attractive to those outside of the community. Due to the restrictions placed on the mining sector, industry exports would drop by $36.7 million (from $51.2 million to $14.4 million). All other sectors would show increases in their export trade and combined would have an increase of $13.1 million after the policy change. When the losses from the mining sector are added to the export gains from the other productive sectors, the economy would experience a net loss of $23.6 million in the demand for exports.

Effects on Public Sector Service

Taxes are the "lifeblood" of a city, since without tax contributions it would be impossible to provide the community with the services that the residents desire. Under the restricted mining scenario discussed in this paper, tax collections from four of the five city sources (sales tax, property taxes, use taxes, general fund taxes, and other revenue sources) would be decreased by approximately $720,000. These taxes would be used to finance almost all city operations, from street paving to police and fire operations to parks and recreation upkeep any many other activities. The loss of these funds would force either a loss of services or an increase in existing tax rates in order to maintain the existing level of services. In either case, there may be a negative impact on individual and community well-being.

CONCLUSION

Personal lifestyle choices and corporate business decisions affect environmental and social sustainability. Conversely, institutional systems affect personal choices, business decisions, and environmental sustainability. In addition, policies intended to affect any aspect of personal or corporate behavior, the economy, or the environment will inevitably affect all four domains.

Because achieving sustainability goals is easier in the presence of a vibrant economy, it is essential to determine à priori how policies designed to address issues in the minerals sector will impact the economy. This concern about economic vitality must also be tempered with the knowledge that although a strong economy is necessary to the satisfaction of material needs and to fund environmental protection, it is not sufficient to ensure sustainability (Spangenberg [19]). Wealth is a tool rather than an end in and of itself, one that can be used to achieve objectives related to the quality of the lives people lead, the opportunities they have to participate in society, and the manner in which they interact with and affect the environment (Anand and Sen [4]).

We have endeavored to analyze the trade-offs to a policy that could be used to address community sustainable development issues by limiting some of the negative impacts of aggregate mining in a medium sized city. As there are no "free lunches", there are also no policies that are without their own set of negative consequences when implemented. The idea of CGE analysis is to provide one more tool for decision-makers and interested stakeholders to use when trying to find the "best" solution to community problems. However, CGE modeling, like all other tools, is not "foolproof" and should not be used alone when making decisions about future courses of action.

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