

Cato Institute Policy Analysis No. 69: An "Industrial Policy" for Space?

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Executive Summary

There is perhaps no public policy issue today that is more important, more widely discussed, and yet more misunderstood than the commercialization of outer space. For an issue of such enormous economic and national-security significance it is also, oddly enough, relatively noncontroversial. Judging from the public debate, it would seem that everyone is "for" it and looks with eager anticipation toward the technological innovations, jobs, and profits that space commercialization appears to promise. The rise of high technology, the commercial success of the satellite-communications business, the reelection in 1984 of a president with seemingly unbounded confidence in American ingenuity and a determination to make this nation "Number One"-- all have aroused great expectations regarding the potential of U.S. business in the far reaches of the Last Frontier. They have also resulted in a commitment to the space program, in the form of continued space-shuttle flights--despite the Challenger disaster--and the development of a manned orbiting space station. Finally, they have resulted in a national commitment to the "Star Wars" anti-missile defense system.

"The benefits our people will receive from the commercial use of space literally dazzle the imagination," President Reagan declared in July 1984.

We can produce rare medicine with the potential of saving thousands of lives and hundreds of millions of dollars; we can manufacture superchips that improve our competitive position in the world computer market; we can build space observatories enabling scientists to see our way to the edge of the universe; and we can produce special alloys and biological materials that benefit greatly from a zero-based gravity environment.[1]

Not to be outdone, Milton R. Copulos of the Heritage Foundation has proclaimed that space commercialization will herald an era of economic growth and opportunity "unparalleled in our existence," constituting a "revolution whose benefits could bring a new era of prosperity and peace to mankind." [2]

If the enthusiasm of the business community itself is any indication, there is indeed reason for optimism. Space, after all, is already big business--for companies receiving federal subsidies. The federal government, which dispensed \$11 billion to contractors involved in space-related activities in FY 1984 alone, has amply demonstrated its willingness to subsidize firms eager to work with the National Aeronautics and Space Administration and the Department of Defense to develop the expanses of outer space.[3] Much of the money for it comes directly from Washington or flows from companies that use the shuttle and pay below-market prices to NASA in return.

NASA, carrying out Reagan administration policy, is moving forward in its efforts to help favored private companies use the space shuttle for space-based manufacturing and research purposes, and dozens of firms are eager to realize the

profits to be made in private rocket-launch services. Satellite communications, an industry brought into existence by federal subsidy, generates \$3 billion a year. Remote sensing (the use of satellites to detect conditions on earth) and materials processing (in which drugs, alloys, and crystals are produced in weightlessness) will soon become moneymakers themselves. Moreover, construction of the "infrastructure" of space--outer-space industrial parks with energy-generating plants, inventories of spare parts, launch systems, and the like--also represents an enormous commercial undertaking.

Space commercialization, in other words, is a reality. Even so, countless questions regarding the nature of its development--especially whether it should be directed by the federal government or by the private sector--remain unanswered. As will be shown, the intellectual and public policy environment in which these questions will be decided is not, at this time, a promising one for making progress toward a free market in space. Of the policy recommendations under consideration, almost all would strengthen the federal government's domination of space commercialization. Federal control represents a serious obstacle to true commercialization, if by that one means a business environment in which the forces of the market, not the whims of the federal government, dominate. Complicating the picture still further, patterns of government policy inimical to a private-sector space industry are already in place, and their removal is almost invariably opposed by the most articulate proponents of the development of space as a center for commercial activity.

The Potential for Space Commercialization

Although there is no way to determine the commercial potential of space with any accuracy, it is significant as a guide to public policy that the estimates offered by industry experts vary enormously. Dozens of industry spokesmen, tantalized by the prospect of huge space profits, have paraded before congressional committees to present the conclusions of presumably serious investigations into the potential volume of space business. All have presented their findings with remarkable certitude. Yet the vast discrepancies suggest that these calculations would make a poor basis for policy choices, especially given the inherently speculative nature of space commercialization.

The most recent congressional hearings on space commercialization were conducted in June 1985 by the Subcommittee on Space Science and Applications of the House Science and Technology Committee. Vice President Mark Oderman of the Center for Space Policy, a consultant to private industry, the financial community, and the government, presented the results of his organization's "overview market study for commercial space in the year 2000" to the subcommittee on June 18. "Our overall projections show that the total commercial revenues will range from a low of \$16.8 billion to a high of \$51.3 billion (\$1985) by the turn of the century," Oderman said.[4]

Jerry Grey, publisher of *Aerospace America*, has stated that in satellite communications alone annual revenues will range from \$40 billion to \$100 billion by the year 2000. Materials-processing will account for another \$10 billion to \$20 billion, launch services for \$5 billion, NASA for \$8 billion, and military operations for perhaps \$25 billion. With remote sensing added in, the total comes to between \$100 billion and \$200 billion.[5]

Milton Copulos finds these predictions unreasonably pessimistic. Comparing space commercialization with "industrial revolutions before it," he has written that the advent of space- based manufacturing could herald an era of extraordinary economic expansion.

By the year 2000, those space-manufactured products already planned are expected to generate annual sales of over \$65 billion. Taking into account other space products that are sure to be developed, space commerce by the end of the century could reach \$200 billion a year. As man's experience in space grows, and his understanding of its potential increases as well, by the year 2010, space-based space-related enterprises could add between \$500 billion and \$1 trillion to the U.S. Gross National Product.[6]

Some industry experts, however, are less certain of what the future may hold. Citing studies by Data Resources, John Egan of Coopers & Lybrand told the House subcommittee that "the aggregate of U.S. businesses . . . doing work in space may be 20-30 billion dollars by the year 2000. It is also possible that it may be 2 to 5 times that or more. It is also just as possible that it may be 2/3 or 1/4 of that size." [7] Gregg Fawkes of the National Chamber Foundation, the research arm of the U.S. Chamber of Commerce, predicts that by the year 2000 profits from space commercialization "will probably be something nobody's even thought of yet." [8]

The Goals of Space Commercialization

In order to realize these economic possibilities, the Reagan administration, working with NASA and private industry, has adopted a national space-commercialization policy. The policy was unveiled in the president's January 1984 State of the Union message and elaborated in subsequent months. Key elements of the program include the development of an orbiting and permanently manned space station within the next decade to serve as a base for commercial activities, and the removal of regulatory disincentives to private-sector activities to encourage industry to engage in outer-space commercial ventures.

Specifically, the administration's policy goals, as outlined by Deputy Assistant Secretary for Oceans and International Environmental and Scientific Affairs Harry R. Marshall Jr., include transferring ownership or management of government activities to commercial industries; expanding existing relationships between government and industry in space endeavors; freeing private enterprise from unnecessary government regulations; and ensuring access to tax incentives available to other business sectors.[9] The heart of the Reagan space-commercialization policy, however, is the \$45.8 million in the FY 1987 budget targeted specifically for space commercialization, plus the \$9.6 million targeted for NASA's Technology Utilization program.

The combined effect of these efforts is thoroughly antithetical to a free market in space, since a large part of the program consists of increasing funds for NASA so that it can dispense money to favored corporations. Space-commercialization policy, in this regard, is not unlike those notorious foreign aid programs in which, to bolster a Third World country's private sector, tax dollars are given to its government. The federal government, in this scheme, also functions as a powerful bureaucratic middleman whose decisions are based on political considerations, not market conditions.

Government Subsidies and Risk Mitigation

The administration's space-commercialization policy is, of course, entirely satisfactory to the space-commercialization lobby, which is composed primarily of recipients and potential recipients of federal money united in their desire to mitigate risk. Although proponents seem convinced that profits from the industrial development of the Last Frontier will be tremendous indeed, they show little inclination to assume the risks that must be taken if those profits are to be realized. Federal policy, moreover, is geared to mitigating those risks by reducing private investment.

NASA funding to promote space commercialization goes largely to bankroll research that private industry says it cannot afford to conduct on its own. When commercial ventures need industrial facilities "they could not fund privately," Craig Covault reports in *Commercial Space*, "NASA will fund such apparatus to stimulate commercialization." Furthermore, NASA "will start to distribute seed money to space ventures as long as those ventures bring to the project a large amount of capital of their own to risk . . . to help mitigate risk whenever it appears that such an investment could play a critical role in bringing new endeavors to a profitable operation." [10]

It is this seed money that is responsible for the entry of major corporations now leading the way in space commercialization. Most of these firms are large military contractors--McDonnell Douglas, RCA, Hughes Aircraft, Ford Aerospace, General Dynamics, and others[11]--that agreed to participate only after the federal government announced it would subsidize their activities. According to Covault, "The large aerospace companies exist almost entirely on government contracts, and when there was no money to be made by investing their own capital, they had no interest in undertaking such risky investments. Now they are starting to make those investments." [12] Prior to the subsidies, McDonnell Douglas, with its joint program with Johnson & Johnson on the biological separation in orbit of drug materials, was the only large U.S. aerospace company involved in space commercialization. Since then, Grumman Aerospace Corp. has signed with NASA to negotiate a joint endeavor aimed at flying a large research-materials processing furnace in the space shuttle, and Rockwell International has signed a similar agreement for flying a fluids-experiment apparatus on the space station.[13]

It is understandable that potential participants in space commercialization are reluctant to risk their money without some guarantee of a return on investment, since space commercialization does present tremendous challenges to the capital-formation capacities of many traditional corporate institutions. Such space authorities as former deputy director

of NASA Hans Mark of the University of Texas find a convenient analogy in the rail industry of the 19th century and the fledgling automobile and aviation industries of the 20th century. Both, they note, came into being through federal subsidy and/or federal contract.[14] Even large concerns, like Johnson & Johnson and McDonnell Douglas, have found it advantageous to team up to finance their space activities, so burdensome is the strain of capital formation to them as individual corporations. Payback periods are so lengthy that it is not unusual for an entire decade to elapse before positive returns are realized. Moreover, because space projects are so risky, insurance rates skyrocket while underwriters fear that they will be unable to cover a full shuttle load.

For these and other reasons, companies eager to develop the commercial possibilities of space have consistently called for the federal government to increase its role in their enterprises. Even in the one area of space policy in which a free market does function--insurance--the consensus clearly favors greater government regulation. A 1985 report by the Senate Committee on Commerce, Science and Transportation has called for an end to the free market in space insurance. According to the report:

Although demand [for space insurance] is rising sharply, the supply of underwriting coverage has actually declined due to 6 consecutive years of losing operations for the space insurance industry. Insurance availability problems have become apparent precisely when increased insurance protection is needed to offset the high risks of both newly evolving commercial space applications and continuation of the established satellite communications industry.

The report suggests that the government might well choose

the active role of subsidizing insurance rates or actually providing insurance. The latter role would be more appropriate to deal with the problem of capacity restraints. The government should act as a general 'insurer of last resort' to provide insurance when it cannot be provided by the private market at all or provided only at excessively high rates.[15]

Which means, of course, that the taxpayers assume the risk.

Space-Shuttle Pricing

Just as government insurance of space projects would discriminate against private insurers, NASA's below-cost pricing of space-shuttle flights--which many in the private sector consider the single most important obstacle to private-sector space commercialization--discriminates against a private launch industry. This subsidization of shuttle costs, ostensibly to encourage companies to undertake space projects, may thus be considered a classic example of how government "encouragement to business," as Henry Hazlitt has written, "is sometimes as much to be feared as government hostility." [16]

The shuttle is enormously costly. Over \$14 billion has already been spent to develop it, and its operating costs are so onerous that companies now using it to launch their satellites insist that their space operations would cease if users were charged full price. Though NASA puts the actual cost of a launch at about \$150 million--private sources claim it is as high as \$250 million--shuttle users have been charged as little as \$38 million a flight. NASA plans to raise the price to \$71 million by 1988, still less than half the actual cost.[17] The difference, of course, is made up by the taxpayers. Some companies, such as MRA and McDonnell Douglas, have even received free shuttle service in return for sharing experimental research or access to equipment they use.[18]

Federal subsidization of shuttle flights, while favored by those who have used the shuttle in the past and continue to use it today, perpetuates government domination of space commercialization. By offering bargain-basement prices, it not only promotes inefficiency and squanders taxpayer dollars but represents a tremendous obstacle to private-sector firms eager to compete for expendable launch vehicle (ELV) business themselves. While a private launch system is necessary for a flourishing private sector in space--without it, the industry has no alternative but to use government facilities--it is economically impossible for private entrepreneurs to compete with government services as long as the government can always subsidize its prices to attract customers. Under current pricing policies, private-sector launch systems hoping to remain competitive would, by one calculation, have to cut their costs to less than half of NASA's even when the agency charges enough to achieve "full-cost recovery." [19]

The consequences are already being felt. General Dynamics and Transpace Carriers have announced that they will get out of the launch business unless shuttle prices are raised.[20] Other private entrepreneurs with new concepts for reusable space vehicles, like Third Millennium and its winged Space Van, or Pacific American Launch System and its Phoenix, have been unsuccessful in finding investment capital. They place the blame, as do the ELV companies, on NASA pricing.[21]

There is little reason to believe that shuttle pricing policies will soon change. Asked by Rep. Bill Lowery (D-Calif.) in late 1983 to comment on whether "the Federal Government [should] be in a position of competing against the private sector" in shuttle pricing, Transportation secretary Elizabeth Dole stated emphatically that "there is plenty of room for both. I don't anticipate that there would be a change in the space shuttle system's pricing policy." [22]

The Industrial-Policy Enthusiasts

Given the eagerness with which spokesmen for space-commercialization interests seek policies that would allow them to reap the profits while the taxpayer assumed the risks, it is perhaps no surprise that the one goal these interests almost invariably support is a full-scale "industrial policy" for space, whereby the government would work as a full partner with industry in space projects. Although the congressional Office of Technology Assessment itself has concluded that NASA "is not well equipped to choose specific technologies for commercial exploitation or to foster the creation of new space industries," [23] firms involved in space commercialization would themselves create a government-supported space industry that could, in dollar value as well as in potential for mischief, rival the public works pork barrel of the 1960s and the synthetic-fuels and nuclear-power boondoggles of the 1970s.[24]

In the June 1985 Space Science and Applications Subcommittee hearings referred to earlier, for example, William R. Claybaugh of W. R. Claybaugh & Co. urged Congress to provide "access to government-credit backing for companies developing new, low-cost space transportation, government guarantee of initial purchases, or a charter company." [25] James Samuels of Shearson-Lehman, in a list of similar recommendations that he called "by no means exhaustive," suggested that the government "guarantee to purchase a product or service" and even "restrict or bar competitive new entrants in either equipment or service markets." [26]

Even those who warn against industrial policy per se couch their warnings in terms that leave no doubt of their hostility to a free market in space commercialization. Jonathan Conrad and Dean Porter of the Sconset Group, for example, contend that the government "should never place itself in the position to evaluate business risk by picking winners versus loser. Socialism masquerading as industrial policy is no more an answer to space commercialization than pure laissez-faire economics." [27]

Former deputy director of NASA Hans Mark felt compelled in his statement before the subcommittee to "say a word about government subsidies. I know there are many people who object to the fact that the government subsidizes anything. In my judgment, this view is not only shortsighted but it is contrary to a long and successful history of government subsidies for emerging technologies." Calling for "the provision of certain guarantees to protect potential investors from really catastrophic losses," Mark concluded that "some purists will argue that these measures distort the 'market.' That is true but I believe it is a small price to pay for the efficiencies that are being gained by private sector operations as opposed to those of the government." [28]

The experience of companies already working with the federal government on space commercialization is instructive for suggesting the extent to which the fusion of government and industry in this enterprise is already a reality. Walter Vogel, vice president of engineering and technology for Deere & Co., told the subcommittee that in his company's early efforts toward space commercialization it

only worked with NASA. We then saw the need for including a university in our program. Later we recognized the importance of information from industrial companies for a more complete approach to a solution to our problems. Our work with many universities, private concerns and government agencies has shown that coordination of these many independent groups to improve our collective performance is an ongoing need and new ways to organize must be devised. [29]

Mark is quite explicit in his view that the government's role extends far beyond merely establishing and enforcing

general guidelines for private-sector competition or providing incentives to stimulate industrial innovation, such as easy credit and purchase guarantees. He argues that the government should draw into its orbit virtually every institution of the society in a government-directed space-commercialization program. The goal of national policy, he says, should be to "harness the talents of industry and government" to this end.[30]

The Military-Commercial Symbiosis

Even those few space enthusiasts who champion free enterprise and support space commercialization in the belief that it will mean new and thrilling opportunities for the private sector unfortunately fail to understand or acknowledge that government domination of space commercialization is already in an advancing--if not an advanced--stage of development. Their confusion on this score is well demonstrated, it would seem, by their enthusiasm for the technological innovations they seem convinced will result from such military programs as the Strategic Defense Initiative, which they support with equal enthusiasm. Thus, advocates of SDI who helped develop the High Frontier concept-- with help from Boeing Aerospace, a major military contractor-- lobby for SDI in part on the grounds that it would mean commercial opportunities here on earth. In doing so, they ignore the basic economic tenet that government allocation of resources, far from being beneficial to an economy, is wasteful and destructive.

High Frontier nevertheless distributes a paper produced by the National Center for Policy Analysis, entitled "Economic Benefits of High Frontier," that boasts that the anti-missile defense system

requires the construction of an infrastructure: space stations, a space transportation system, mass production techniques for satellites and their components, etc. Yet this very infrastructure is what is needed to unleash the commercial development of space. In the very act of defending ourselves against nuclear missiles, we will be opening the doors to pathbreaking changes in our civilian life.[31]

As has been noted already, many of the corporations playing a major role in space are themselves major military contractors. The calls for continued subsidies to these companies in the name of space commercialization take on both patriotic and protectionist overtones. Advocates of low shuttle prices argue that subsidies are necessary because the governments of France, West Germany, Japan, and the Soviet Union devote substantial sums to their commercial launch capabilities. Unless the United States continues current subsidies, the argument goes, it will rapidly fall behind these international competitors. Ironically, the greatest foreign offender appears to be the French company Arianespace, which is said to use unfair trade practices to subsidize its own launches, offering artificially low prices to exporters and subsidizing mission insurance--precisely those policies the U.S. space industry wants for itself.[32] Emmanuel Fthenakis of Fairchild Industries summed up this attitude when he urged Congress to continue to offer below-cost shuttle prices because the United States "is poised to lead this new age of space development and we should never relinquish that role. The competition is heating up, however, and for us to stay in front, the government and the public must commit now to the further development of space." [33]

In contrast to those who merely pay lip service to free enterprise in their advocacy of space commercialization, some people sincerely believe that government allocation of resources through military contracting represents a tremendous economic benefit. Conrad and Porter of the Sconset Group contend that military contracting has been a major force for technological innovation and see government armament programs as a model for space commercialization. The "very foundation of mass production for civilian industry, the production of cast steel parts, advanced chemistry technology, and mass production of penicillin all evolved from military need," they told Congress, noting that military requirements "have historically been major drivers of government technology development." [34]

Mark appears to agree, contending that the appropriate historical model for space-commercialization policy is the aviation industry:

Just as our civilian aviation industry was spawned from our experience in flying government aircraft, both military and civilian, so a commercial space industry will be derived from government research and manned space flight programs.

The analogy between these developments is striking. The birth of the very profitable American aviation industry depended critically on government-owned (and government-operated) wind tunnel facilities, to develop new aircraft. Likewise, new space-based industries will depend on government-owned (and government-operated) facilities such as

space shuttles and space stations to develop technologies that will ultimately lead to new industries.

Space operations have been big business for over two decades. The joint NASA/industry teams which have developed and carried out the Mercury, Gemini, Apollo and Shuttle programs--and are currently involved in defining the missions and configurations of the Space Station--represent the continuing and strong involvement of the private sector in space technology and space operations. However, these things are not commercial enterprises because the market is limited to the government and profits are fixed. The only true commercial space-based industry so far is satellite communications. It was nurtured (subsidized) by the government during the early 1960's and is today a \$2 billion a year private industry.[35]

Mark's argument that the proper model for space commercialization is the development of the aviation industry for military purposes is disingenuous for several reasons. The aviation industry can hardly be considered an unqualified commercial success, if, that is, public policy seeks to develop an industry that can move from its current dependence on government to a free market. The aviation industry has never been weaned from government dependence and was able to develop its civilian and commercial operations only by snaring military contracts that allowed the various aviation companies to stay in business. Further, the aviation industry is to a large extent synonymous with the aerospace industry that it became and the space-commercialization industry it hopes to become. Finally, the historical evidence suggests that government efforts to stimulate industrial innovation--one of the chief goals of space policy--have been a failure.

The Case against Industrial Policy

A recent study of federal research and development policy conducted by the Center for Science and Technology Policy at New York University that surveyed the aviation industry as well as several others found that government efforts to stimulate industrial innovation have been dismal indeed. Working from the premises that "technological change is an important source of productivity growth and, simultaneously, that R & D expenditure is a principal determinant of technological advance," Richard R. Nelson and Richard N. Langlois found that "the consensus surrounding this conclusion has essentially come undone" over the last decade. The experiences of the 1970s cast doubt on the presumed tight link between a nation's overall R & D spending and its rate of productivity growth. Although it is true that high rates of R & D spending attended the rapid growth of productivity in the United States, Western Europe, and Japan during the 1950's and 1960's, spending in R & D continued to be high in most countries during the ubiquitous slowdown in productivity growth after 1973. Only in the United States and France was the slowdown presaged by a decrease in R & D expenditures, and in both those countries the decrease was almost exclusively in defense and space rather than in civilian areas. Moreover, recent studies of the differences in productivity growth among countries suggest that, even in the 1950's and '60s, the countries with the highest ratio of R & D spending to gross national product--the United States and Great Britain--had among the lowest rates of productivity growth.

All industrial-innovation policies assume that the direction of technological change can be anticipated. Again, the study noted, the evidence suggests otherwise. One theme that united the history of technological change is the pervasiveness of uncertainty. Although it takes a form in (say) the pharmaceutical industry very different from that in the commercial aircraft industry, uncertainty seems nevertheless to be endemic. A quick reading of these case studies is enough to dash any supposition that technological change is somehow a cleanly plannable activity. In fact it is an activity characterized as much by false starts, missed opportunities and lucky breaks as by brilliant insights and clever strategic decisions. Only in hindsight does the right approach seem obvious; before the fact, it is far from clear which of a bewildering array of options will prove most fruitful or even feasible. Strange as it now seems to us, aviation experts were once divided on the relative merits of the turboprop and turbojet engines as power plants for the aircraft of the future; and the computer industry was by no means unanimous that transistors--or, later, integrated circuits--were to be the technology of the future. Policy must recognize uncertainty as a fact of life, and must not try to repress it.

Mark's arguments notwithstanding, Nelson and Langlois found little evidence that military R & D consistently results in useful spinoffs for the private sector. The results of their study suggest that the potential for the generation of spillover by procurement-related government R & D support may be limited to the early stages of technology's development, when government and civilian demands are not yet specialized. As a technology matures, the

requirements of the government and the private sector normally diverge. This means not only that spillover diminishes but also that military and commercial R & D increasingly compete for resources. In the mature phases of a technology's development, spillover may be as much to the military from the commercial sector as the other way around.

Finally, it is in picking winners--the supposed strength of any industrial policy--that the government's record is most markedly bad. "Here," the authors conclude, "the historical record seems, for a change, unequivocal. Unequivocally negative." The supersonic transport is cited by the study as typical of programs in which "federal agencies attempt to insert themselves directly into the business of developing particular technologies for a commercial market in which they had little or no procurement interest." In light of such failures, say Nelson and Langlois, the effort of government officials "to try to identify projects that will be winners in a commercial market competition," while always seductive, is "to be avoided." The lesson is not specific to these cases; it is not that these particular government agencies lacked some necessary expertise that could in principle have been remedied by hiring a large or better cadre of experts. The lesson here is a general one, about the location of knowledge and the mechanism of its transmission in the R & D system. Our central conclusion might be summed up in one word: complexity. The wide diversity of technological and institutional details, of knowledge structures among American industries, recommends against an industrial policy to boost 'industrial innovation' in some global sense in the hope of affecting macroeconomic problems.[36]

Conclusion

The major advocates of space commercialization consistently urge the federal government to maintain and expand policies that would result in a system whereby taxpayers assume the risks and government-subsidized firms reap the profits. Proponents of these policies hold out promises of unimagined technological advancement, increased employment opportunities, an ever-rising standard of living, a strong America, and even world peace--with little evidence that these promises can be kept. The historical record shows that government "development" of the new space-commercialization industry would guarantee an inefficient use of resources, dry up sources of funds for truly innovative ventures, discourage competition, and possibly exacerbate international tensions. The most vociferous advocates of space commercialization almost uniformly favor policies that would, in the long run, endanger the realization of the very vision they have set before us.

FOOTNOTES

[1] Quoted in David Osborne, "Business in Space," *Atlantic Monthly* (May 1985): 45.

[2] Statement of Milton R. Copulos, Hearings before the House Committee on Science and Technology, subcommittee on Space Science and Applications, June 18, 1985, pp. 1-2.

[3] Statement of James Samuels, Hearings, June 19, 1985, p. 4.

[4] Statement of Mark Oderman, Hearings, June 18, 1985, p. 3.

[5] Quoted in Osborne, p. 51.

[6] Milton R. Copulos, "Government Obstacles to the Commercial Use of Space," *Heritage Foundation Backgrounder* no. 413, (Washington, March 4, 1985), p. 1.

[7] Statement of John Egan, Hearings, p. 8.

[8] Quoted in Osborne, p. 51.

[9] Harry R. Marshall, Jr., "Commercialization of Outer Space," *Department of State Bulletin* (January 1985): 3.

[10] Craig Covault, "Evolving Government Policy Eases Way for Space Ventures," *Commercial Space* (Spring 1985): 15-16.

[11] Lad Kuzela, "Who'll Win the Race for Profits in Space?" Industry Week, August 6, 1984, pp. 29-30.

[12] Covault, p. 17.

[13] Ibid.

[14] Statement of Hans Mark, Hearings, p. 10.

[15] John C. Danforth, "Insurance and the Commercialization of Space," S. Print 99-16 (Washington: Government Printing Office, March 1985), p. 27.

[16] Henry Hazlitt, Economics in One Lesson (New York: McFadden Books, 1962), p. 27.

[17] Copulos, "Government Obstacles," p. 3.

[18] Osborne, p. 53.

[19] Copulos, "Government Obstacles," p. 3.

[20] Osborne, p. 56.

[21] Tom Brosz, "The Priesthood of Space," Reason (August 1985): 41.

[22] Hearings before the House Committee on Science and Technology, Subcommittee on Space Science and Applications, November, 18, 1983, p