Message to Debaters on Economics of the 2011-2012 Topic

By Edward Hudgins

Resolved: The United States federal government should substantially increase its exploration and/or development of space beyond the Earth's mesosphere.

It has been five decades since the first satellite was launched into orbit and the first human launched into space. It has been over four decades since Project Apollo put the first humans on the Moon. Yet the science fiction dreams of regular commercial flights to giant orbiting hotels and to colonies on other worlds have not become science fact.

NASA's 2010 budget is $18.7 billion. In the past, half of that NASA's budget was spent on space shuttle missions and the International Space Station, but the shuttle program is ending after thirty years in operation. The station is as complete as it is likely to be, and in the near future American astronauts visiting the station will be carried on Russian rockets.

In 2005 the Bush administration initiated the Constellation program. It was meant to replace the shuttle with Ares rockets to ferry crews and cargo to the space station. It also would develop an Orion capsule—similar to the Apollo Lunar Module—that could carry humans to lunar orbit, and an Altair lunar lander. It was hoped that this system might also be a stepping stone for manned missions to Mars. Budgets for the program would be at least of the magnitude of the shuttle and station.

President Obama cancelled the Constellation program though he has not correspondingly cut NASA's budget.

The United States thus faces an uncertain future concerning the direction of the space program: Should the federal government substantially increase exploration of and/or development of space?

Space Is a Place

When we speak of "development" we should make an important conceptual shift in our thinking. Space is a place, not a government program. It is a place for performing scientific and commercial activities. It is a place where humans might work, live, play, and do everything that they might do on Earth.

Thinking this way, we might see the goal of development as making us into a spacefaring civilization. At a certain point the American West ceased to be a frontier for pioneers and became just another part of America. In the case of space, we might consider it to be developed when access to it is regular, affordable, and much more routine, like transatlantic flights. It might be declared "developed" when the habitats appropriate for human activities are permanent and not cost-prohibitive.

But since the question at hand concerns government expenditures, we must address federal programs, and principally the operations of NASA, as they relate to the development of space.

Purposes of Activities in Space

To understand the resolution we must review the five reasons usually given to justify government involvement in space.

Defense. The first reason given is for defense. Protecting the country from overseas enemies is an important Constitutional responsibility of the federal government. Space hardware—whether intercontinental ballistic missiles or surveillance,

communications, and other satellites—have been important for this task. While there are legitimate questions about exactly what hardware is most useful in the context of which particular defense strategies, this is a separate discussion from matters of civil space.

Prestige. The second reason given for government space expenditures is to enhance America's prestige. When the "space race" between the United States and the Soviet Union began with the latter's launch of the satellite Sputnik in 1957 and the human Yuri Gagarin in 1961, the intangible goal of prestige was one motive for federal spending and for setting the goal of putting a human on the Moon before the Russians. The belief was that other countries, especially former colonies or those with emerging economies, would see the country most advanced in space as the one with the best political/economic system and philosophy. In matters of foreign policy those countries might look to the space leader as the world leader.

The same sentiment is emerging concerning the American relationship with China today. China now has the world's second largest economy with a high growth rate. The U.S. government is heavily in debt to China. The sight of Chinese astronauts on the Moon, perhaps collecting remains of old Apollo landing crafts as souvenirs, could reinforce a perception worldwide that American is a declining power, bankrupt both literally and philosophically.

But to what extent do government-financed feats in space really impress the leaders and public of other countries? To what extent can billions of dollars in taxpayer expenditures be justified under the value goal of "prestige?" And are there other American achievements that might be more impressive than a space program.

Science and exploration. The third reason given for government space expenditures is to promote science and exploration. Projects include putting observatories such as the Hubble Space Telescope, the Spitzer infrared telescope, and the Chandra X-ray telescope into space; sending unmanned probes to the planets or other bodies in space—the Mars landers; or sending humans to the Moon, Mars, or other planets. These missions, usually valued in the hundreds of millions of dollars, have been a relatively small part of NASA's budget but have yielded important scientific discoveries.

The argument is made that since such enterprises are not commercial ventures and have no possibility of generating revenues to offset their costs, that government should finance them. But how much money is right for such projects? Are costs high because governments are involved? Are there non-government alternatives?

Infrastructure. A fourth reason given for government expenditures is the creation of infrastructure. This is the notion that only governments can provide certain prerequisites for most civil and commercial activities. On Earth these prerequisites are said to include roads, bridges, and various utilities.

In the case of space, the "roads" are actually the vehicles that travel to space. The argument is that government might fund vehicle development and construction, launch the crafts and handle control and tracking during missions. The government might also carry out research on advanced space transportation technology. The idea is that at some point this government spending will result in lower transportation costs and, perhaps, the private sector can take over.

Infrastructure also includes orbiting platforms on which activities can be performed, that is, space stations. It also could include utilities. Currently all vehicles

traveling into space must generate their own power for life support and everything related to their missions. In the future there might be core power facilities that orbiting vehicles or mini-stations might simply plug into the way any house, enterprise, or establishment on Earth plugs into a power grid.

One might ask, does the government-provided infrastructure argument hold even for Earth infrastructure or are there private options? In America's early history private turnpikes charging tolls offered roads for travel and trade. In the early twentieth century there were competing utilities in many cities until local governments mandated monopoly suppliers.

One can ask, does the infrastructure analogy work for space? Is hardware—especially launch vehicles—really analogous to roads? One also might ask, are there private sector alternatives? And one might ask, how can we measure the return on a government infrastructure investment?

Commercial activities. The fifth reason given for government space expenditures is to promote commercial activities. This is related to the infrastructure reason but usually is focused more on specific commercial ventures, sectors, or industries.

The most successful space-related commercial ventures have been satellites, principally for communications but also for studying or seeking out Earth resources—oil, for example. A great portion of these operations are privately funded for private profit. But some of these represent private sector business performed for the government with taxpayer dollars, for example, launching weather or earth-survey satellites.

According to a survey commissioned by the Satellite Industry Association, global revenues for satellite-related services were $160.9 billion in 2009, up 11.9 percent from 144.4 billion in 2008. While the most recent survey did not identify the proportion of this revenue earned by American enterprises, in the past that share was about 40 percent, or some $65 billion. The American industry claimed 250,733 jobs associated with the satellite industry, down from 262,952 in the previous year.

Worldwide, some $71.8 billion of the total revenue came from satellite television and related services, an 11 percent increase over the previous year. Satellite manufacturing took in $13.5 billion, 29 percent increase. Launch services accounted for $4.5 billion in revenues, up 18 percent. And ground equipment took in $49.9 billion, up 8 percent.

Other commercial enterprises have also been proposed that, it is argued, could become profitable with initial government help. One example is the provision of space-based solar energy for Earth. There is available technology that would allow large solar energy collectors to be placed in orbit and that could beam energy to Earth via laser or microwave. Such a system could radically reduce American dependence on imported fuel or even domestic fossil fuels. Further, such a system could sell energy to the International Space Station or to future private space stations, that is, become the electricity infrastructure in orbit.

A variation of such an enterprise would be for energy generated at one point on Earth—for example, by natural gas that currently is burned off in the oil fields of Saudi Arabia or Kuwait—to be converted into a form of energy that can be bounced off of an orbiting devise and "downloaded" into an electric grid half a world away.

But the problem with this and similar ventures is that such a plan could only be profitable, independent of government subsidies in the form of cheap flights into orbit, if launch costs dropped radically, by one or two magnitudes, from, say, $10,000 per pound of cargo placed in orbit to $100 per pound. Currently, such energy from space would only be "cheap" if the huge launch costs borne by the taxpayer are ignored. Such energy would be like spending $40 or even $400 to produce gasoline that sells for only generating $4. It makes no economic sense with launch costs as high as they are currently.

It is difficult to argue for government subsidies of commercial activities because it is almost impossible to show how such ventures would ever break even much less make a profit and no longer require government help.

Creative Accounting

Any discussion of the economics of space activities and whether it is worthwhile for the federal government to increase spending for space development and exploration depends on moderately accurate cost figures, especially from the government sector. Acquiring such figures is a perennial problem. NASA and Congress have been known to engage in "creative accounting" when placing price tags on various projects. For example, many more NASA employees lend support to a typical shuttle launch than are listed in official budgets as part of the shuttle or space station support teams. NASA has, in the past decade or so, been required to consider whether contracting out for services in some cases might be more efficient than performing the functions in house. Here too how NASA crunches the numbers will be important in determining whether the government

space agency purchases a service from a private vendor or not. Private vendors have complained that NASA will fail to include all of its costs when making such calculations.

Politicized Space Policy

Another problem we must face when deciding whether to increase spending for space exploration and development is the nature of the government agencies that will be spending those dollars.

NASA is a government agency constituted in various space centers. These include Goddard in Greenbelt, Maryland; Kennedy Space Center in Florida; the Johnson Space Center in Texas; the Marshall Center in Alabama; the Stennis Center in Mississippi; the Glenn Center in Ohio; Aims in California; and Langley in Virginia. (The Jet Propulsion Laboratory in California is a unique NASA facility. It is managed by the nearby California Institute of Technology, which runs the facility without as many regulations and as much red tape as ties up government employees at other NASA operations.)

The locations of these facilities were in part made based on political considerations. For example, when NASA was beginning to plan the Moon landing in the early 1960s, the logical place for the center to train astronauts and control the missions would have been Goddard or Kennedy (then named Cape Canaveral) from where the rockets were launched. That center was set up in Texas because Vice President Johnson from Texas wanted it there.

Just as Pentagon facilities have come under fire as wasteful, redundant, or not appropriate to meet current defense needs, so too have NASA facilities. But there is little political chance of cutting the NASA fat.

NASA presents us with a classic public choice problem. There is an iron triangle of elected officials who protect the jobs of government workers and facilities in their states and districts and the contractors and unions that benefit from handouts from NASA agencies. NASA officials can always cite some benefit of a project or program—even without comparing the uses of taxpayer dollars on those projects and programs compared to alternative uses.

NASA centers are spread around the country. Senators and representatives from those states will never attack the expenditures for facilities in other states since they rely on the political support of elected officials from those localities to support their facilities and vice versa.

NASA also fights other government agencies for control over programs and projects. For example, Mission to Planet Earth was initiated in 1991 to study the planet's environment. But why should this task be performed by NASA? Would it not be an activity for the Environmental Protection Agency or the Department of the Interior? Wouldn't it be more efficient if these agencies contracted with private providers to launch their remote-sensing satellites or, better still, simply purchase data from private providers? The reason NASA controls this program is that it won a political fight.

The design of the shuttle itself was less efficient than it might have been because of the necessities of politics. NASA sought political support for that vehicle from the military. To secure that support, NASA had to design the shuttle as a potential duel civilian-military system. This meant giving it a "cross-range" maneuvering capacity. The added weight of heat tiles needed to give it that capacity reduced the shuttle's cargo capacity considerably.

It is also crucial to remember that NASA is a government bureaucracy. It is subject to many of the same standard operation procedures and red tape that make all government agencies less efficient than the private sector. How, then, will NASA be able to bring down the costs of access to space?

Astronomical Costs

With these points about accounting and politics made, let us turn to the crucial matter of costs.

The initial idea behind the space shuttle was to have a reusable vehicle that would bring costs down from those of the Saturn V rockets that put humans on the Moon. The goal was to have almost a launch per week.

In the end the launch costs per pound of cargo went up. While good figures are hard to come by, one estimate suggested that in the early 1990s the cost of putting a pound of cargo in orbit on the Shuttle was about $6,000 in real dollars, compared to only $3,600 on a Saturn V. Duke University Professor Alex Roland maintained that the cost was as high as $35,000 per pound. Today most observers put the cost of putting a pound in space at about $10,000.

It became apparent in the early 1980s that the shuttle would cost far more than anticipated; even at its best, the shuttle averaged only about seven flights a year, far from the once-a-week that many had hoped for. NASA needed a mission to justify its continued existence. Regardless of any commercial or scientific benefits, an orbiting space station seemed to give the shuttle something to do.

But the cost of the station, which was supposed to be up and running in the early 1990s and have a permanent crew of twelve, went from a promised $8 billion to nearly

$40 billion before a 1993 stripped-down $30 billion redesign. The station for a while was named “Freedom” and was a kind of challenge to the Soviet’s Mir station. But after the fall of the Soviet Union the United States invited Russian, the European Union, Canada, and Japan to be its partners on the now-named International Space Station, supplying various parts of the station. The crew usually consisted of only three individuals and much of their time was spent maintaining the station rather than doing science.

Like the shuttle, the station did not live up to NASA’s projections. One General Accounting Office report found that, through June 2002, the actual cost of designing, building, and launching the station would be $48.2 billion. (The GAO included the sunk costs of the various discarded designs.) The cost of operating the station after its assembly through 2012 would add another $45.7 billion to the price tag for a total bill of $93.9 billion.

A special presidential advisory commission, chaired by then-Martin Marietta Corporation CEO Norman Augustine, in 1991 stated, "We do not believe that the space station . . . can be justified solely on the basis of the (non-biological) science it can perform, much of which can be conducted on Earth or by unmanned robots." And the biological research for the most part consisted of studying the effects of weightlessness on humans. This is something that has been studied constantly since the first manned missions and this research is redundant at best. It is argued that such research is necessary for long-term missions to Mars and the planets. But NASA is decades away from such missions if they ever materialize at all.

Scientists with an interest in space would place the space station very low on any list of priorities. Building a $50 billion or $100 billion station to handle scientific

experiments valued in only millions of dollars is like insisting on a chauffeur-driven limousine to go to the corner store for milk.

Whose Money on the Line?

If space development means bringing down costs of access to orbit and creating an infrastructure for future habitation, NASA clearly has failed in this task. And its nature as a government entity, with many decisions based on politics rather than economics, makes it unlikely that future money will be spent any better and that it will be any more successful than in the past.

A basic institutional problem with entrusting space development to NASA is the lack of incentives and opportunities to be innovative. When private money is invested in an enterprise, real flesh-and-blood individuals stand to lose their fortunes from failure or make their fortunes from success. When the money is provided by government, failure is less likely to mean government workers and private contractors losing jobs. Since funding decisions are made politically, failure often means continued if not increased expenditures.

Consider an example of a missed opportunity because no private money was involved. One idea that has been suggested for years by private space experts concerns the shuttle's 150 ft. tall external fuel tanks, which cost around $40 million each. Shuttles fly 98 percent of the way to orbit with these tanks. Once the nontoxic liquid oxygen and hydrogen from those tanks burn off, the tanks are dropped into the ocean.

If those tanks were placed in orbit with each shuttle flight to date, there would be 132 platforms—with nearly 40 acres of interior space, the size of the Pentagon—waiting to be sealed and "homesteaded" by private owners for scientific experiments, space

hotels, honeymoon suites, or any other activity of which an entrepreneur could conceive. This would not be the first time such a concept was used. In the 1970s NASA used a tank stage of a Saturn V for the Skylab.

Consider an example of the difference between private and government approaches to exploration. In the early 1980s, when NASA was considering plans for a space station, it considered the idea of a space pod, similar to the one seen in the movie *2001: A Space Odyssey*, to help with station construction. The price for developing and building a proto-type was put at about $1 billion. In the end the pod idea was not pursued. At about the same time oceanographers were facing a similar challenge. They needed a small vehicle that could withstand incredible pressures—generated outside by the ocean rather than inside by a pressurized vehicle in a vacuum—and a hostile environment that would mean instant death if the vehicle failed. Deep Rover was developed for about a million dollars and the developers would be those risking their money and their lives in the vehicle.

Here is an answer to the argument that because the costs of space activities are so high, governments must foot the bill for scientific work, which returns no immediate revenue on investments. Perhaps the reason costs are so high is because governments rather than private parties finance and manage such work.

Government vs. Private Providers

This brings us to the question of whether private alternatives to government exploration and development of space are being blocked by the government itself.

With the advent of the space program, it was assumed by policy makers that space would be an arena for government rather than the private sector. Private contractors built

a good portion of NASA hardware. But this was not a private sector, market operation any more than Boeing building a bomber for the Pentagon was.

As the Apollo program that put humans on the Moon was winding down in the early 1970s, NASA might have considered turning over more operations to the private sector. One way to do this would have been to contract out for services—ultimately including human flights to orbit—rather than for hardware. Instead, NASA decided to develop the shuttle system. In the 1970s, as the shuttle was being developed, and during the early years of the shuttle's operation, the federal government required its payloads—for example, remote-sensing satellites—to be placed into space on government vehicles. This mandate deprived the potential private launch providers of customers.

As noted earlier, when NASA began to contract out for launch services, the government's creative accounting became a problem; private providers argued that NASA did not include its full costs in its calculations in comparing itself with private providers.

A major problem in the launch sector has been government regulation. For example, in 1982 Space Sciences Inc. launched the first privately-funded American rocket, the *Conostoga*, since the days of rocket pioneer Robert Goddard in the 1930s. NASA might have contracted with that company for services but, of course, did not. Worse still were the licensing barriers that Space Sciences faced. There was no real provision for allowing private launches.

One problem was that under international space treaties, a country's government is responsible for any damage done to third parties by space vehicles launched from its soil. This was a mandate for government regulations that have made private launches

difficult to impossible. In the case of civil aviation, private airlines simply purchase insurance. But no insurance market could develop for private launches with such a treaty obligation in place.

In the past decade the licensing problems have been mitigated to a certain extent by the creation of a space office in the Department of Transportation as a kind of one-stop-shopping location for launch licensing.

Another serious hindrance to private space activities has been the export control regime. In 1998 Congress passed the Strom Thurmond National Defense Authorization Act. That law transferred jurisdiction over exports from the Commerce Department to the State Department, which has been much stricter and slower in approving exports. As a result, the American satellite industry has been seriously harmed. Business partnerships of long standing with foreign launch providers, even where there was no national security problem, have been harmed.

Private Alternatives

In spite of the burden of government, private sector space activities beyond the satellite sector have been on the rise in recent years, led by entrepreneurs from the information and communications revolution. The prospects now are for the private sector to bring the innovative spirit seen in that revolution to the space sector. One might also expect that just as America's international prestige has been enhanced by the commercial achievements of companies like Apple and Microsoft in making that revolution, so the private companies doing the same in space will be an advertisement for the superiority of the free market system. Consider a few examples:

The X Prize. The $10 million Ansari X Prize was established by private money, principally from Iranian-American entrepreneur Anousheh Ansar, to award to the first entrepreneur who sends a craft capable of carrying three persons at least 62 miles into space and return it to Earth twice in a two-week period. On October 4, 2004, the 47th anniversary of the launch of Sputnik, the prize was won by SpaceShipOne, a craft designed by Burt Rutan and his company, Scaled Composites, and built with money from Microsoft cofounder Paul Allen.

British businessman Richard Branson, who founded Virgin Atlantic, has teamed up with Rutan to found Virgin Galactic. That company is producing a next generation craft. Within the next year and a half his company should be offering suborbital flights for $200,000. He already has a waiting list of passengers.

SpaceX. Rutan's company is looking to offer flights to orbit in the future, but another company might perform that feat first. SpaceX was founded by Elon Musk, the co-founder of Paypal, in 2002 with $100 million of his own money. Musk has argued that a private company could produce rockets for less than the government and he's being proved right.

SpaceX has won contracts from the Air Force to launch payloads into orbit. Under pressure to contract out more to the private sector, NASA's Commercial Orbital Transportation Services program, started in 2006, has sought private providers for crew and cargo to the space station. SpaceX won a $278 million contract to further develop its Falcon 9 rocket for this purpose.

In 2010 SpaceX received the largest commercial launch contract, to use the Falcon 9 to launch Iridium satellites. And in 2010 SpaceX became the first private

company to launch and return a spacecraft—its Dragon capsule—from orbit. This feat sets the stage for private flights into orbit and to space stations. In April 2011, SpaceX announced that it is developing what will be the world's largest rocket—the Falcon Heavy—a craft that has only been surpassed by the now-retired Saturn series that put humans on the Moon. Launch is expected in late 2013.

SpaceX is only one of a new constellation of private launch companies that could well make NASA obsolete; Blue Origin, a rocket company founded by Amazon.com founder Jeff Bazos, has also received a NASA contract.

Bigelow Aerospace. Rockets built by SpaceX and other companies will not necessarily be carrying astronauts to government space stations. One of the most exciting private space plans comes from Las Vegas-based Bigelow Aerospace. Entrepreneur Robert Bigelow is devoting $500 million to manufacture and orbit a private space station. It will be an inflatable structure made of lightweight but rugged materials. A material like Kevlar weighs a fraction of the cost of metal being used in the government station but is strong enough to take a bullet or a micrometeor. Thus the cost for such modules should be much lower than for the ISS.

Bigelow hopes to orbit in three launches the same amount of interior space that it will take 30 to 40 shuttle launches to put up with the government station. He has already launched a one-third size test station into orbit.

Beyond Government Contracts

One further argument might be offered for increased government spending for space development. Contracting with the private sector for placing cargo and astronauts into space is certainly a step forward from the government continuing in such activities.

But it would be better for space development if such contracts are simply a transition to the government getting out of the space business altogether.

Companies that provide space hardware—Boeing, for example—that might have been much more entrepreneurial in developing cheap access to space, have tended to become addicted to the comfort of government contracts. And NASA has more than hinted in the past that it would look unkindly on companies that somehow challenged NASA's political interests.

In the long-run, if any project in orbit is worth the costs of launch and operations in space, customers should go to the private sector for services. And only if the private sector can continue to bring the costs of access down will space truly be commercialized, developed, and even settled.

Science and Space Costs

We return finally to the issue of space exploration and the argument that only governments would be willing to invest in such science. To begin with, in the past "big science" projects were handled by the private sector. For example, Carnegie Institution spent $2.29 million between 1920 and 1929 on the Mt. Wilson observatory ($20.4 million in 1996 dollars), $2.38 million from 1930 to 1939 ($26.37 million in current dollars), and $2.15 million between 1940 and 1949 ($18 million in current dollars). The Rockefeller Foundation, starting in 1929, paid out $6 million to build the Mount Palomar Observatory, which saw first light in 1948. That's about $60 million in 1996 dollars.

Private organizations like the National Geographic Society have sponsored important science expedition and enterprises in the past. If private commercial providers

of space services continue to bring costs down, a consortia of such groups, which would include universities, could better afford to launch their own probes to the planets.

But what about manned missions to the planets? Surely only governments could mount such ventures. An excellent illustration of how NASA costs tend to be high while private entrepreneurs who do not put NASA's institutional interests first could cut costs is seen in proposals for manned missions to Mars. In 1991 President Bush announced the goal of placing humans on the Red Planet by 2019. Such a mission would bring unparalleled scientific returns. But NASA's "90 Day Report" put the mission's price at a staggering $450 billion, effectively killing the idea.

Sensing that a less costly mission was possible, then-Martin Marietta engineer Robert Zubrin and other scientists devised what they called a Mars Direct approach that would use existing technology and dispense with the space stations, Moon bases, and NASA's other expensive infrastructure. For example, one of the most costly parts of a Mars mission is carrying the fuel for the return trip. Zubrin saw that rather than carrying return fuel to Mars, an unmanned ship could land first with a simple chemical laboratory to manufacture methane and oxygen (i.e., rocket fuel) out of Mars's carbon dioxide atmosphere.

Using NASA's methods of cost calculations puts the cost of Zubrin's approach at between $20 billion and $30 billion, some 95 percent less than the government approach. NASA could mount two or three manned Mars mission for the cost of the space station.

Science and exploration could only benefit with lower costs provided by private commercial space enterprises.