

Public and Private Sector Coordination for Effective Lunar Resource Use

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Abstract. Government may impose inefficiencies on the private sector to achieve social goals. By implementing a framework which creates technological obstacles and allowing affected businesses to resolve those obstacles in whatever manner they choose, government authorities may create a fair and consistent regulatory environment for the private sector while stimulating solutions for commercially unviable technologies, such as human spaceflight.

HARNESSING SELF-INTEREST FOR THE BENEFIT OF SOCIETY

Embodied by private-sector businesses, market capitalism has demonstrated that individuals working towards the satisfaction of their own interests will, over time, coordinate among themselves to create a self-directed system for the efficient delivery of goods and services desired by a nation's citizens (Smith, 1904). Although it has its imperfections, free-market capitalism has proven itself to be the most effective model of co-operation now available to the human race by dramatically expanding the resources available to western nations while continuing to reduce associated costs as efficiencies are improved.

While the profit motive embodied by private sector businesses fosters operational efficiency, it is also very good at resolving inefficiency: When forced to overcome inefficient restrictions imposed by a third-party, private sector businesses will strive to minimize the costs associated with those restrictions and deliver the best possible solution available under the circumstances. Government regulation, trade tariffs and taxation are the mechanisms through which society imposes inefficiencies on the private sector and this often creates an adversarial relationship between businesses and the government agencies which regulate their actions. However, if this friction is properly managed, the result can improve the effectiveness of private sector markets and the manner in which they serve society. Although imposed inefficiencies often increase the costs borne by the citizen customers of business, it is often through the resolution of imposed inefficiency that the private sector delivers its greatest benefit to society.

The way in which the government of the United States applied environmental regulation to the automobile industry provides a good example of how regulation can guide the development of private sector industry for the benefit of society. Through the 20th Century, tremendous efficiencies were gained in the automobile industry in North America, with industry consolidation and manufacturing improvements reducing the cost of automobiles to the point where almost every North American family could acquire one. However, other aspects of the "car culture" harmed society in general; with emissions from automotive exhaust and waste from the manufacturing process harming the environment and health of the nation's citizens.

To correct this discrepancy between the objectives of business and those of society as a whole, the United States government introduced environmental legislation such as the 1965 amendment to the Clean Air Act, the Motor Vehicle Air Pollution Control Act (U.S. Gov., 1965), which established standards for automobile emissions. However, rather than mandating how businesses were to go about correcting the problems

faced, the legislation indicated only what the environmental objectives of industry were to be; leaving individual businesses to apply their knowledge to the industry they knew best and devise solutions in their long-term interest. Faced with this new set of inefficiencies mandated by government, the automobile industry created a set of effective, long-term solutions which would address the new emission restrictions with a minimal impact on their customers. Although the inefficiency of environmental regulation was addressed by automobile manufacturers within a few years, the resolution of this new problem continued to improve over time; with the profit motive of the capitalist system encouraging affected private sector businesses to strive towards finding the most effective and least expensive solution available in order to maximize the profitability of their companies. Private sector companies did not remain satisfied with a solution which merely addressed the legislated requirements: Their own self-interest ensured that they would continue to strive towards finding the most effective and least expensive solution available. The results of this legislated innovation and the business self-interest which overcame it are the catalytic converters, cleaner burning fuels and more efficient engines society enjoys today, with stronger contemporary environmental legislation, such as the Low Emissions Vehicles program initiated in 1990 by the State of California, now spurring the development of zero-emission electric and fuel-cell vehicles.

As private sector companies move beyond Earth, inefficiencies may be imposed by government in a similar manner to direct industry towards providing the solutions desired by society. By harnessing the directed self-interest of private sector companies, governments may continue in their ideal role of developing social policy while leaving the specific implementation of that policy to the businesses which are best at it.

Beneficial Inefficiency in the Claim of Lunar Resources

On Earth, the process of establishing claim to resources not only defines the territory of interest, it also transfers the risk and expense of exploration to the claimant, with an often expensive process of surveying and exploration performed before a claim may be defined. As a claimant is rarely certain of the presence of resources in a given territory, they are assuming a significant risk that their invested capital will be wasted if targeted resources are not discovered in marketable quantities. As the claimant is unlikely to expend significant effort to transport people and equipment to a remote location to perform a claim survey if they do not plan to profit from the activity, this process demonstrates an intent of use and encourages a claimant to seek claim only in those areas from which they are likely to benefit. This self-enforced efficiency also assures a government agency that an accepted claim is likely to be developed, with the resources of the claim benefiting the government's citizens and coffers through tax revenues and infrastructure created in the area of development. Even in cases where robotic telepresence is used on Earth to examine and stake claim to resources under the sea, the effort required to transport robotic equipment and the technically trained staff who will operate it to the area of claim is an expensive endeavour unlikely to be pursued by those who have no interest or ability to extract the resources under claim.

However, unlike Earth-based resources such as oil, gas or precious metals, the value of lunar resources is often derived from the geography of the mass in question and not necessarily the quality of its content. Given the tremendous cost involved in transporting each kilogram of mass to the Moon, even unrefined lunar regolith may find a market as radiation and debris shielding (O'Dale, 1998), with that material easily viewed from a distance and surveyed at little cost using remote instrumentation. Detailed lunar resource maps constructed by remote sensing satellites and the lack of obstructions, such as vegetation or a measurable atmosphere, may also reduce the risk assumed by a claimant when exploring a given area for a specific resource and enable them to stake claims to territory in which they are certain to find significant quantities of a desired material.

Presuming sensor, computing and communication technologies continue to improve, it may be possible to develop a set of low-cost remote sensing platforms which could be transported to the lunar surface for only a few million dollars. Remotely surveying a territory to identify regions which have a high probability of containing valuable deposits of water ice or He3, a robotic surveying "swarm" could specifically target an area of interest and, using the precedents for establishing claim via robotic telepresence of under-sea resources on Earth (White, 1991), claim development rights for resources which have a potential value of tens of billions of dollars after expending only a few hundred thousand dollars in effort to secure those

rights. With robotic systems reducing the threshold of risk and difficulty in the claims process for each potential dollar's worth of space resources, this increases the possibility that claims will be submitted by poorly-planned businesses which lack the capital to adequately utilize claimed resources, monopolists seeking to lock out competition by pursuing large-scale "land grabs" or gadflies establishing claims without a genuine interest in development.

As with past development of new territory on Earth, these issues could likely be resolved through a clarification of the claims process; with new regulations limiting claims to those companies with a demonstrated capability to develop lunar resources. However, it may also be possible to develop an effective claims process through the use of market forces, using legislated inefficiency to prove intent of use while furthering societal goals through the development of industry.

Demonstrating Ability and Intent Through Human Spaceflight

Although human spaceflight is a desirable goal from a social perspective, it is difficult to justify economically. From communication satellites through to orbital astronomy and planetary exploration, robotic systems have shown themselves capable of performing tasks which once required people on-site. Disposable and requiring no infrastructure beyond that needed for the immediate task at hand, robotic systems have been gradually replacing the role of humans in space and technological advances may be expected to continue that trend -- with human beings left in a supervisory role on Earth.

Presuming it is desirable for society to establish and maintain a permanent presence of human beings in space, this economically impractical objective could be incorporated into private sector development by making human participation an essential component in the claim-staking process for off-Earth resources. Given the objective of setting a policy which would, with minimal bureaucracy and effort, identify those claimants best able to develop resources of the Moon, regulatory agencies could impose a financial and technological hurdle over which interested private sector companies must pass before they would be able to stake legal claim to lunar resources. As with the imposed inefficiency of automobile emission reduction, private sector companies would not be told specifically how to overcome this hurdle: Their only concern would be to develop the most effective means of resolving this externally imposed task.

Introducing a human component to the lunar claims process, a potential claimant would be expected to:

- Deliver one or more human surveyors to the territory being claimed;
- Have these surveyors stake claim markers to define each square kilometer of territory; and
- Return the surveyors to Earth with a physical sample of material from each staked location.

Given the tremendous expense involved in transporting a human being to the Moon, only those companies interested in developing a resource claim would expend the effort to do so. The agency issuing the claim would thus be assured that the claimant had sufficient resources to develop the area of interest since, if they were able to deliver at least one human being and all related support infrastructure to the territory, the company could also be assumed capable of delivering whatever robotic or human-tended mining equipment would be required to harvest those resources. This inefficiency would also limit the speed with which the claims process proceeded (and so reduce the likelihood of 'land grabs' from early movers) while reducing or eliminating the number of claims to be expected from gadflies and other parties with no serious interest in claim development.

Since it is in the best interest of any private sector company to reduce their operational costs, market forces would be brought to bear upon the now essential activity of human spaceflight. With a clear profit motive directed towards developing the most effective and least expensive mechanism possible for transporting humans to and from areas of territorial claim, technologies related to human spaceflight would continue to be improved over time and, much like the technologies for reducing automobile emissions, produce novel and innovative solutions to resolve this imposed inefficiency.

As human spaceflight technologies improved and the number of companies capable of overcoming the initial hurdle for claims grew, government could re-visit the requirements for the claims process and increase the degree of human participation required for the enterprise. Much as progressively strict regulation for automobile emissions have spurred the development of zero-emission electric and fuel cell vehicles in the State of California, so too could stronger requirements for human participation in commercial lunar development work towards establishing a permanent off-Earth infrastructure for the support of lunar settlers; thus achieving the social objective of a permanent human presence in space while providing private sector businesses with the flexibility needed to develop the best means of doing so.

Resource Development for the Benefit of Humanity

It is often expressed that space resources belong to all of the human race, should not be considered the property of any one nation and that all people should benefit from their use. This concept is documented in Article 11 of the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (the "Moon Treaty"), in which it is stated that "The moon and its natural resources are the common heritage of mankind" (U.N., 1979) and further that "Neither the surface nor the subsurface of the moon, nor any part thereof or natural resources in place, shall become property of any State, international intergovernmental or non-governmental organization, national organization or non-governmental entity or of any natural person" (U.N., 1979).

Even if the restrictions of the Moon Treaty were adopted by all space-faring nations, careful thought to the establishment of the "international regime" referred to in the treaty to manage these shared resources would doubtless create a mechanism to allow private sector businesses to develop space resources in some capacity. However, while a policy directed by the Common Heritage of Mankind provision of the Moon Treaty would ensure that a handful of nations did not own the resources of the Moon, it is not clear that the intent of the treaty -- that the resources of the Moon and space be used for the benefit of all humanity -- would be achieved. Aside from producing a semantic stumbling block around which nations and businesses would have to operate to ensure they were not declaring territorial ownership, a lunar development policy directed by the Common Heritage of Mankind provision may leave the human race (outside those involved with lunar industry) no better off than if businesses were operating without such an agreement. Thus, while the Moon Treaty would impose a legislated inefficiency on business and create an adversarial friction between the public and private sectors, it is not clear that society would meaningfully benefit from it.

On Earth, mechanisms have been put in place to ensure that a nation's citizens are fairly compensated for resources used by private sector companies; one of which, the Alaska Permanent Fund Corporation, may provide an example framework for re-distribution of wealth to the citizens of Earth. The concept behind the Permanent Fund is that a state's resource wealth should be distributed to its people such that all citizens directly benefit from the extraction and use of those resources (Birdsall, Subramanian, 2005). Created as the constitutional amendment Article IX, Section 15 of the State of Alaska, the amendment states:

"At least twenty-five percent of all mineral lease rentals, royalties, royalty sales proceeds, federal mineral revenue-sharing payments and bonuses received by the state be placed in a permanent fund, the principal of which may only be used for income-producing investments." (State of Alaska, 1977)

With the earnings from those investments distributed annually to each qualified resident by cheque. Thus, the citizens of Alaska see a direct benefit from use of their resources, businesses are provided with certain claim to territory and the regulating government is not encumbered by a complicated mechanism of wealth distribution.

Considering the Alaska Permanent Fund Corporation as a successful example of wealth distribution, if space resources belong to all of humanity, could a similar mechanism be created to ensure the resources of the Moon benefit all people of Earth? By following Alaska's example of providing businesses with clear title to land while delivering direct benefits to its citizens, a "Space Dividend Fund Corporation" could be

created to provide all human beings with a benefit from the use of space resources. However, rather than using generated capital to distribute cheques to every individual human being, the corporation could instead be used to finance activities which would directly benefit the people of Earth.

Creation of a Space Dividend Fund Corporation

The core purpose of a Space Dividend Fund Corporation would be to ensure that private sector companies are provided with clear title to developed territory for the duration of their claim while exercising the spirit of the Moon Treaty to provide benefits from those resources to all of the human race. Section 7 of Article 11 of the Moon Treaty describes the creation of an “international regime” to oversee the development of lunar territory as follows (U.N, 1979):

The main purposes of the international regime to be established shall include:

1. The orderly and safe development of the natural resources of the moon;
2. The rational management of those resources;
3. The expansion of opportunities in the use of those resources;
4. An equitable sharing by all States Parties in the benefits derived from those resources, whereby the interests and needs of the developing countries, as well as the efforts of those countries which have contributed either directly or indirectly to the exploration of the moon, shall be given special consideration.

Points 1 through 3 of this section may be resolved through government regulation of the private sector, as is done on Earth today without need of a centralized international regime. However, it is the “equitable sharing” noted in point 4 which the Space Dividend Fund Corporation seeks to address.

Although the private sector does an excellent job of addressing issues for which there is a market for their resolution, many of the major problems faced by the people of Earth are not adequately resolved by free market capitalism. Ushering in a new age of philanthropy, organizations such as The Bill & Melinda Gates Foundation have been established to address this discrepancy and use the profits generated from their various commercial endeavours to resolve issues of human development. Self-funded from an endowment of approximately \$28.8 billion (U.S.) (BMGF, 2005), the Gates Foundation has been able to direct its attention to those areas in which it believes the greatest positive impact can be made. Having produced measurable results in the reduction of malaria, tuberculosis, HIV/AIDS and multiple other issues affecting developing nations (BMGF, 2005), this private sector charity provides an excellent example of what can be accomplished when significant capital resources are combined with the freedom of action and organizational expertise of the private sector to address issues of human development.

Providing lunar industry with clear title to territory in exchange for funding a benefit to society, an independent Space Dividend Fund Corporation financed by the profits of lunar industry could be established and operated with an objective of “doing the most good” on Earth. Rather than providing bartered space technology “spin-offs” to those not directly participating in space industry, the Space Dividend Fund Corporation would use capital set aside from lunar-derived profits and, following the example of private multi-billion-dollar “mega charities” such as the Gates Foundation, directly address the issues of disease, malnutrition and climate change which ravage the planet. Freed from the difficulties of irregular funding and changing policy targets which government-funded charitable operations face today due to international political disagreement, changes in direction from elected national representatives and variable economic cycles, the Space Dividend Fund Corporation could implement its objectives with the consistent, multi-decade schedules which are required for the effective resolution of issues such as disease eradication, water quality and third-world education.

Incorporated into terrestrial tax treaties to ensure that contributions to the fund would neither amount to a tax on lunar development nor affect existing national tax revenues, the capital resources available to the Space Dividend Fund Corporation would grow with the success of space industry. By establishing fund contributions as a fixed 25% of tax paid by space-based companies to their respective national

governments, private sector space industry could deliver consistent benefits to the developing nations of Earth through the fund while being left free to maximize their profitability in whatever manner they deemed best. Operating from a pool of capital independent of terrestrial sources, a Space Dividend Fund Corporation would harness the new space resource of private sector profits for the benefit of all the human race and provide a clear answer to that oft-heard question: "What good does space exploration do for Earth?"

CONCLUSIONS

Inefficiencies forced upon the private sector by national governments have proven to be a successful mechanism for implementing social policy on Earth. This same strategy may be utilized in space to bring about desirable but economically impractical objectives such as a permanent human presence on the Moon. Legislating a mandatory human component to the lunar claims process would make off-Earth spaceflight a permanent part of space business while creating an inefficiency which limited participation to those companies with sufficient capital and infrastructure to pursue the activity. As with imposed inefficiencies of the past in areas such as the reduction of automobile emissions, the private sector would be encouraged by their own profit motive to develop the most effective infrastructure possible for cis-lunar human spaceflight and habitation.

To provide lunar industry with clear title to territory and resources while ensuring the Moon's wealth is used for the benefit of all humanity, a Space Dividend Fund Corporation could be established to follow the same wealth-distribution example as that successfully employed by the State of Alaska's own dividend fund. Financed from a percentage of tax revenue generated by the profits of lunar industry, this corporation may follow the successful example of private sector "mega charities", such as the Bill & Melinda Gates Foundation, to directly address issues faced by developing nations; among those being the eradication of preventable disease and the development of social infrastructure. Instead of providing bartered "spin-offs" to various unrelated parties, lunar industry would use the new space resource of private sector profits to deliver direct assistance through its Dividend Fund Corporation to developing nations and address issues of global concern. Providing lunar industry with property rights while delivering an unquestionable benefit to the planet, such an arrangement would provide a clear answer to the question "What good does space exploration do for Earth?"

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