## 1ac mmt aff

### 1ac plan

#### The United States Federal Government should establish a national space policy substantially increasing its international space cooperation with the People’s Republic of China over establishing an international regime, including a Space Bank, for joint human spaceflight for deep space exploration.

### 1ac mmt adv

#### Global economic decline is inevitable --- productivity crisis and peak resources --- only space development can prevent it

**Beldavs and Sommers 17** [Vidvuds Beldavs serves as the strategist for FOTONIKA-LV, the photonics research platform of the University of Latvia, he is also a founding member of the International Lunar Decade Working Group formed in November 2014 to advance the idea of the International Lunar Decade, Jeffrey Sommers, Associate Professor of Political Economy & Public Policy in Africology and Global Studies Fellow at the University of Wisconsin-Milwaukee, also Visiting Faculty, Stockholm School of Economics in Riga, advised governments up to the prime minister level and has written on political economy for The Financial Times, The Guardian, The Moscow Times, and others, “The Resurrection of Malthus: space as the final escape from the law of diminishing returns,” EPSC Abstracts, Vol. 11, EPSC2017-989, 2017, European Planetary Science Congress]

In 1798, Thomas Malthus predicted humans had approached a precipice and were set to drop over its edge. Population growth was set to intersect with the limits of nature (law of diminishing returns). Yet, precisely at the point of his prediction, a set of contingent variables were in play that launched humans in the opposite direction (toward unprecedented expansion and for many, prosperity). Today, we find ourselves at the Malthusian moment again. Will we find answers to the law of diminishing returns? Humans will either escape the gravitational pull of nature’s limits and challenges to innovation, or they will fail the test of thriving into the future. Space provides both the means by which we can overcome our new Malthusian moment. The challenges will be how to find the political will to do so and the related problem of how to pay for it. The two chief challenges facing us going forward, are the end of cheap nature and the productivity crisis. Ultimately, both can be solved by accelerating our return to space. The political will must be found for doing so, but so must ways of financing it. Innovation is hampered by the materials needed for creating productivity and quality of life enhancing technologies. Many of these materials require rare earth metals that could block the development and spread of new technologies. Asteroids and other astral bodies contain minerals that could solve material constraints imposed by nature. Moreover, the vast technological challenges to accessing the wealth of space would require innovations that later could be commercialized, thereby advancing both productivity and quality of life. The question is how to pay for it? Governments, as previously stated, the past four decades cut taxes, thus making less money available for research. Moreover, even as tax rates were lowered, offshore finance grew, thus further eroding public revenues. At first, tax cuts were funded by more public borrowing. But, as bond holders grew uncomfortable with this arrangement, governments eventually reduced spending. At the same time, supply-side policies were eroding wages under the banner of ‘flexibility.’ Thus, the puzzle was presented of how to sustain economic demand in an environment where both wages and public spending were under assault? The answer provided in the 1990s was expansion of private debt. This too inflated up to the point where it was no longer sustainable and saw its crescendo in the 2008 financial crisis. Thereafter, policymakers decided upon austerity: the twin contractions of both public and private debt. The effort worked imperfectly, ironically preventing total economic disaster, but well enough to slow growth. This economic environment can’t provide the vast resources needed to fund science sustaining basic research at our universities, let alone the comparatively smaller resources needed for their application to building space hardware. There are four possible means by which the return to space could be achieved: 1) Independent investors. We see some of this today, but it’s mostly limited to a few billionaires as vanity projects and/or as expression of some genuine vision. While helpful, the sums required to accelerate the return to space far exceed the capacity of this group to alone fund both it and the basic research required to advance it. 2) New financial instruments. The challenge is how to make investment in space more profitable than, say, real estate, or financial markets flooded with quantitative easing produced cash. Such instruments would have to provide the means by which long-term investments in space, where the returns would take more than a generation to materialize. Of course, long-range investments are already funded, but one must convince markets that the returns would come and in quantities needed to justify investor returns now. 3) Modern Monetary Theory. If money can be created in the trillions of dollars and euros to fund global efforts to stabilize financial markets without generating inflation, then the same could be done to finance science and space. Given the limits of taxation in today’s environment, it may be that governments simply begin funding infrastructure by creating credit on computer keyboards. Automatic triggers could be put in place to reign in this spending upon inflation hitting set targets. 4) Combinations of the above. Government guarantees coupled with outright grants parallel to public private partnerships as with COTS (Commercial Orbital Transportation Services) . Conclusions We are again at a Malthusian turning point. But the world is awash in capital seeking higher returns. Higher returns can be made possible through significant expansion in research and space development involving a combination of new financial instruments, monetary policy and billionaire entrepreneurs leveraging public resources to drive down costs and risks of activities in space while continuing to expand the range of opportunities for public and private investment. Space economics is the study of commercial activities in space in an environment where all resources are defined by the Outer Space Treaty as an international commons to be utilized for the benefit of all mankind. This raises major challenges for a field that has largely evolved studying economic activity under varying degrees of private ownership and capitalism.

#### Only the Space Bank’s creative use of MMT can generate the certainty and investment capital needed to develop space

**Beldavs 19** [Vidvuds Beldavs serves as the strategist for FOTONIKA-LV, the photonics research platform of the University of Latvia, he is also a founding member of the International Lunar Decade Working Group formed in November 2014 to advance the idea of the International Lunar Decade, “Modern monetary theory and lunar development,” served as Business Trends Advisor to Cummins, Inc., and served as the Executive Director of the Technology Transfer Society, was the Hudson Institute’s initiator of the International Baltic Economic Commission for the governments of Estonia, Latvia and Lithuania, October 14, 2019, *The Space Review,* http://www.thespacereview.com/article/3811/1]

Space Money is a form of stablecoin pegged to the value of major currency transactions in Space Money. It should be interconvertible with dollars, euros, and other sovereign economy currencies.

Since space resources have no competitors on Earth there would be no inflationary impact on Earth from their development. If lunar development can also be also viewed as a form of jobs creation program, and if full employment is the goal of the sovereign economies on Earth, policy makers will need to make large investments in those economies to generate demand for work. For some economies, such as China and its need to develop its interior where much of the population is still in poverty, these and other priorities are likely to take precedence over lunar industrial development.

Quantitative Easing injected as much as $27 trillion into the US economy since the 2008 economic crisis with inflation kept at moderate levels. Kim Stanley Robinson in his article “There Is No Planet B” has proposed using a similar mechanism to fund a Green New Deal. Why not use such a process to create the possibility of planets B, C, D, and beyond, and save the biosphere of the Earth in the process? This process can work to the point where inflationary pressure bids up costs for resources (including labor) beyond inflation targets.

How lunar development can be financed with Space Money

The natural resources of the solar system are assumed to be boundless relative to the anticipated needs of Earth’s industrial civilization for centuries to come given that technologies to extract, process, and transport products produced from outer space to the point of use can be developed and social stability can be maintained to make use of resources possible. At present, the expectations for the success of developing and deploying technologies is relatively limited as evidenced in the modest levels of space financing and the high levels of risk associated with space ventures. As expectations about the future become firmer, and perceptions of risk decrease, the cost of financing can be expected to decline and the rate and quantity of space investments to increase. A benefit to companies already serving space markets would be that their market capitalization would increase by this effect more than would be justified by their direct market successes and innovative new products.

In Depression-era America, Congress chartered the Tennessee Valley Authority (TVA) to develop a series of hydropower projects for the economic development of the southeastern US. There was no data-based forecast of demand for electricity in the region that drove construction of the generating facilities but the resource was known: hydropower could be generated from the water in the Tennessee River basin. Space resources are known to be essentially boundless. Low-cost launch and space energy systems can unlock large scale use of space resources much as World War II demand for the war effort: aluminum for aircraft and power for Oak Ridge benefited from the prior development of hydropower.

The Space Bank will play a role in the process by providing guarantees for financing projects that increase confidence in the development of technologies for use of space resources as well as of the markets for purchasing and trading space resources and products developed from space resources.

Even very-high-potential projects, where benefits may take decades to be fully realized, get gummed up in government budget processes driven by short-term considerations and the politics of balancing unrelated priorities. Guarantees could be factored by expected downside risks and upside impact. Projects that would have a high upside impact factor could be highly rated even if risks are also high.

Technology R&D outside of megaprojects like space-based solar powersupported can be financed thru financing extended by financial intermediaries authorized to lend Space Money or to leverage their authorized holdings of Space Money with other private and public investments that could include making equity investments. The European Investment Fund provides a model how a regional or sectoral investment program serving SMEs can be structured.

The Lunar Big Push can be effected through the Space Bank over the decade. For the Big Push to be effective in achieving takeoff of the Space Economy two primary requirements need to be met: acommitment to lunar development as a global goal affirmed by UN General Assembly (a UN Committee on the Peaceful Uses of Outer Space initiative), and a financial commitment to the Space Bank by the leading economies in the world. (a G20 initiative.)

Given that economic feasibility of lunar development was established, then business cases for numerous projects could close. Thereafter private investment would dominate rather than money created on the basis of expectations about the long-term future in outer space.

MMT is an approach proposed to work towards full employment with money injected in the economy as needed to achieve this goal. An economy operating under MMT would not require tax receipts to cover all government costs and investments. The government would simply issue money as needed and use taxes, interest rates, and other tools to maintain economic stability.

MMT can work in an economy where the sovereign authority can control the money supply. Economic goals that involve cooperation between multiple sovereign states, as with the proposed Big Push for lunar development, do not lend themselves to an instrument like MMT within a sovereign state because the sovereign authorities of the participating states could not control the money supply determined by factors outside of the control of the sovereign authority. What’s needed is an international institution with the authority to create money, and instruments to control the quantity of money in circulation and to maintain the stable value of the money that is created as the economic systems strives to achieve the overriding goal for which purpose it has been created.

The expectations of the performance of the economy determines the value of money circulating in a sovereign economic system. In economic systems operating under MMT the economic goal is full employment. In the Big Push, money is created to fund achievement of milestones in lunar development that can include the completion of infrastructure, development of key enabling technologies, and creation of competitors to serve a market need such as lunar water for fuel depots LEO, space farms to raise food, and other applications. Space Money that will be created needs to serve as a means of exchange between operations in space and suppliers and customers that may be operating in one of the terrestrial economies raising the need for convertibility of Space Money to other currencies. In the Proposed space resources economy in which agents from multiple sovereign economies are participating the value of the money in circulation will be determined by expectations regarding progress towards the economic use of space resources. The quantity of space resources within the Solar System is boundless relative to the needs of an Earth-Moon economy. The existence of these resources establishes a potential value much like resources on Earth as discussed below.

In an earlier article (see “The asteroid mining bank”, The Space Review, January 28, 2013), I proposed use of resource assays performed according to specified rules to define mining claims that would give the claimant a level of rights to the use of the assayed resource. The standards to use, as well as the manner of making the claim, would need to be defined by internationally agreed to rules. For simplicity in establishing rules for use of lunar resources I suggest use of the international regime called for in Article 11 of the Moon Treaty.[3] The estimated value of resources in the claim could then be used to seek financing to develop the claim from the Asteroid Mining Bank that would have rights to emit a currency to cover transactions in outer space. These ideas were further developed in another essay (see “Blockchains and the emerging space economy”, The Space Review, October 10, 2016), where I proposed that development of a space economy involving asteroid or other space resources requires both spacecraft technology as well as financial technology. Financial technology envisioned the creation of Space Money based on verified outer space resources that could be exploited under international law.

With plans firming up for the first woman on the Moon to be launched by the US in 2024 there is no doubt about the advancements in spacecraft technology. However, there has been little progress to advance requisite financial technology or the policy underpinnings of such technology. In this article I propose a process based on Modern Monetary Theory (MMT) using the open source Libra Blockchain linked to verified outer space resources defined by rules agreed to in an international regime negotiated by the parties to the Moon Treaty with financing guaranteed through a Space Bank in which the central banks of all states parties to the Moon Treaty have the right to become members.

#### Unilat fails --- only international MMT can inject the policy stability needed to underwrite space development

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A stable source of long-term financing for lunar development

During the Apollo era, when reaching the Moon was a high national priority, NASA’s budget reached a maximum of 4.4 percent of the Federal budget. After space exploration was removed as a national priority in 1972, NASA’s budget has steadily declined to 0.47% (2019) with a nominal increase in 2020. Barring a new space race with China or a major shift in public attitudes, it will not increase much more. Despite the pro-space rhetoric of the Trump Administration and enthusiasm from space advocates such as Elon Musk, US budgets for space are driven by the political clout of members of Congress serving districts with space facilities. To drive industrial development of the Moon there needs to be a stable source of funds dedicated to achieve industrial development goals that is not subject to biannual election politics. This would be possible with private investment, but there is no business case for investments in Moon that are not dependent on government funding.

A common understanding is that taxes are the primary source of government revenue with government borrowing augmenting tax revenue. Politicians loathe to increase taxes to fund discretionary activities, including NASA budgets, which are always weighted against other priorities. Borrowing funds to pay for space development could be attractive, if in the long term borrowed money could be repaid. However, so far no scenario of economic sustainability of lunar development has been presented.

Modern Monetary Theory (MMT) is emerging as a response to failed austerity policies pursued by countries in Europe and elsewhere marked by strict limits on government spending, balanced budgets, and minimalization of government debt after the 2007–2008 global economic crisis. Many governments viewed that economies had experienced a financial bubble and that reforms were needed to rein in out-of-control economies. The massive spending cuts of the reforms resulted in large unemployment and cancellation of space initiatives like the Vision for Space Exploration. MMT offers an approach to increase spending to meet social and economic goals rather than pursuing economic austerity. As a result of austerity policies, many countries faced high unemployment. MMT injects new money directly into the economy to put people back to work without increasing taxes or government borrowing.

In this paper I make the case that MMT can be used to create as much money as needed to fund a long-term lunar development plan, much as an MMT type of scheme, quantitative easing, has been used by the US Federal Reserve to inject upwards of $10 trillion dollars in the US economy following the economic crisis of 2008 to enable sustained economic recovery marked by low inflation and strong job growth.

MMT is an economic theory that treats sovereign governments as different from households and other economic agents in that governments, unlike households, can emit (create) money to pay for government obligations.[3] The value of the dollar or any other currency that is internationally traded with floating exchange rates is a function of the expectations of the market about the economy of the country, taking into consideration economic trends, political climate, government actions like tax policy, level of corruption, investments in infrastructure and science and innovation, and other factors. In conventional practice expectations can be shaped by the decisions of the central bank (for the US, the Federal Reserve) to set underlying interest rates to control money supply.

According to MMT, as long as inflation is bounded to enable sustainable development of the economy, the government can create fresh money to cover identified expenses, including growth-promoting investments. Money emitted by the central bank in such a system does not have to be based on tax receipts or other payments to the government or on financial reserves in the form of gold or other assets held by the government. The sovereign authority does not have to borrow money, it can create as much money as needed simply by changing account values digitally without printing money. Such money can be used to make any government payments, including those needed to achieve an overriding economic goal, which has been generally stated as full employment.

The only limit to this money creation, in principle, is the underlying capacity of the economy to produce goods and services. Insufficient capacity drives up prices, resulting in rising inflation. Inflation that is excessive erodes capacity of money as a store of value and can lead to hyperinflation and economic collapse. In contrast, deflation, which is the reduction of the value of units of money, reduces the value of assets. Whether the economy is MMT or a conventional economy where government budgets are dependent on tax receipts inflation must be controlled to maintain sustainable growth. Taxes dampen economic growth and price escalation.

MMT is made possible thru the emergence of fiat money whose value is based on the expectations of performance of the economy. The US exited the gold standard in 1934 and, after a series of gyrations that increasingly decoupled creation of money from the value of gold, the US adopted a pure fiat currency in 1976. Fiat money, as commonly defined, “does not have use value, and has value only because a government maintains its value, or because parties engaging in exchange agree on its value.”

MMT is coming into favor as a counter to austerity policies of sovereign countries that view that national budgets cannot sustainably operate in the red but must either cut spending or increase taxes or both. In contrast, MMT sets the goal not of balancing budgets or limiting federal indebtedness but rather to strive for full employment. An MMT type of approach appears to have been working with the quantitative easing employed by the US Federal Reserve to facilitate recovery from the 2007–2008 economic crisis. At the time, the federal funds rate had been reduced to near zero, which reduced the value of conventional lending by banks. Huge quantities of money were injected while inflation was closely monitored to control the rate. MMT has been proposed as an approach to address climate change with schemes like the Green New Deal. MMT is controversial and not seen as a panacea. Mario Draghi, the head of the European Central Bank, sees MMT as a question to be addressed but that it is more a tool for national governments to control the distribution of money rather than the quantity of its creation. MMT is resisted by central bank governors in Europe and faces political and institutional opposition in the US.

Establishing the analog of sovereign state authority for Space Money

MMT can work for sovereign states with their own currency that control their own money supply. There are no sovereign states beyond the Earth and, since an economy based on space resources does not yet exist, there is no political or institutional opposition to an MMT approach for the outer space economy. Article II of the Outer Space Treaty even raises questions about claims to rights to territory on the Moon and other celestial bodies based on sovereignty:

Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.

The essential function of sovereign authority in an MMT economic system is to issue money and control money supply such that the money that is issued is recognized by agents in the economy as being a stable store of value and that inflation can be controlled to a determined value. Such an authority can be established by a treaty among sovereign states. No sovereign state would surrender its sovereignty to a treaty-based authority without gaining substantial value from this decision. This is the basis of the Eurozone with participating states forgoing their sovereign authority to issue and control money supply to the European Central Bank (ECB).

The Space Bank would have a different purpose from the ECB in the Eurozone. Rather than surrendering their sovereign authority to emit money and to control its supply, the states participating in the Space Bank would grant authority to the Space Bank to issue “Space Money” to be used for space-related investments and development and in activities on the Moon and in cislunar space that would operate under the international regime authority that also establishes the Space Bank. In addition to mining and manufacturing and energy production, such activities could include hotels and resorts in cislunar space with visitors from many countries who would pay for services in Space Money rather than in the currency of the state of origin. Space Money would maintain a flexible exchange rate with terrestrial currencies such as the dollar, euro, pound sterling, ruble, and others, enabling purchases to be made by organizations operating in space that purchase goods from terrestrial suppliers.

Rather than the goal being full employment, as in conventional MMT, the goal becomes generating maximum benefits to the participating sovereign states and their people thru achievement of industrial development of the Moon. If large-scale workforce reduction takes place on Earth in oil, gas, and other extractive industries as well as the automotive industry, all developed economies will be faced with the challenge of what to do with tens of millions of people with advanced technical educations but with diminished roles on Earth. Lunar industrial development on the scale of the Big Push can be a driver that generates employment across many sectors in emerging industries, made possible by lunar industrial development. Space resorts serving the needs of tourists from Earth have the potential to evolve to large space habitats that can ultimately house millions. The participating states and their central banks could define their national goals as full employment or other national goals without limiting the capacity of the Space Bank to emit additional funds to meet lunar development goals.

What’s needed is the commitment by spacefaring countries to lunar industrial development. This commitment to the overall goal would provide confidence that, if technical milestones can be met, governments will work to fulfill the successive milestones to achieve the potential of lunar industrial development for all mankind.

#### US-China cooperation is necessary to establish credible policy framework for the Space Bank

**Beldavs 19** [Vidvuds Beldavs serves as the strategist for FOTONIKA-LV, the photonics research platform of the University of Latvia, he is also a founding member of the International Lunar Decade Working Group formed in November 2014 to advance the idea of the International Lunar Decade, “Modern monetary theory and lunar development,” October 14, 2019, *The Space Review,* http://www.thespacereview.com/article/3811/1]

The International Lunar Decade

The proposed International Lunar Decade (ILD) from 2021 to 2030 can provide a framework to coordinate international action, shaping an innovation ecosystem to accelerate technology developments as well as technical and non-technical innovations working towards the goal of sustainable development in space enabling sustainable development on Earth. One measure of achieving that goal would be that, by 2030, more than one major project such as lunar water and fuel depots at LEO or an space-based solar power installation could be achievable.

The ILD framework can be structured to organize the work to negotiate the International Regime including policies for use of lunar materials as well as to take steps to establish the institutional structures that would enable the system to operate including the Space Bank.

Roles of the Moon Treaty and Outer Space Treaty

The Moon Treaty, specifically the international regime called for in Article 11, can provide the policy framework and rules to enable such a process to work. The foundation of the credibility and authority of the Space Bank would be based on the credibility of the States Parties to the Treaty and their commitment to goals for the long-term development of the Moon and a robust Earth-Moon economy. The rules defined in the International Regime would not only define how space resources could be used and how the use of space resources would be governed but would also establish the role of the Space Bank to maintain sustainable development and stability of the space economy. This will be increasingly needed as more and more transactions are executed with Space Money independent of national economies of Earth. However, the participation of states in the governance of the Space Bank would continue to provide channels for assuring benefits to sovereign states and their people on Earth. If sovereign powers emerge in outer space that are not dependencies of sovereign states on Earth, the international regime will need to address this eventuality.

At present there are 18 states parties to the Moon Treaty and an additional four signatories that include France and India. Of those, India has the capacity to reach the Moon and France is also a credible power in outer space. For the Moon Treaty and the associated international regime to play a foundational role for the Space Economy, all spacefaring countries would need to become parties to the treaty. While no alternative to the Moon Treaty exists and there is not even an internationally recognized forum where rules for the use of outer space resources could be negotiated, a prevailing opinion in the US is that the Moon Treaty is a failed treaty because no major spacefaring country is a party to the Treaty. Dennis O’Brien has proposed an Implementation Agreement for the Moon Treaty. If major countries like China would agree to such an implementation agreement, this would open a pathway towards expansion of the number of parties to the Treaty.

As Article 1 of the Outer Space Treaty states:

The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind.

The Space Bank is conceived to fulfill the mandate of Article I of the Outer Space Treaty to enable all states, regardless of their degree of economic or scientific development, to benefit from exploration and use of outer space. This could be achieved directly by enabling residents of all participating states to have accounts with the Space Bank. As the total quantity of Space Money emitted by the Space Bank increases, every person or legal entity holding Space Money could have their holdings expanded proportionally to the increase in money emitted by the Space Bank. Such a money system could be managed thru digital money issued by a system like Libra. It is assumed that the value of units of Space Money would remain highly stable. As money supply would be expanded, individual accounts could be indexed such that over time an initial quantity of, say, 100 could expand reflecting the aggregate increase in the value of the space economy.

Distributed ownership with distributed governance

Given the creation of a Space Bank that is owned by the central banks of participating states as presented earlier, Space Bank can emit Space Money according to an algorithm designed to promote sustainable growth in space development. Even though blockchain technology is a building block of the system, Space Money is not a cryptocurrency like Bitcoin but could be more like Libra, a digital currency being advanced by the Libra Association, where the value of the money that is emitted is backed by a reserve of assets as described in the Libra White Paper. Below is a comparison of Libra and Space Money:

#### Global decline in economic productivity ensures systemic collapses that result in great power war and the spread of authoritarianism

**Sundaram 19** [Jomo Kwame Sundaram, a former economics professor, was United Nations Assistant Secretary-General for Economic Development, and received the Wassily Leontief Prize for Advancing the Frontiers of Economic Thought in 2007, and Vladimir Popov, a former senior economics researcher in the Soviet Union, Russia and the United Nations Secretariat, is now Research Director at the Dialogue of Civilizations Research Institute in Berlin, “Economic Crisis Can Trigger World War,” Feb 12, 2019, http://www.ipsnews.net/2019/02/economic-crisis-can-trigger-world-war/]

Economic recovery efforts since the 2008-2009 global financial crisis have mainly depended on unconventional monetary policies. As fears rise of yet another international financial crisis, there are growing concerns about the increased possibility of large-scale military conflict.

More worryingly, in the current political landscape, prolonged economic crisis, combined with rising economic inequality, chauvinistic ethno-populism as well as aggressive jingoist rhetoric, including threats, could easily spin out of control and ‘morph’ into military conflict, and worse, world war.

Crisis responses limited

The 2008-2009 global financial crisis almost ‘bankrupted’ governments and caused systemic collapse. Policymakers managed to pull the world economy from the brink, but soon switched from counter-cyclical fiscal efforts to unconventional monetary measures, primarily ‘quantitative easing’ and very low, if not negative real interest rates.

But while these monetary interventions averted realization of the worst fears at the time by turning the US economy around, they did little to address underlying economic weaknesses, largely due to the ascendance of finance in recent decades at the expense of the real economy. Since then, despite promising to do so, policymakers have not seriously pursued, let alone achieved, such needed reforms.

Instead, ostensible structural reformers have taken advantage of the crisis to pursue largely irrelevant efforts to further ‘casualize’ labour markets. This lack of structural reform has meant that the unprecedented liquidity central banks injected into economies has not been well allocated to stimulate resurgence of the real economy.

From bust to bubble

Instead, easy credit raised asset prices to levels even higher than those prevailing before 2008. US house prices are now 8% more than at the peak of the property bubble in 2006, while its price-to-earnings ratio in late 2018 was even higher than in 2008 and in 1929, when the Wall Street Crash precipitated the Great Depression.

As monetary tightening checks asset price bubbles, another economic crisis — possibly more severe than the last, as the economy has become less responsive to such blunt monetary interventions — is considered likely. A decade of such unconventional monetary policies, with very low interest rates, has greatly depleted their ability to revive the economy.

The implications beyond the economy of such developments and policy responses are already being seen. Prolonged economic distress has worsened public antipathy towards the culturally alien — not only abroad, but also within. Thus, another round of economic stress is deemed likely to foment unrest, conflict, even war as it is blamed on the foreign.

International trade shrank by two-thirds within half a decade after the US passed the Smoot-Hawley Tariff Act in 1930, at the start of the Great Depression, ostensibly to protect American workers and farmers from foreign competition!

Liberalization’s discontents

Rising economic insecurity, inequalities and deprivation are expected to strengthen ethno-populist and jingoistic nationalist sentiments, and increase social tensions and turmoil, especially among the growing precariat and others who feel vulnerable or threatened.

Thus, ethno-populist inspired chauvinistic nationalism may exacerbate tensions, leading to conflicts and tensions among countries, as in the 1930s. Opportunistic leaders have been blaming such misfortunes on outsiders and may seek to reverse policies associated with the perceived causes, such as ‘globalist’ economic liberalization.

Policies which successfully check such problems may reduce social tensions, as well as the likelihood of social turmoil and conflict, including among countries. However, these may also inadvertently exacerbate problems. The recent spread of anti-globalization sentiment appears correlated to slow, if not negative per capita income growth and increased economic inequality.

To be sure, globalization and liberalization are statistically associated with growing economic inequality and rising ethno-populism. Declining real incomes and growing economic insecurity have apparently strengthened ethno-populism and nationalistic chauvinism, threatening economic liberalization itself, both within and among countries.

Insecurity, populism, conflict

Thomas Piketty has argued that a sudden increase in income inequality is often followed by a great crisis. Although causality is difficult to prove, with wealth and income inequality now at historical highs, this should give cause for concern.

Of course, other factors also contribute to or exacerbate civil and international tensions, with some due to policies intended for other purposes. Nevertheless, even if unintended, such developments could inadvertently catalyse future crises and conflicts.

Publics often have good reason to be restless, if not angry, but the emotional appeals of ethno-populism and jingoistic nationalism are leading to chauvinistic policy measures which only make things worse.

At the international level, despite the world’s unprecedented and still growing interconnectedness, multilateralism is increasingly being eschewed as the US increasingly resorts to unilateral, sovereigntist policies without bothering to even build coalitions with its usual allies.

Avoiding Thucydides’ iceberg

Thus, protracted economic distress, economic conflicts or another financial crisis could lead to military confrontation by the protagonists, even if unintended. Less than a decade after the Great Depression started, the Second World War had begun as the Axis powers challenged the earlier entrenched colonial powers.

They patently ignored Thucydides’ warning, in chronicling the Peloponnesian wars over two millennia before, when the rise of Athens threatened the established dominance of Sparta!

Anticipating and addressing such possibilities may well serve to help avoid otherwise imminent disasters by undertaking pre-emptive collective action, as difficult as that may be.

The international community has no excuse for being like the owners and captain of the Titanic, conceitedly convinced that no iceberg could possibly sink the great ship.

#### Those wars cause extinction --- loose nukes

Mann 14 [Eric Mann is a special agent with a United States federal agency, with significant domestic and international counterintelligence and counter-terrorism experience. Worked as a special assistant for a U.S. Senator and served as a presidential appointee for the U.S. Congress. He is currently responsible for an internal security and vulnerability assessment program. Bachelors @ University of South Carolina, Graduate degree in Homeland Security @ Georgetown. “AUSTERITY, ECONOMIC DECLINE, AND FINANCIAL WEAPONS OF WAR: A NEW PARADIGM FOR GLOBAL SECURITY,” May 2014, <https://jscholarship.library.jhu.edu/bitstream/handle/1774.2/37262/MANN-THESIS-2014.pdf>]

The conclusions reached in this thesis demonstrate how economic considerations within states can figure prominently into the calculus for future conflicts. The findings also suggest that security issues with economic or financial underpinnings will transcend classical determinants of war and conflict, and change the manner by which rival states engage in hostile acts toward one another. The research shows that security concerns emanating from economic uncertainty and the inherent vulnerabilities within global financial markets will present new challenges for national security, and provide developing states new asymmetric options for balancing against stronger states. The security areas, identified in the proceeding chapters, are likely to mature into global security threats in the immediate future. As the case study on South Korea suggest, the overlapping security issues associated with economic decline and reduced military spending by the United States will affect allied confidence in America’s security guarantees. The study shows that this outcome could cause regional instability or realignments of strategic partnerships in the Asia-pacific region with ramifications for U.S. national security. Rival states and non-state groups may also become emboldened to challenge America’s status in the unipolar international system. The potential risks associated with stolen or loose WMD, resulting from poor security, can also pose a threat to U.S. national security. The case study on Pakistan, Syria and North Korea show how financial constraints affect weapons security making weapons vulnerable to theft, and how financial factors can influence WMD proliferation by contributing to the motivating factors behind a trusted insider’s decision to sell weapons technology. The inherent vulnerabilities within the global financial markets will provide terrorists’ organizations and other non-state groups, who object to the current international system or distribution of power, with opportunities to disrupt global finance and perhaps weaken America’s status. A more ominous threat originates from states intent on increasing diversification of foreign currency holdings, establishing alternatives to the dollar for international trade, or engaging financial warfare against the United States.

#### Global spread of authoritarian nationalism causes nuclear war

**Orts 18** [Eric Orts, the Guardsmark Professor at The Wharton School, University of Pennsylvania, June 27, 2018, “Foreign Affairs: Six Future Scenarios (and a Seventh),” <https://www.linkedin.com/pulse/foreign-affairs-six-future-scenarios-seventh-eric-orts>]

7. Fascist Nationalism. There is another possible future that the Foreign Affairs scenarios do not contemplate, and it’s a dark world in which Trump, Putin, Xi, Erdogan, and others construct regimes that are authoritarian and nationalist. Fascism is possible in the United States and elsewhere if big business can be seduced by promises of riches in return for the institutional keys to democracy. Perhaps Foreign Affairs editors are right to leave this dark world out, for it would be very dark: nationalist wars with risks of escalation into global nuclear conflict, further digital militarization (even Terminator-style scenarios of smart military robots), and unchecked climate disasters. The global challenges are quite large – and the six pieces do an outstanding job of presenting them. One must remain optimistic and engaged, hopeful that we can overcome the serious dangers of tribalism, nationalism, and new fascism. These "isms” of our time stand in the way of solving some of our biggest global problems, such as the risks of thermonuclear war and global climate catastrophe.

#### A myriad of emerging threats risk extinction --- try or die for maximizing the effectiveness of global institutional resilience, which facilitates cooperative existential risk management

Brooks 14 [Rosa, 11/13, Professor of Law at Georgetown & Schwartz Sr. Fellow at the New America Foundation, November 13, 2014, <http://www.foreignpolicy.com/articles/2014/11/13/a_strategyless_nation_america_democrats_grand_strategy_foreign_policy>]

I've written about these issues before (here and here), and at risk of being both a narcissist and a broken record, I'll quote myself: The world has grown more complex. Believe it. The world now contains more people living in more states than ever before, and we're all more interconnected. A hundred years ago, the world population was about 1.8 billion, there were roughly 60 sovereign states in the world, the automobile was still a rarity, and there were no commercial passenger flights and no transcontinental telephone service. Fifty years ago, global population had climbed to more than 3 billion and there were 115 U.N. member states, but air travel was still for the wealthy and the personal computer still lay two decades in the future. Today? We've got 7 billion people living in 192 U.N. member states and a handful of other territories. These 7 billion people take 93,000 commercial flights a day from 9,000 airports, drive 1 billion cars, and carry 7 billion mobile phones around with them. In numerous ways, life has gotten substantially better in this more crowded and interconnected era. Seventy years ago, global war killed scores of millions, but interstate conflict has declined sharply since the end of World War II, and the creation of the United Nations ushered in a far more egalitarian and democratic form of international governance than existed in any previous era. Today, militarily powerful states are far less free than in the pre-U.N. era to use overt force to accomplish their aims, and the world now has numerous transnational courts and dispute-resolution bodies that collectively offer states a viable alternative to the use of force. The modern international order is no global utopia, but it sure beats colonial domination and world wars. In the 50 years that followed World War II, medical and agricultural advances brought unprecedented health and prosperity to most parts of the globe. More recently, the communications revolution has enabled exciting new forms of nongovernmental cross-border alliances to emerge, empowering, for instance, global human rights and environmental movements. In just the last two decades, the near-universal penetration of mobile phones has had a powerful leveling effect: All over the globe, people at every age and income level can use these tiny but powerful computers to learn foreign languages, solve complex mathematical problems, create and share videos, watch the news, move money around, or communicate with far-flung friends. All this has had a dark side, of course. As access to knowledge has been democratized, so too has access to the tools of violence and destruction, and greater global interconnectedness enables disease, pollution, and conflict to spread quickly and easily beyond borders. A hundred years ago, no single individual or nonstate actor could do more than cause localized mayhem; today, we have to worry about massive bioengineered threats created by tiny terrorist cells and globally devastating cyberattacks devised by malevolent teen hackers. Even as many forms of power have grown more democratized and diffuse, other forms of power have grown more concentrated. A very small number of states control and consume a disproportionate share of the world's resources, and a very small number of individuals control most of the world's wealth. (According to a 2014 Oxfam report, the 85 richest individuals on Earth are worth more than the globe's 3.5 billion poorest people). Indeed, from a species-survival perspective, the world has grown vastly more dangerous over the last century. Individual humans live longer than ever before, but a small number of states now possess the unprecedented ability to destroy large chunks of the human race and possibly the Earth itself -- all in a matter of days or even hours. What's more, though the near-term threat of interstate nuclear conflict has greatly diminished since the end of the Cold War, nuclear material and know-how are now both less controlled and less controllable. Amid all these changes, our world has also grown far more uncertain. We possess more information than ever before and vastly greater processing power, but the accelerating pace of global change has far exceeded our collective ability to understand it, much less manage it. This makes it increasingly difficult to make predictions or calculate risks. As I've written previously: We literally have no points of comparison for understanding the scale and scope of the risks faced by humanity today. Compared to the long, slow sweep of human history, the events of the last century have taken place in the blink of an eye. This should ... give us pause when we're tempted to conclude that today's trends are likely to continue. Rising life expectancy? That's great, but if climate change has consequences as nasty as some predict, a century of rising life expectancy could turn out to be a mere blip on the charts. A steep decline in interstate conflicts? Fantastic, but less than 70 years of human history isn't much to go on.... That's why one can't dismiss the risk of catastrophic events [such as disastrous climate change or nuclear conflict] as "high consequence, low probability." How do we compute the probability of catastrophic events of a type that has never happened? Does 70 years without nuclear annihilation tell us that there's a low probability of nuclear catastrophe -- or just tell us that we haven't had a nuclear catastrophe yet?... Lack of catastrophic change might signify a system in stable equilibrium, but sometimes -- as with earthquakes -- pressure may be building up over time, undetected.... Most analysts assumed the Soviet Union was stable -- until it collapsed. Analysts predicted that Egypt's Hosni Mubarak would retain his firm grip on power -- until he was ousted. How much of what we currently file under "Stable" should be recategorized under "Hasn't Collapsed Yet"? This, then, is the character of world messiness in this first quarter of the 21st century. So on to the next question: Where, in all this messiness, does the United States find itself?

This has urgent implications for U.S. strategic planning. Precisely because U.S. global power may very well continue to decline, the United States should use the very considerable military, political, cultural, and economic power it still has to foster the international order most likely to benefit the country if it someday loses that power.

The ultimate objective of U.S. grand strategy should be the creation of an equitable and peaceful international order with an effective system of global governance — one that is built upon respect for human dignity, human rights, and the rule of law, with robust mechanisms for resolving thorny collective problems.

We should seek this not because it’s the “morally right” thing for the United States to do, but because a maximin decision rule should lead us to conclude that this will offer the United States and its population the best chance of continuing to thrive, even in the event of a radical future decline in U.S. wealth and power.

#### We are reaching a historic global moment of economic crisis --- only space exploration can solve the twin periods of financialization and peak resources / resource inequality

**Beldavs and Sommers 13** [Vidvuds Beldavs serves as the strategist for FOTONIKA-LV, the photonics research platform of the University of Latvia, he is also a founding member of the International Lunar Decade Working Group formed in November 2014 to advance the idea of the International Lunar Decade, Jeffrey Sommers, Associate Professor of Political Economy & Public Policy in Africology and Global Studies Fellow at the University of Wisconsin-Milwaukee, also Visiting Faculty, Stockholm School of Economics in Riga, advised governments up to the prime minister level and has written on political economy for The Financial Times, The Guardian, The Moscow Times, and others, “Back to the future: Space and escaping the gravitational pull of economic crisis,” Nov 19, 2012, <https://www.thespacereview.com/article/2190/1>]

We have arrived at a historical moment of economic crisis where no exit appears visible. The limits of financialization and the “service” economy have been reached. The way forward is through a return to developing the real economy. However, we are also at the limits of globalization. Technological advances and their commercialization with new products, though necessary, will not solve the problem.

Most countries plan to produce more engineers and PhDs in the sciences to innovate out of the morass. Yet, globally, we are already producing more people with high levels of education for which they will find no meaningful roles. In the US, many science postdocs can’t get tenure and seek out alternative opportunities. Others supplement adjunct salaries with poverty relief programs, while scores more abandon their chosen disciplines seeking alternative lines of work. China, which is producing vastly more technical specialists than the US, is finding it hard to generate jobs that match the skills and expertise that are being acquired. This problem will be compounded as universities around the world disgorge increasing numbers of highly trained specialists.

Meanwhile, states with few natural resources and little manufacturing are pursuing austerity policies in an attempt to escape the present crisis. The result has often been a further deepening of economic problems. Energy-rich countries are temporarily in better financial shape, but not as good as assumed just a few years ago. Advances in extraction technologies for gas and oil mean energy prices will be lower than previously forecast. In short, we are moving towards energy price declines as reserves for oil and gas have risen over earlier forecasts, which will slow the growth of “green economy” jobs.

Most countries are developing innovation centers and technology parks linked to research universities. Countries like Russia have made major bets on future high technology development. Russia’s $33 billion gamble on nanotechnology has reputedly generated rent-seeking, but relatively few competitive industries. Thousands of scientists must be matched to real problems that result in globally competitive products. Their solutions must find financing and entrepreneurial talent to create new industries. Yet, what is uncertain is whether in light of the kind of technological challenges to overcome, that competitive products will be developed and that successful enterprises will emerge that can compete in the global environment while paying highly trained specialists higher wages.

The crisis we face is much deeper than the end of globalization. Humanity is reaching the limits of its ecological niche on this planet. The financialization of the economy that led to the present crisis is a symptom of the deeper crisis. Finding opportunities in the real economy is limited, while clever people created a virtual financial world with seemingly limitless opportunity. Yet this virtual world is dependent on the real economy. For the virtual financial economy to continue to deliver real rewards, the real economy must ultimately see real development. However, we no longer have a frontier to conquer and, thankfully, we are running out of low income countries where goods can be produced ever cheaper through factor accumulation (cheap labor). Limited to the environment of the Earth, there is no known economic model that can deliver high income jobs globally. While arguments for exploration of space have not been a national priority for two generations, it is time we reconsider a return to the space frontier.

Arguments for expansion beyond the Earth that look to address existential threats to human survival such as nuclear war, plague, climate change, and asteroid impact are not compelling, because such threats are long-term possibilities with varying probabilities of occurrence. The compelling argument for space industrialization is that we are near the limits of our ecological niche on Earth and, as a species, must expand our territory much as territorial expansions have occurred many times before. The most powerful historical example is the American frontier with its extraordinary global impact. Moreover, in the medium term, the technologies needed to make space exploration a reality will likely deliver innovations that will make life on Earth more livable going forward. Space industrialization is the next industrial revolution that Robert J. Gordon could not find in his National Bureau of Economic Research article “Is US Economic Growth Over?”

### 1ac space development adv

#### Unilateral approaches to lunar and translunar space development ensure militarization, accelerating space mil and terrestrial resource conflicts while undermining sustainable human space presence

**Beldavs 19** [Vidvuds Beldavs serves as the strategist for FOTONIKA-LV, the photonics research platform of the University of Latvia, he is also a founding member of the International Lunar Decade Working Group formed in November 2014 to advance the idea of the International Lunar Decade, “Modern monetary theory and lunar development,” served as Business Trends Advisor to Cummins, Inc., and served as the Executive Director of the Technology Transfer Society, was the Hudson Institute’s initiator of the International Baltic Economic Commission for the governments of Estonia, Latvia and Lithuania, October 14, 2019, *The Space Review,* http://www.thespacereview.com/article/3811/1]

Lunar development has been paced to the hard budgetary constraints placed on NASA, ESA, and other space agencies that are subject to political approval. If funding could be made available based on the soundness of a plan from a long-term perspective, then lunar exploration and development as envisioned in the Bush-era Vision for Space Exploration would have been possible. Even the space colonies vision of Gerard K. O’Neill of millions of people living and working in outer space could be realized. What’s needed is a way to depoliticize spending for outer space. Given that long-term goals have been agreed to, then maintaining funding to achieve the goals could result in not only achieving the goals but doing so sooner. It would be less wasteful and, by implication, much less costly over the long haul. Multiyear budgeting can help but cannot prevent imposition of spending limits on space development as long as the spending is constrained by the national budget and competing near-term priorities of a sovereign state.

Development of the space economy calls for new approaches

Existing approaches to financing space development cannot succeed with a complex, multi-sectoral problem like lunar industrial development. While it would be remarkable, the NASA goal of landing the first woman on the Moon by 2024 is clouded by political uncertainties and weak public support. Vastly more uncertain are prospects for significant industrial development of the Moon in coming decades with current approaches. A Jeff Bezos could probably fund a lunar landing, given support from NASA and plenty of luck. But a human lunar landing would just be a tiny step towards creating sustainable industrial capacity on the Moon. Even a modern-day Apollo, augmented with significant coordinated private investment, would face the danger of funding stagnation if the Moon would lose political favor to other priorities.

Namrata Goswani raises the concern that America’s incoherent Moon strategy is weakening its space leadership (see “America’s incoherent Moon strategy is weakening its space leadership”, The Space Review, September 23, 2019). The challenge, however, cannot be effectively addressed with a nation-state solution regardless of the coherence of its Moon strategy. Industrial development of the Moon is a global challenge that calls for an international response that includes the US and China, together with the other major spacefaring powers and all of the G20 nations, and including vital roles for developing countries. A focus on national competition is likely to encourage greater militarization of outer space, increased risks, and lots of resources wasted on weapons systems that do not advance the goal of industrial development of the Moon.

This paper proposes a pathway towards sustained long-term funding to provide government budgets and coordinated private investment to meet lunar development milestones in a sufficiently large long-term lunar development plan to develop the enabling technologies, infrastructure, and industrial capacity to enable a sustainable Earth-Moon economy and space settlement. What is proposed is a framework for international cooperation, within which rules-based competition would drive development within an innovation ecosystem that engages a widening array of players across multiple sectors and technologies working towards the goal of industrial development of the Moon.

Lunar industrial development would create conditions for emergence of:

Transportation/logistics infrastructure, including fuel depots at strategic locations (LEO, Earth-Moon L-1, lunar orbits); LEO assembly operations, in-space manufacturing, lunar launch facilities, shuttle operations between LEO and other near Earth orbits and lunar orbit.

Energy infrastructure

Infrastructure for life support, including space agriculture.

Industries emerging on the Moon to meet demand for products in markets critical to the emergence of an Earth-Moon economy: water, oxygen, basalt and other structural materials, and metals

More broadly, lunar industrial development could:

Strengthen expectations of long-term sufficiency of natural resources, reducing conflicts over terrestrial resources. Escape the trap of win-lose competition by embracing international cooperation with rules-based cooperation for sustainable development for centuries to come made possible through use of outer space resources.

Safeguard the Earth’s biosphere while continuing development.

Over time, help enable full employment in the economies of participating countries -- an increasing concern in the face of the expected negative impact of automation on overall employment.

Develop new technologies, by way of the technical challenges to space development, which will help overcome problems (economic, environmental, and social) on Earth.

At present, no lunar development project has a business case that does not depend on government financing. NASA can request, for example, that an Astrobotic deliver payloads to the lunar surface, or ESA can commission a lunar rover built by industry, but so far no projects exist which can generate profits without government payments. There is also no clear scenario for achieving economic feasibility of lunar development.

#### The impact is extinction

**Beldavs 19** [Vidvuds Beldavs serves as the strategist for FOTONIKA-LV, the photonics research platform of the University of Latvia, he is also a founding member of the International Lunar Decade Working Group formed in November 2014 to advance the idea of the International Lunar Decade, “Modern monetary theory and lunar development,” October 14, 2019, *The Space Review,* http://www.thespacereview.com/article/3811/1]

Conclusions

Outer space development is similar to development of countries lacking industrial infrastructure, modern financial systems, and a suitably trained workforce. Numerous studies have addressed the problem how large flows of developmental assistance to developing countries often have had little incremental impact in advancing these countries towards sustainable economic development. Similarly, large investments in space exploration since the Apollo lunar landings 50 years ago have seen little progress towards industrial development in space. There is compelling evidence that outer space resources could enable sustainable development for humankind for centuries to come while safeguarding the biosphere of Earth. Incremental development, particularly if it is largely driven by nation-state governments, is unlikely to lead to breakout. Such space development is likely to lead to increased militarization of space, chewing up vital resources while threatening the survival of industrial civilization. International cooperation within a rules-based order that permits vigorous competition within a stable framework can lead to breakthrough to a self-sustaining space economy.

This paper presents an outline of an approach to make a Big Push to achieve industrial development of the Moon. While there are numerous studies of space-based solar power, lunar water, oxygen extraction from regolith, design of lunar bases, and other topics, there is a paucity of research and writing on the process of space development and of the nature of the space economy. I present the idea of a Big Push for lunar development, although the necessary elements for a Big Push—how investment can be generated, analysis of alternative pathways for development, critical building blocks, and other issues—remain to be defined.

#### China key to effective international regime governing the Moon --- excluding China ensures the fragmented blocs, preventing lunar development

**Beldavs 15** [Vid Beldavs, serves as the strategist for FOTONIKA-LV, the photonics research platform of the University of Latvia, he is also a founding member of the International Lunar Decade Working Group formed in November 2014 to advance the idea of the International Lunar Decade, December 7, 2015, “Prospects for US-China space cooperation,” https://www.thespacereview.com/article/2878/1]

The law’s limitations

Exclusive mining rights will need to be defined within an international regime that governs territory, such as the Moon, to which sovereign rights do not apply under the Outer Space Treaty. Insofar as lunar water has been identified as a possible resource to reduce the costs of reaching Mars, this issue will need to be resolved before the lunar water can be mined. China is among the states that show interest in lunar water.

No country or company has mined the Moon or an asteroid, or has had industrial operations of any kind in space. Mining technologies may, in fact, be more advanced in countries such as Australia and Canada than in the US. In fact, space mining conferences held in Australia and in Canada have attracted significant attendance by mining companies and the equipment industries that serve them. Notwithstanding the ambitious plans of Deep Space Industries and Planetary Resources, it is not at all clear that they will possess superior technology for space mining to other potential competitors including from China, India, Japan, Korea, Russia, or the EU. No one has yet processed materials in space other than lab-scale experiments. China and India, which have both mounted large-scale industrial projects, may have a body of industrial process know-how that is already competitive with US capabilities to process asteroid or lunar materials into products. There are multiple other aspects of industrial development in space where knowledge and technologies exist somewhere in the world where the US may not have an inherent competitive advantage.

The future that is being created through the new law will create more competitive opportunities for US commercial space companies. But, this legislation cannot guarantee them superior technology or exclusive mining rights or use of shared infrastructure in cislunar space that can reduce communications, transportation and operating costs.

The Wolf Amendment is counter to US national interests

Clearly sensitive technologies need to be protected. But, protecting US intellectual property is not known to be a domain where the House Appropriations Committee of the US Congress has recognized expertise or where it has been invested with any specific authority. Additionally, NASA is a relatively tiny domain in the vast territory of advanced technology under development by the US. The Wolf Amendment, in fact, offers no protection of American technology but instead empowers members of a Congressional committee with no relevant expertise or authority to play a foreign policy role.

Congressman Culbertson clearly recognizes that space technology is key to addressing major challenges facing not only the US, but the entire world community. To bar the United States from participation in global initiatives in the peaceful uses of outer space because China is also involved is, at best, is an overemotional response to the potential for illicit technology transfer with a totally inappropriate instrument.

Far more relevant to US national interests would be for Rep. Culbertson to support developing more effective strategies to advance US commercial interests in space. Otherwise, the Chinese, not bounded by ineffective legislation, will eat our lunch.

No one has yet developed the technologies for ISRU whether on the Moon, the asteroids, Mars, or beyond. Yet ISRU technologies are central to the whole idea of asteroid and lunar mining. If the Chinese can work with everyone else on the planet, but the US can only work with a short list as approved by the Appropriations Committee, it should be expected that the Chinese, drawing on the knowledge base of the entire world, will advance more quickly. We have no lead in ISRU, and our lead in other domains of space technology may not be particularly relevant to this challenge.

It is time for Congress to wake up to the emerging commercial space future and work to fully unleash our commercial space potential rather than complaining about a very high level meeting in Beijing where common challenges in the peaceful uses of outer space were discussed with NASA experts present.

How to enhance American commercial space potential through international collaboration

To fully unleash US (and other participating countries’) commercial space potential, the following challenges need to be addressed:

Negotiation of internationally recognized policies to govern commercial activities in space, including mining rights on the Moon and other policies required to conduct commercial activity beyond Earth orbit.

Development of technologies that enable cost-effective ISRU operations with the goal to achieve major reductions in costs.

Development of infrastructure that contributes to reduced risk and costs of activities in space including communications, energy, logistics, and transport facilities, and potentially other services that enable sustained operations in space at lower cost and risk.

Development of sources of financing for space exploration and long-term industrial and commercial development in space that leverage partnership between public and private investment and make possible projects with long planning horizons and extended time to positive cash flow.

Development of markets for ISRU production, space manufacturing, and related research and innovation, support services, and commercial activities through public-private partnerships, infrastructure investment by governments, and investment schemes that address value chain development and not just individual products.

Build broad public support through global celebration of major space accomplishments like Sputnik, the Apollo Moon landing, the launch of ISS and other events. Open opportunities for research and development not only in existing major spacefaring powers but also for smaller countries and developing countries as well as for universities. Place particular emphasis on opening opportunities for entrepreneurial action by small business. Reach out to schools and communities with opportunities to take part.

The next International Space Exploration Forum planned offers the opportunity to begin to address the international challenges to commercial space development that are shared by all parties. Appropriately, the high-level ISEF conference includes ministerial level participation along with space agencies and related industry and academia. Particularly important will be the participation of China.

China is a country with which the US has very extensive commercial, academic, financial, cultural and strategic ties. GE, IBM, Caterpillar, and numerous other major US corporations have extensive R&D operations in China. But the US has no legacy of collaboration with China in space in space, even dating back to the International Geophysical Year in 1957 where China chose to not participate due to its perception of US meddling. China was not invited to participate in ISS. And the Wolf Amendment seeks to even prevent dialogue with China on the peaceful uses of outer space.

China is both a developing country and a rapidly growing advanced industrial economy with significant financial, industrial, and knowledge resources. China also has a profound understanding of economic development and the role of education, research, innovation, and technology commercialization as evidenced by its sustained, rapid economic development. China appears to be an excellent potential global partner, together with the US and the EU, to lead a global campaign to open the space frontier to peaceful commercial development for the benefit of all humanity.

US-China-EU Strategic Space Partnership

Such a partnership can be founded on the basis of a space development investment bank (SDIB). Recently, China took the lead in the formation of the Asian Infrastructure Investment Bank (AIIB) with a proposed capitalization of $100 billion that includes expressed interest by 57 nations, including primarily developing states in the Asia-Pacific region but also the majority of EU member states. The US, Canada, and Japan have declined to participate in AIIB.

What if the US, the EU, and China worked out a structure for SDIB that would promote accelerated commercial development of space? Capitalized at, say, $100 billion, SDIB could provide the long-term financing for infrastructure such as a lunar power utility whose role would be to supply power initially to exploration activities and, later, to ISRU development. Other projects could include space hubs for transportation, logistics management, refueling, and no doubt tourist and recreational facilities. Insofar as SDIB would fund projects that enable or encourage national space initiatives, the capitalization of the bank would be on call to spend as the investment committee chooses to serve the global interest of advancing development of a robust space economy that brings benefits to all member states. SDIB could leverage funding by governments as well as by private sources of capital.

Funding by itself, however, cannot open the space frontier. Needed are appropriate government policies, enabling technologies, and strategic direction that lead to the development of a growing array of markets for space businesses.

#### Specifically, the lack of an international regime undergirding resource extraction causes disputes with China that escalate to global and space war

Jon Kelvey 14. Writer and journalist based in central Maryland. "Asteroid Mining Could Become a Reality in Our Lifetimes. Is It Even Legal?" Slate Magazine. <https://slate.com/technology/2014/10/asteroid-mining-and-space-law-who-gets-to-profit-from-outer-space-platinum.html>

This is what worries Gabrynowicz. Current efforts to clarify the legal status of asteroid-mined resources, if approached the wrong way, she says, could guarantee Arctic-like international disputes over future space activities. The reverse is also a concern: Disagreements over space could influence disputes on Earth. It might be fun to imagine Battlestar Galactica–type conflicts over resources in space, but why spend millions on space weapons when you can hurt your competitor at home and on the cheap?

The foundational document that governs doing stuff in space is the 1967 Outer Space Treaty, on which the United States, Russia, China, and more than 100 other countries are signatories. It reads with an optimism that seems strange today in the era of the mothballed space shuttle. The treaty bans nuclear weapons in space, forbids nations to make claims to celestial real estate, and clearly allows for private space enterprise. According to Gabrynowicz, “Non-state actors … are authorized to be in space, that’s what Article 6 of the Outer Space Treaty is all about.” In fact, it’s apparent that the drafters of the treaty expected that resources would be extracted from space at some point, she says, “But we’ve just never reached agreement on what happens to extracted resources. … So what is happening is you have companies that are chomping at the bit to clarify the rules.”

On Sept. 10, the House Science, Space, and Technology Committee held a hearing on the Asteroid Act, a refreshingly short and readable five-page bill that would recognize the ownership by companies of resources they have extracted from asteroids and would also prohibit companies from interfering with the operations of competitors. Planetary Resources sent a letter to the committee in support of the bill.

The Asteroid Act is not the way that Gabrynowicz would go, however, and she said as much at the congressional hearing. (She was the only space lawyer invited to testify among a group of scientists.) In her view, the bill fails to address basic issues, such as who would license and regulate asteroid mining operations, as well as larger issues, such as the legality of mining operations under international law. However Congress might decide to interpret the Outer Space Treaty, she says, failing to make sure other signatory nations are on the same page could lead to geopolitical consequences. If other space-faring nations interpret the Asteroid Act as the United States playing loose with the Outer Space Treaty, they might decide to do so themselves—and in unpredictable ways. China, for instance, has declared its intention to send humans to the moon, and hinted at possible mining operations. If China sees the United States as having already violated the terms of the Outer Space Treaty, what version of the rules will China be playing by in its own operations? “The point here is recognizing that it’s not just a matter of law,” Gabrynowicz says, “It’s a matter of political strategy.”

Instead of giving asteroid mining a unilateral thumbs up at home, Gabrynowicz would begin building a new layer of international agreements, “You start with three to four countries and begin to reach some sort of agreement on what would happen to the extracted resources,” Gabrynowicz says. It’s a process that might take years, but that’s all the more reason to start now, before any real wealth or resources are actually being hauled through space.

#### Low level US-China space conflict causes miscalc---escalates to terrestrial nuke war

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In Chapter 2, Bruce MacDonald discusses key features of escalation and its management in space operations. These include: (1) Escalation incentives in space will be high especially for China once conflict has broken out. (2) Uncertainty over scale of space effects usage is uncertain, making their usage in a crisis potentially escalatory if effects are greater than planned. (3) Inexperience of countries in space gives rise to a “sorcerer’s apprentice” problem, placing leaders at risk of making unwise decisions.

MacDonald outlines five phases of escalating conflict involving space—from pre-conflict thought to nuclear war—each one with more risk than the previous ones. No clear-cut escalation barrier exists in space, and given the short-term tactical benefits of escalating ahead of an adversary, each additional escalation could create incentives for further escalation that an adversary would not always anticipate. Escalation in space is a slippery slope with few off-ramps.

He recommends: (1) dialogue, including peacetime discussions; (2) given the crisis instability in space and the US dependence on space, the US should emphasize deterrence with warfighting in a supporting role; and (3) expand wargaming.

In Chapter 3, James Lewis places space escalation within the context of China’s broader strategy: The “bottom line” for China is to make progress towards its regional objectives without provoking a fight.

Escalation now is not the same as it was during the Cold War nuclear era, and Chinese thinking on escalation is not the same as US Cold War thinking on nuclear escalation. Instead, China probably sees escalation as a tool to manipulate opponents as part of strategies to advance Chinese interests through non-violent methods. In this Gray Zone conflict: If America is waiting for the onset of armed conflict, it will miss the game.

Fundamental tensions exist in the Chinese strategy, which may make them miscalculate. (1) Gray Zone salami tactics are inherently in tension with core doctrine that stresses rapid escalation to seize the initiative (e.g. the concept of “active defense”). (2) Nationalist sentiment is increasingly used for regime legitimacy and kept in check by social control mechanisms; but in an unexpected crisis, the regime’s nationalist rhetoric could force them to escalate.

During crises, kinetic space actions, with their lack of casualties, may appeal to China as an ideal demonstration of nationalist resolve—but may instead lead to a war China is unlikely to win.

#### China currently binds itself to the OST, but international consensus is key.

Dr. Brian Weeden 19. Director of Program Planning, Secure World Foundation. “Testimony before the U.S.-China Economic and Security Review Commission.” Hearing on China in Space: A Strategic Competition? April 25, 2019. https://swfound.org/media/206425/weeden\_uscc\_testimony\_april2019.pdf

China’s Adherence to Existing International Space Treaties

Along with numerous other nations, the Republic of China (Taiwan) signed the Outer Space Treaty on January 27, 1967, the first day it was opened for signature.4 Subsequently, the People’s Republic of China (PRC) became a successor State Party to the Outer Space Treaty. The Outer Space Treaty is the foundational international treaty regulating the activities of states in the access, exploration, and use of outer space, including the Moon and other celestial bodies, and establishes for states basic international legal rights and obligations pertaining to space activities. Many provisions of this treaty were subsequently expanded upon by later UN treaties on outer space, including the 1968 Astronaut Rescue and Return Agreement,5 the 1972 Liability Convention,6 and the 1975 Registration Convention,7 all of which both the US and China are parties to. However, neither the United States nor China are parties to the 1979 Moon Agreement.8

In brief, states parties to the Outer Space Treaty enjoy the right to access, use, and explore outer space, including both ‘void’ space and celestial bodies.9 The treaty establishes that these rights to access, explore, and use are not contingent upon permission of other states parties to the treaty, nor of the international community as a whole. Freedoms of access and use are therefore foundational norms of law applicable to outer space. Next, the treaty balances these broad freedoms with various obligations regulating state behavior (and the behavior of those they are responsible for). A main obligation is the prohibition on the placement of nuclear weapons or other weapons of mass destruction into orbit, or the placement of them on celestial bodies. Additionally, states are restricted from asserting territorial sovereignty over space, including over celestial bodies.

A number of obligations requiring states to take particular actions are also contained in the Outer Space Treaty. States bear international responsibility for national activities in outer space, whether such activities are carried on by governmental agencies or by non-governmental entities. They are additionally required that all these national activities are carried out in conformity with the Outer Space Treaty and with international law in general. States are also required to provide “authorization and continuing supervision” for space activities conducted by their non-governmental entities. This means that states are ultimately responsible for what their private entities (such as commercial entities) do in outer space and must ensure that these private entities observe international law. This is noteworthy because it is unique in international law that the activities of commercial companies could implicate the international responsibility and potential liability of their authorizing government.

While China, like many other countries, lacks a comprehensive and uniform national space legislation, China has enacted two administrative regulations addressing the issues of launching and registration of space objects: the 2001 Measures for the Administration of Registration of Objects Launched into Outer Space (Registration Measures) and the 2002 Interim Measures on the Administration of Licensing the Project of Launching Civil Space (Licensing Measures).10 Additionally, China has also enacted the Interim Instrument of Space Debris Mitigation and Management (Space Debris Interim Instrument). The Registration and Licensing Measures have been enacted in the form of departmental regulations, which constitute one of the lowest level of laws in China.

Over the past twelve years, China has issued a series of policy documents, the “white papers” on space activities, to complement the existing regulatory framework. The white papers are issued every five years by the Information Office of the State Council, and while they are not legally binding, they are significant because they reflect the growing size of Chinese space activities and the more active role played by China at the international level. The importance of the white papers is threefold: 1) they promote transparency over the nature of the Chinese space program and facilitate acceptance of China as a reliable partner for international projects; 2) they reinforce China’s position of promoting the peaceful uses of outer space and respecting international obligations; and 3) they demonstrate that Chinese authorities are aware of the importance of giving a formal and consistent framework to the Chinese space program. Relatedly, Chinese authorities appear to be aware of the need for a structured national as; as stated by the SecretaryGeneral of the CNSA in 2014, national space law has been listed in the national legislation plan, and the CNSA is directly engaged in the process of working towards enacting the legislation.

In cases where physical damage results from space activities, states bear potential international liability for any physical damage which is caused by space objects of which they are the launching state. These provisions found in Article VII of the Outer Space Treaty were expanded upon in the 1972 Liability Convention, of which both the United States and China are Parties to.11 However, to date, there has never been a liability case brought to court under these treaties and there remain significant ambiguity as to what constitutes negligence in determining liability for damage to other space objects.

The Outer Space Treaty also requires that states treat astronauts from other states with considerable care, as ‘envoys of mankind,’ and that any personal or space objects from other states which land in a state’s territory, or which they discover, shall receive assistance and returned to the original launching state.12 These provisions where expanded upon by the 1968 Astronaut Rescue and Return Agreement, of which both the United States and China are parties to.

The international registration of space objects, first called for in a UNGA Resolution in 1961,13 was also subsequently expanded by the 1975 Registration Convention.14 The United Nations Office for Outer Space Affairs (UNOOSA) keeps and regularly updates an online index of launched space objects, which contain basic orbital parameters and other identifying information. This information is supplied by states on a regular and voluntary basis. UNOOSA does not verify this data and posts it online for the purposes of having a publicly-accessible basic and centralized registry of space objects. The China National Space Administration (CNSA) maintains the Chinese registry, which was established in 2001.15 China notifies UNOOSA of its space launches on a rolling basis. The UNOOSA online registry lists 23 such submission letters from China to UNOOSA since 1990.16 As of April 1, 2019, the UNOOSA online registry lists 307 space objects as China’s.17 It is common practice for all States, including the United States, to register payloads and large rocket bodies but not small pieces of orbital debris.

China’s Role in Developing Guidelines on the Long-Term Sustainability of Outer Space Activities

In 2010, the COPUOS Scientific and Technical Subcommittee created a Working Group on the Longterm Sustainability of Space Activities.18 The goal of this effort was to expand upon the success of the international space debris mitigation guidelines to focus more broadly on effort to promote and enhance the long-term sustainability of space. The long-term sustainability guidelines (“LTS guidelines”) generated from this Working Group were to be a compilation of existing best practices and focused on four main topics: sustainable space utilization supporting sustainable development on Earth; space debris, space operations and tools to support collaborative space situational awareness; space weather; and regulatory regimes and guidance for actors in the space arena.19 For the purpose of transparency, SWF’s current Executive Director, Dr. Peter Martinez, was the chair of this Working Group prior to coming to SWF.

China and the United States were both active participants in the LTS effort, with experts serving in each of the Expert Groups that began the process and then the subsequent political discussions. In general, China was a constructive participant in the discussions, particularly in contrast to Russia. From 2014 until the end of the LTS effort, Russia sought to undermine, delay, and obstruct the LTS discussions in response to the U.S. and European sanctions following Russia’s aggression in Crimea and Ukraine. Notably, China (along with Brazil) broke from Russia during a key moment in the LTS discussions when Russia tried to halt the entire effort. China reaffirmed its support for the LTS discussions and in doing so assured their continuation despite Russian objections.

The LTS Working Group was largely successful. In 2016, the first set of 12 guidelines were agreed to by a consensus of all the members of COPUOS and the mandate of the LTS Working Group was extended through 2018.20 In 2018, the LTS Working Group reached consensus on nine more guidelines and the preamble text, bringing the total to 21, as well as agreeing to review their implementation and potentially update them.21 However, last minute blocking actions by Russia prevented COPUOS from agreeing on a final report that could be submitted to the United Nations General Assembly. Despite this lack of a final report, many countries, including the United States and China, continue to regard the LTS effort as a success and discussed their national implementation of the LTS guidelines during the most recent STSC meeting in February 2019.22

China’s Views on Space Mineral Resources and Sovereignty

Over the last few years, the topic of sovereignty in space and utilization of space resources, such as water or minerals, has become an increasingly salient topic in COPUOS. Concerns over the unequitable exploitation of space resources led to the negotiation and drafting of the Moon Treaty, which was opened for signature in 1979. However, the Moon Treaty failed to gain traction among most countries, with very few signatories compared to the other four main space treaties. The topic of space resources has been rekindled in recent years due to the rise of private sector entities planning to harvest asteroids or explore the Moon.

Governance of space resources remains an undecided issue. A few countries have taken steps to update their national regulations regimes to support such activities, notably the United States23 and Luxembourg,24 but most remain uncertain about the path forward. A minority of countries at COPUOS consider space resource utilization incompatible with the Outer Space Treaty’s prohibition on national appropriation, or at least illegal without the sort of international governing framework outlined in the Moon Treaty. However, a majority of countries believe that it is possible to extract and use resources such as water, minerals, or regolith without running afoul of appropriation, but are not sure what the framework should be for doing so or what the constraints should be.

Chinese statements in COPUOS on sovereignty and utilization of space resources have generally been in line with the G77 voting bloc of developing countries. Specific statements were made by the G77 since 2017 emphasize equitable access and space as the province of all humankind and reinforce the need for an international coordinated framework for governance of space resource utilization to avoid gaps or contradictions from domestic regimes.25,26,27 Thus, China has positioned itself firmly in the camp of most developing countries who are concerned about “rich” States being able to access space resources to the exclusion of less advanced states.

#### Lack of international coop precludes the massive economic investments needed to develop sustainable space presence

**Montgomery 19** [David Montgomery, “We Were Promised Moon Cities,” *CityLab,* July 18, 2019, https://www.citylab.com/life/2019/07/apollo-11-moon-landing-lunar-cities-space-science-history/594301/]

It’s the economics, stupid

But what if lunar settlements could pay for themselves?

“The minute somebody learns how to make money by setting up a base on the moon, there will be a base on the moon,” said Ty Franck, a science fiction author who, with Daniel Abraham, co-wrote the popular The Expanse series of novels, set in a future where humanity has colonized the moon, Mars, and other parts of the solar system.

There are all sorts of ways a lunar settlement could make money. The moon could be mined for raw materials. Solar panels could gather abundant energy, unimpaired by an atmosphere, and beam it back to Earth. Ordinary people could fund a settlement through space tourism. A base on the moon could lower costs for other endeavors, including asteroid mining or trips to Mars.

But none of those are sure bets, which is partly why none of them have been tried.

“Based on the data we have at the present time, we do not have any evidence to say there are economically mineable deposits on the moon,” said Dyar, the specialist in lunar geology.

One possible exception is helium-3, an isotope that could be vital for nuclear fusion. It’s rare on Earth but might be abundant on the moon. Even that is speculative, however.

And the legalities of moon-mining are on very uncertain legal ground. The 1967 Outer Space Treaty, to which every spacefaring nation is a party, guarantees the use of space for scientific research, but isn’t clear about commercial uses. Nation-states are forbidden from claiming territory on the moon, which would complicate digging up parts of it and selling it.

Gabrynowicz, the space law expert, said even a scientific outpost that wanted to dig up lunar ice for study will require an international agreement first. Anything for commercial purposes would be more controversial. Some nations, including the United States and Luxembourg, have passed national laws granting their citizens property rights over any materials extracted on celestial bodies, but these laws differ in important aspects and don’t form a universal framework for lunar mining.

#### The impact’s extinction

Collins 10 [Patrick Collins, \*Professor of Life & Environmental Science at Azabu University & Systems Engineer at Andromeda Inc., Italy, and Adriano Autino, Expert in the economics of energy supply from space, “What the growth of a space tourism industry could contribute to employment, economic growth, environmental protection, education, culture and world peace,” *Acta Astronautica* 66 (2010) 1553–1562]

7.2. High return in safety from extra-terrestrial settlement Investment in low-cost orbital access and other space infrastructure will facilitate the establishment of settlements on the Moon, Mars, asteroids and in man-made space structures. In the first phase, development of new regulatory infrastructure in various Earth orbits, including property/usufruct rights, real estate, mortgage financing and insurance, traffic management, pilotage, policing and other services will enable the population living in Earth orbits to grow very large. Such activities aimed at making near-Earth space habitable are the logical extension of humans’ historical spread over the surface of the Earth. As trade spreads through near-Earth space, settlements are likely to follow, of which the inhabitants will add to the wealth of different cultures which humans have created in the many different environments in which they live. Success of such extra-terrestrial settlements will have the additional benefit of **reducing** the danger of human extinction due to planet-wide or cosmic accidents [27]. These horrors include both man-made disasters such as nuclear war, plagues or growing pollution, and natural disasters such as super-volcanoes or asteroid impact. It is hard to think of any objective that is more important than preserving peace. Weapons developed in recent decades are so destructive, and have such horrific, long-term side- effects that their use should be discouraged as strongly as possible by the international community. Hence, reducing the incentive to use these weapons by rapidly developing the ability to use space-based resources on a large scale is surely equally important [11,16]. The achievement ofthisdepends on low space travel costswhich, at the present time, appear to be achievable only through the development of a vigorous space tourism industry. 8. Summary. As discussed above, if space travel services had started during the 1950s, the space industry would be enor- mously more developed than it is today. Hence the failure to develop passenger space travel has seriously distorted the path taken by humans’ technological and economic development since WW2, away from the path which would have been followed if capitalism and democracy operated as intended. Technological know-how which could have been used to supply services which are known to be very popular with a large proportion of the population has not been used for that purpose, while waste and suffering due to the unemployment and environmental damage caused by the resulting lack of new industrial opportunities have increased. In response, policies should be implemented urgently to correct this error, and to catch up with the possibilities for industrial and economic growth that have been ignored for so long. This policy renewal is urgent because of the growing dangers of unemployment, economic stagnation, environmental pollution, educational and cultural decline, resource wars and loss of civil liberties which face civilisation today. In order to achieve the necessary progress there is a particular need for collaboration between those working in the two fields of civil aviation and civil space. Although the word ‘‘aerospace’’ is widely used, it is largely a misnomer since these two fields are in practice quite separate. True ‘‘aerospace’’ collaboration to realise passenger space travel will develop the wonderful profusion of possibilities outlined above. 8.1. Heaven or hell on Earth? As discussed above, the claim that the Earth’s resources are running out is used to justify wars which may never end: present-day rhetoric about ‘‘the long war’ ’or ‘‘100 years war’’ in Iraq and Afghanistan are current examples. If political leaders do not change their viewpoint, the recent aggression by the rich ‘‘Anglo-Saxon’’ countries, and their cutting back of traditional civil liberties, are ominous for the future. However, this ‘‘hellish’’ vision of endless war is based on an assumption about a single number—the future cost of travel to orbit—about which a different assumption leads to a ‘‘heavenly’’ vision of peace and ever-rising living standards for everyone. If this cost stays above 10,000 Euros/kg, where it has been unchanged for nearly 50years, the prospects for humanity are bleak. But if humans make the necessary effort, and use the tiny amount of resources needed to develop vehicles for passengers space travel, then this cost will fall to 100 Euros/kg, the use of extra-terrestrial resources will become economic, and arguments forresource wars will evaporate **entirely**. The main reason why this has not yet happened seems to be lack of understanding of the myriad opportunities by investors and policy-makers. Now that the potential to catch up half a century of delay in the growth of space travel is becoming understood, continuing to spend 20 billion Euro-equivalents/year on government space activities, while continuing to invest nothing in developing passenger space travel, would be a gross failure of economic policy, and strongly contrary to the economic and social interests of the public. Correcting this error, even after such a costly delay, will ameliorate many problems in the world today. As this policy error is corrected, and investment in profitable space projects grows rapidly in coming years, we can look forward to a growing world-wide boom. Viewed as a whole, humans’ industrial activities have been seriously underperforming for decades, due to the failure to exploit these immensely promising fields of activity. The tens of thousands of unemployed space engineers in Russia, America and Europe alone are a huge waste. The potential manpower in rapidly developing India and China is clearly vast. The hundreds of millions of disappointed young people who have been taught that they cannot travel in space are another enormous wasted resource.

#### Every delay kills trillions of humans

Bostrom 3 [Nick, Winner of the 2010 Eugene R. Bostrom Award for the Pursuit of Human Advancement (awarded by Seth Gannon; read Bostrom’s acceptance essay, linked on Bostrom’s CV when you get a chance), other lesser quals include Professor of Philosophy, Yale University, Director of the Future of Humanity Institute at Oxford University, “Astronomical Waste: The Opportunity Cost of Delayed Technological Development,” 2003, Utilitas Vol. 15, No. 3, pp. 308-314, <http://www.nickbostrom.com/astronomical/waste.html>]

As I write these words, suns are illuminating and heating empty rooms, unused energy is being flushed down black holes, and our great common endowment of negentropy is being irreversibly degraded into entropy on a cosmic scale. These are resources that an advanced civilization could have used to create value-structures, such as sentient beings living worthwhile lives. The rate of this loss boggles the mind. One recent paper speculates, using loose theoretical considerations based on the rate of increase of entropy, that the loss of potential human lives in our own galactic supercluster is at least ~10^46 per century of delayed colonization.[1] This estimate assumes that all the lost entropy could have been used for productive purposes, although no currently known technological mechanisms are even remotely capable of doing that. Since the estimate is meant to be a lower bound, this radically unconservative assumption is undesirable. We can, however, get a lower bound more straightforwardly by simply counting the number or stars in our galactic supercluster and multiplying this number with the amount of computing power that the resources of each star could be used to generate using technologies for whose feasibility a strong case has already been made. We can then divide this total with the estimated amount of computing power needed to simulate one human life. As a rough approximation, let us say the Virgo Supercluster contains 10^13 stars. One estimate of the computing power extractable from a star and with an associated planet-sized computational structure, using advanced molecular nanotechnology[2], is 10^42 operations per second.[3] A typical estimate of the human brain’s processing power is roughly 10^17 operations per second or less.[4] Not much more seems to be needed to simulate the relevant parts of the environment in sufficient detail to enable the simulated minds to have experiences indistinguishable from typical current human experiences.[5] Given these estimates, it follows that the potential for approximately 10^38 human lives is lost every century that colonization of our local supercluster is delayed; or equivalently, about 10^31 potential human lives per second. While this estimate is conservative in that it assumes only computational mechanisms whose implementation has been at least outlined in the literature, it is useful to have an even more conservative estimate that does not assume a non-biological instantiation of the potential persons. Suppose that about 10^10 biological humans could be sustained around an average star. Then the Virgo Supercluster could contain 10^23 biological humans. This corresponds to a loss of potential equal to about 10^14 potential human lives per second of delayed colonization. What matters for present purposes is not the exact numbers but the fact that they are huge. Even with the most conservative estimate, assuming a biological implementation of all persons, the potential for one hundred trillion potential human beings is lost for every second of postponement of colonization of our supercluster.[6]

#### Getting off the rock is theoretically feasible --- it’s just an economic question --- keep your options open

Everett 16 [Sean, CEO of Prome Biological Intelligence, a global biotechnology company, editor of Medium’s news outlet dedicated to space colonialization titled “The Mission”, BS Mathematics & Actuarial Science, MBA from UChicago, 2016, “Humanity’s Extinction Event Is Coming” https://medium.com/the-mission/humanitys-extinction-event-is-coming-c0f84f1803f]

But the reality is that an asteroid impact, a change in our magnetic field, or the rising temperature of Earth’s climate are all events that we currently cannot escape. There is no back-up plan. We are, for better or worse, tied to the fate of this planet. As history has shown, that’s not a good fate to be tied to. In fact on September 7, 2016 a 30-foot asteroid flew between the Earth and the Moon. Our most powerful instruments only detected it with two days notice. Two days. If the asteroid was only 1000-foot wide, it would destroy all human life and we’d have no back-up to get out of it. Even the White House is worried about it. Five, yes five, major extinction events have occurred on our planet that we know about. We’re due for another. And when that happens, what’s our alternative? You can’t move to another house. You can’t buy survival, even with a billion dollars in the bank. The only way out, is up. We must find a way to become multi-planetary if we want to save humanity, your family, and yes, even yourself. Only this can restore the honor we seemed to have lost from the brave days of the 60s, while also ensuring our survival. It’s for the species, folks. And as a species, we have not allowed ourselves the opportunity to blast off for the stars. Only the space race in the 60s when we were afraid enough of a self-inflicted global extinction event (read: nuclear) that we put forth the funding required to launch into orbit and onto our moon. We didn’t have calculators back then, and now we have supercomputers in our pocket, but no one is allowed out of our atmosphere, save for a few communication and spy satellites. Doesn’t that make you mad? It’s not some oppressive government that tells us no. It’s us. We pay our taxes. We elect leaders. Those leaders choose Defense as the primary budget line item, but forget about defending against the forthcoming apocalypse. Funding for NASA in the United States has decreased from 4% of the national budget in the 60s to about 0.5% from 2010 onwards. That’s just the money side. But in order to move past this threshold from our home planet to space and then onto other planets, we need to do two things: Travel there. Survive. Luckily, we can simplify the problem of passing this barrier by sending machines in our place. Like TARS from Interstellar, they can go places humans cannot and explore the environment for habitability and resources, even in particularly hostile conditions. Maybe not black hole hostile, but definitely Mars hostile, as the Curiosity Rover has shown. Only now, with a few bold, private startups are we beginning to see a re-emergence of the space industry. We are about to pass a few very important tests that allow us to explore and visit the cosmos. The first is launching physical things into space. This is the catalyst that will jump start a new space race. Prices of sending cargo are falling dramatically, down to nearly $500 per pound of payload with SpaceX’s Falcon 9 heavy re-usable rocket. Note that the re-usable part is key. We can’t throw away our “space car” every time we Uber it. And once that becomes standard and cost-optimized we might be able to get that down to $10 per pound. Imagine what could happen when it costs the same amount to ship something across town as it does into space. The second, and this is just as important, is the wave of autonomous machines. Tesla has popularized the notion of self-driving cars. SpaceX lands their rocket onto a small barge in the ocean autonomously. Companies are buying startups in the space. Self-driving will be our gift, our talisman, on the quest to save the species by becoming multi-planetary. II. Shipping Ourselves to Space The graph below is from the Founders Fund manifesto, showing the decreasing cost of launching something into space. It begins with the 1960s US-versus-Russia space race and extends to the present day SpaceX-versus-Blue Origin reusable rocket race. The cheapest method we have today is SpaceX’s Falcon series rockets. With the Falcon 9 Heavy, it’s predicted launching cargo into space will be cheaper than ever before, at $750 per pound of payload delivered to low earth orbit (LOE)on an expendable rocket. You have to note here, however, that these statistics are as cheap as possible. It costs more to deliver payload on a non-reusable rocket, and on something that’s further out than LEO, like geosynchronous orbit, or to Mars. For example, based on SpaceX’s published pricing, it would be at least 4x more expensive to deliver far less cargo to Mars. So what happens when we reduce that cost to $10 per pound? Namely, an explosion of startups, much like iOS. Instead of pushing to production for your continuously deployed web and mobile app, we will see future developers push to production by deploying physical things into space. “STAGE” takes on an entirely new meaning for software developers when it means your automated regression tests fail, it could blow up a rocket and hurt people on board. That’s why SpaceX and Blue Origins exist. To make this continuous-deployment-to-space process as cheap and fast as possible. By Elon’s calculations, every 15 minutes. III. Self-Driving Space Explorers The most successful products for space, at least in the beginning, will make money by pushing this stuff into orbit. Things like science experiments and new 3D printers. A company called Made in Space creates a number of these products, including the empty box you see below used for sending things up with Blue Origin. The box shown in gray is a specialized 3D printer that works in zero gravity. Remember how most 3D printers work. It squeezes out a single layer of liquid ooze, and then another, over and over again until it builds up enough vertically that it creates an object. This can be simple plastic or more esoteroic metals. But when you’re “dripping” something, held down in place by gravity, the entire process has to be re-imagined for space. Things in zero-G would just float away. Enter these chaps. There’s also the very real need for oxygen, food, water, and shelter from the harsh elements. Funny how we will end up recreating Maslow’s Heirarchy in every new voyage or planetoid we want to colonize. And space mining is off to the races with the recent announcement of Deep Space Industry’s Prospector-1: Their vision is to extract water from asteroids and use the chemical components to hydrate us, but also as oxygen (breathing) and hydrogen (fuel). To do that, you have to identify candidate asteroids, physically get to them, land and attach, and then do surveying, prospecting, and extraction. In short, you’re going to need some level of self-driving capabilities to make this happen. And wouldn’t it be nice if it “just worked” right out of the box. Unfortunately, in space you don’t have fleets of these space craft, millions of miles of training data, maps, or an internet connection to the cloud so how the heck are deep learning algorithms going to work? I don’t think they will. And that’s what I believe we need a better approach

#### AND---the commercial space industry is key to crisis response, crop monitoring, and innovation

Joshua Hampson 17. Security Studies Fellow The Niskanen Center. “The Future of Space Commercialization.” Niskanen Center. 1/25/2017. https://republicans-science.house.gov/sites/republicans.science.house.gov/files/documents/TheFutureofSpaceCommercializationFinal.pdf

The size of the space economy is far larger than many may think. In 2015 alone, the global market amounted to $323 billion. Commercial infrastructure and systems accounted for 76 percent of that 9 total, with satellite television the largest subsection at $95 billion. The global space launch market’s 10 11 share of that total came in at $6 billion dollars. It can be hard to disaggregate how space benefits 12 particular national economies, but in 2009 (the last available report), the Federal Aviation Administration (FAA) estimated that commercial space transportation and enabled industries generated $208.3 billion in economic activity in the United States alone. Space is not just about 13 satellite television and global transportation; while not commercial, GPS satellites also underpin personal navigation, such as smartphone GPS use, and timing data used for Internet coordination.14 Without that data, there could be problems for a range of Internet and cloud-based services.15

There is also room for growth. The FAA has noted that while the commercial launch sector has not grown dramatically in the last decade, there are indications that there is latent demand. This 16 demand may catalyze an increase in launches and growth of the wider space economy in the next decade. The Satellite Industry Association’s 2015 report highlighted that their section of the space economy outgrew both the American and global economies. The FAA anticipates that growth to 17 continue, with expectations that small payload launch will be a particular industry driver.18

In the future, emerging space industries may contribute even more the American economy. Space tourism and resource recovery—e.g., mining on planets, moons , and asteroids—in particular may become large parts of that industry. Of course, their viability rests on a range of factors, including costs, future regulation, international problems, and assumptions about technological development. However, there is increasing optimism in these areas of economic production. But the space economy is not just about what happens in orbit, or how that alters life on the ground. The growth of this economy can also contribute to new innovations across all walks of life.

Technological Innovation

Innovation is generally hard to predict; some new technologies seem to come out of nowhere and others only take off when paired with a new application. It is difficult to predict the future, but it is reasonable to expect that a growing space economy would open opportunities for technological and organizational innovation.

In terms of technology, the difficult environment of outer space helps incentivize progress along the margins. Because each object launched into orbit costs a significant amount of money—at the moment between $27,000 and $43,000 per pound, though that will likely drop in the future —each 19 reduction in payload size saves money or means more can be launched. At the same time, the ability to fit more capability into a smaller satellite opens outer space to actors that previously were priced out of the market. This is one of the reasons why small, affordable satellites are increasingly pursued by companies or organizations that cannot afford to launch larger traditional satellites. These small 20 satellites also provide non-traditional launchers, such as engineering students or prototypers, the opportunity to learn about satellite production and test new technologies before working on a full-sized satellite. That expansion of developers, experimenters, and testers cannot but help increase innovation opportunities.

Technological developments from outer space have been applied to terrestrial life since the earliest days of space exploration. The National Aeronautics and Space Administration (NASA) maintains a website that lists technologies that have spun off from such research projects. Lightweight 21 nanotubes, useful in protecting astronauts during space exploration, are now being tested for applications in emergency response gear and electrical insulation. The need for certainty about the resiliency of materials used in space led to the development of an analytics tool useful across a range of industries. Temper foam, the material used in memory-foam pillows, was developed for NASA for seat covers. As more companies pursue their own space goals, more innovations will likely come from the commercial sector.

Outer space is not just a catalyst for technological development. Satellite constellations and their unique line-of-sight vantage point can provide new perspectives to old industries. Deploying satellites into low-Earth orbit, as Facebook wants to do, can connect large, previously-unreached swathes of 22 humanity to the Internet. Remote sensing technology could change how whole industries operate, such as crop monitoring, herd management, crisis response, and land evaluation, among others. 23 While satellites cannot provide all essential information for some of these industries, they can fill in some useful gaps and work as part of a wider system of tools. Space infrastructure, in helping to change how people connect and perceive Earth, could help spark innovations on the ground as well. These innovations, changes to global networks, and new opportunities could lead to wider economic growth.

#### Crop monitoring is key to ag yields

Talip Kilic 18. \*\*Senior economist at the World Bank. \*\*David Lobell, Professor at Stanford University. “Can satellites deliver accurate measures of crop yields in smallholder farming systems?” World Bank. 3/29/2018. https://blogs.worldbank.org/developmenttalk/can-satellites-deliver-accurate-measures-crop-yields-smallholder-farming-systems

How much food is produced on a plot of land? The answer is central to several pressing questions in agricultural and development economics: How efficiently do smallholders use their labor and land? What interventions are most effective at lifting smallholders out of poverty? Are smallholders better off investing more time and resources on the farm, or intensifying their reliance on off-farm employment? The answers in part depend on the ability to accurately measure crop production. This is why household and farm surveys across the developing world, such as those supported by the World Bank Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) initiative, attempt to obtain precise, within-farm measures of crop production and productivity.

In the context of the LSMS-ISA, apart from improvements in land area measurement (based on the research summarized here), production information is still based on farmer recall (except for Ethiopia and Mali, relying on sub-plot crop cutting). Recent research (ours in Uganda; by Desiere and Jolliffe for Ethiopia; and by Abay et al. for Ethiopia) showcased the non-random, systematic errors in farmer-reported production information. This is of course against the backdrop of well-documented, persistent weaknesses in agricultural data in low- and middle-income countries.

A possible alternative is to try estimating crop yields from satellite imagery. There’s a long history of using satellites to assess crop condition or yield, with considerable recent progress. However, this work has mostly focused on large commercial farms or on estimating aggregate yields over large regions. Getting plot-level precision for smallholder farmers has been beyond reach, mainly because the resolution on widely used sensors was too coarse to distinguish individual fields.

The good news is that things are quickly changing, with several new satellite sensors launched in recent years. In our latest paper, our group of Stanford and World Bank researchers tried to see just how well these new satellites can work for estimating maize yield, relative to ground-based measures that rely on farmer reporting; sub-plot crop cutting; and full-plot crop cutting.

Our analysis is using the data from the 2016 round of MAPS: Methodological Experiment on Measuring Maize Productivity, Soil Fertility, which was conducted by the Uganda Bureau of Statistics (UBOS) in Iganga and Mayuge districts of Eastern Uganda. Our paper builds on the earlier work by Burke and Lobell for Kenya, and we summarize the main takeaways below.

First, to give a sense of how much better the new satellite data are, the figure below shows a small part of our study region as viewed by (1) Landsat (the old mainstay of land remote sensing, taking imagery every 16 days); (2) Sentinel-2 (a pair of European sensors launched in 2015-16, taking imagery every 5 days); and (3) Skysat (a set of sensors owned by Planet, a private firm in San Francisco that graciously collected data for our study region during the 2016 growing season). You can see how individual fields become much clearer at 10m than 30m, whereas the 1m data provide fine detail on both fields and individual buildings.

While the paper provides the full details regarding the (panel) sampling design; the questionnaire instruments; and the survey methods, the key features of our study were as follows.

463 plots were visited, and the field boundaries were collected with a GPS.

On each plot, an 8x8 m sub-plot was set-up at random during the post-planting period, and was later harvested, dried, and weighed, allowing for the computation of the sub-plot crop cut (CC) yield.

Approximately half of the plot sample (211 plots) was selected at random for a full plot harvest. The weight of the harvest, combined with the GPS-based plot area, provided the full-plot crop cut (FP) yield.

Self-reported maize yields were obtained for the remaining 252 plots by dividing farmer-reported production (converted to grain, KG-equivalent terms) with GPS-based plot area.

This design represented a heroic amount of effort in the field, and it was masterfully executed by highly-trained UBOS field teams. Often the hardest part in telling whether satellite yields are accurate is having something good from the ground to compare it to. It is extremely rare to have such rich datasets of both subjective and objective yield measures.

Fortunately, we were able to obtain three relatively cloud-free Sentinel-2 images during the season. In the tropics, clear skies can be hard to find, even at the early satellite overpass time of 10:30 am, so even the best images can have clouds as seen below (the plot locations in yellow).

Using these images, we applied methods developed in our group to estimate maize yields, and then compared them with the ground-based measures of yields and inputs. Satellite yields include two versions that were calibrated to FP and CC yields, and an alternative based on crop model simulations, using no ground data (uncalibrated), following Lobell et al. (2015).

The headline findings of our analysis were:

Self-reported yields appeared very unreliable in this region – explaining less than 1 percent of crop cutting-based yield variance.

CC and FP yields correlated well with each other across plots, but not as strong as one might wish for (r = 0.5). This signals substantial sub-plot yield variability even on small plots, and how difficult it still is to get accurate yield measures using sub-plot crop cutting.

Both calibrated and uncalibrated satellite yields capture roughly half of the variance in FP yields on pure stand plots > 0.1 hectare – a very promising finding that one could have only imagined just 5 years ago.

Compared to CC and FP yields, the use of satellite yields in yield analysis faithfully reproduced the effects of production factors such as (objective) soil quality and fertilizer use.

Although CC yields are imperfect approximations of plot-level yields, the errors do not substantially bias remote sensing calibrations. Sub-plot crop cutting, therefore, appears to be a suitable replacement for full-plot harvests.

Even though we placed emphasis on measuring yields at the plot-level, we recognize that many applications will care more about accuracies at aggregate scales. What is expected to become increasingly more useful will be the ability to integrate georeferenced micro survey data on agriculture, such as the LSMS-ISA, with the expanding, publicly-available high-resolution satellite imagery. Such ability, combined with advances in remote sensing methods, has the potential to create an unparalleled scope for research on entire landscapes of agricultural plots.

#### Yield increases are key to avoid food shortages---nuke war

**FDI 12**. A Research Institute providing strategic analysis of Australia’s global interests; citing Lindsay Falvery, PhD in Agricultural Science and former Professor, University of Melbourne. “Food and Water Insecurity: International Conflict Triggers & Potential Conflict Points.” May 25. <http://www.futuredirections.org.au/workshop-papers/537-international-conflict-triggers-and-potential-conflict-points-resulting-from-food-and-water-insecurity.html>

There is a growing appreciation that the conflicts in the next century will **most likely** be fought over a lack of resources.

Yet, in a sense, this is not new. Researchers point to the **French and Russian revolutions** as conflicts induced by a lack of food. More recently, **Germany’s World War Two efforts** are said to have been inspired, at least in part, by its perceived need to gain access to more food. Yet the general sense among those that attended FDI’s recent workshops, was that the **scale** of the problem in the future could be **significantly greater** as a result of population pressures, changing weather, urbanisation, migration, loss of arable land and other **farm inputs**, and increased affluence in the developing world.

In his book, Small Farmers Secure Food, Lindsay Falvey, a participant in FDI’s March 2012 workshop on the issue of food and conflict, clearly expresses the problem and why countries across the globe are starting to take note.

He writes (p.36), “…if people are hungry, especially in cities, **the state is not stable** – riots, violence, breakdown of law and order and migration result.” ¶ “Hunger feeds anarchy.”

This view is also shared by Julian Cribb, who in his book, The Coming Famine, writes that if “large regions of the world run short of food, land or water in the decades that lie ahead, then **wholesale, bloody wars are liable to follow**.”

He continues: “An increasingly credible scenario for **World War 3** is not so much a confrontation of super powers and their allies, as a **festering, self-perpetuating chain of resource conflicts**.” He also says: “The wars of the 21st Century are less likely to be global conflicts with sharply defined sides and huge armies, than a scrappy mass of failed states, rebellions, civil strife, insurgencies, terrorism and genocides, sparked by bloody competition over dwindling resources.”

As another workshop participant put it, people do not go to war to kill; they go to war over resources, either to protect or to gain the resources for themselves.

Another observed that hunger results in passivity not conflict. Conflict is over resources, not because people are going hungry.

A **study** by the **I**nternational **P**eace **R**esearch **I**nstitute indicates that where **food security** is an issue, it is more **likely** to result in some form of conflict. **Darfur, Rwanda, Eritrea and the Balkans** experienced such wars. Governments, especially in developed countries, are increasingly aware of this phenomenon. The UK Ministry of Defence, the CIA, the US **C**enter for **S**trategic and **I**nternational **S**tudies and the Oslo Peace Research Institute, **all identify** famine as a potential trigger for conflicts and possibly even **nuclear war**.