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[PLANK 1]

#### The United States federal government should propose and ratify an international agreement that:

-- defines a ‘space object’ to include orbital debris

-- requires signatories to take all appropriate measures to reduce creation of orbital debris, defined by an amendable technical annex based on IADC Guidelines

-- requires submission of technical documents prior to any launch demonstrating compliance with the technical annex

-- enforces strict liability for damage caused by failure to comply with the technical annex

-- enforces guidelines for environmentally safe rocket launches and deorbiting of space junk to avoid astronomical

[PLANK 2]

#### The United States federal government should propose to Russia, China, India, and the European Union a multilateral agreement imposing a per-launch fee system paid by launching states, with proceeds devoted exclusively to financing the cost of orbital debris remediation, including untrackable debris. The United States should provide a substantial one-time monetary contribution to initiate the fund.

#### The first plank creates a debris mitigation regime with sufficient incentives and accountability to ensure compliance

Michael W. Taylor 6, Colonel, U.S. Air Force, Judge Advocate, LLM from McGill University, August 2006, “Orbital Debris: Technical and Legal Issues and Solutions,” <https://fas.org/spp/eprint/taylor.pdf>

States have responded to the scientific community’s concern about orbital debris. The IADC Guidelines represent the solutions that are currently technically feasible and affordable yet still permit maximum use of outer space. Major space-faring States have implemented or are in the process of implementing their own national orbital debris mitigation policies or rules consistent with the IADC Guidelines. Thus, since the creation of the IADC, the focus of commentators has shifted from “broad pronouncements of liability and responsibility from an environmental perspective” to a discussion which is more “pragmatic.” Specifically, the shift has been away from ex post facto punitive measures to proactive prevention by encouraging compliance with internationally adopted debris mitigation standards.462

A UN General Assembly resolution adopting orbital debris mitigation principles would reflect the strong desire by States to attack the problem and would be a good first step. But more can be done. The difficulty lies not in the desire to do something about the problem, but what form the solution should take.

For a legal (as opposed to technical) orbital debris mitigation regime to have any chance of being accepted by the international community, it must meet at least five criteria. First, there must be an exchange of rights and responsibilities. One-sided treaties in which one group of States gets all of the benefits and another group of States incurs all of the obligations have little chance of ratification. For example, the US is unlikely to ever ratify a treaty creating market-share liability since there would be few, if any, tangible benefits to the US. Second, a mitigation regime should not create specific technical rules in an inflexible treaty since technological capability changes more rapidly than traditional treaties can adapt. Third, the technical requirements should be expressed in terms of soft goals rather than hard requirements. For example, it is better to say that all GEO satellites should be relocated to a disposal orbit 300 kilometers above GEO rather than declare that all GEO satellites must maintain 2 percent of fuel reserves for relocating to a disposal orbit. Fourth, the treaty should avoid creating a new, permanent international organization such as ICAO because many States are adamantly opposed to creating new international bureaucracies. Finally, the new legal regime should be voluntary since some States will not be willing to surrender so much of their sovereignty over their outer space activities. Bearing these concepts in mind, a treaty-based solution is attainable. The following discussion is one such solution with supporting rationale.

Minor revisions to existing treaties can accomplish the goal of helping to reduce the creation of new orbital debris. First, the term “space object” must be defined to make clear that it applies to orbital debris. The definitions of orbital debris currently in the literature can serve as a beginning point for a discussion of the appropriate definition. Second, States should be encouraged to take “all appropriate measures” to reduce the creation of orbital debris. The phrase “all appropriate measures” should be defined within a technical annex that is reviewed on a regular basis and can be flexibly amended without requiring approval from all States party to the treaty. The technical annex would be based upon the IADC Guidelines (or similar UN guidelines if they are ever approved). Third, States may, prior to any launch, submit technical documents concering the rocket and/or payload to an appropriate international organization. The technical documents should contain sufficient information to indicate whether the rocket and payload conform to the treaty’s technical annex. The documents submitted by a State would be available to the public and other States and would be kept on file in the event they are needed for future dispute resolution.

Fourth, in the event one State seeks compensation from another State under the Liability Convention for damage occurring in outer space, the fault rules to be applied will depend on whether the status of the space objects and whether the respondent State complied with the technical annex as it existed at the time of the launch. For collisions between two objects of debris, there would be no liability for either State. For collisions between two functional objects which are capable of maneuvering, the current negligence fault standard of the Liability Convention should apply. In reality, this would likely mean neither State would recover from the other due to the difficulty in proving negligence. However, if the respondent State’s object was orbital debris and it failed to either submit technical documents prior to the launch or the documents fail to prove the object complied with the technical annex, then the respondent State will be strictly liable for damages to the claimant State’s satellite. Finally, if the respondent State’s object did comply with the technical annex at the time of launch, then the respondent State will not be liable to the claimant State unless the claimant State can prove the respondent State operated the object with gross indifference to the potential orbital debris consequences.

This proposal is a combination of incentives to voluntarily comply with flexible technical mitigation rules coupled with increased risk of liability for failure to comply. Some commentators may object that it is unacceptable for a State to avoid liability if debris for which that State is responsible causes damage in space. However, under the current fault-based standard, States are already essentially free from liability. Therefore, this would not be a real change. For this reason, encouraging States to reduce orbital debris is more important than establishing liability. Since this treaty should be an exchange of rights and responsibilities, creating strict liability for failure to comply with the treaty is a strong incentive for voluntary compliance.

The technical documents that will be provided to an appropriate international agency serve several functions. First, they are an incentive to comply with the mitigation rules since failure to supply documents makes a State strictly liable in the event its debris collides with an active satellite. Second, since they are open to inspection, they serve as verification of compliance with the terms of the treaty. Third, they are a repository of easily available evidence. Since the proposed liability regime depends upon the design and operation of the satellite complying with mitigation measures, evidence of the State’s level of compliance will be required. Furthermore, because collisions may not occur for tens or hundreds of years after a launch (if ever), a repository of supporting documentation will make the process of determining liability easier.

The success of the proposal depends, in large part, on the ability to identify a particular piece of debris and associate it with a launching State. To some extent, that is possible with the existing SSN. States should, however, continue to improve debris detection, tracking, and identification systems with a goal of creating a real-time computerized international database of debris.

VII. Conclusion

Orbital debris has become the most significant obstacle to the use and exploration of outer space. There are no quick fixes. Current technology limits us to mitigating the problem when remediation measures are really necessary. Presently, the major spacefaring States have created voluntary mitigation measures and are generally complying with them. These have been helpful in preventing the creation of new debris, but better legal solutions are possible. The current lacuna of international law concerning orbital debris needs to be filled with enforceable rules and definitions that provide certainty and accountability.

All users of space want and need access that is not limited by problems of orbital debris. But to achieve this goal, the users of space, individually and collectively, must be prepared to make some sacrifices. The sacrifices are mostly economic: limitations on the amount of fuel a satellite can carry because essential debris mitigation measures impose a mass penalty, limitations on the mission lifetime imposed by the necessity of debris-avoidance maneuvers and relocation to disposal orbits, or the costs necessary to study and track debris. These economic costs can create tension between States, or between civil, commercial, and military users of space. Comprehensive, mandatory mitigation rules accompanied by increased accountability can help reduce the costs in the long-term by providing a safer space environment. The international community should redouble its efforts to find the best possible technical and legal solutions to this growing problem.

#### Second plank solves debris remediation better and faster

Meghan R. Plantz 12. J.D., University of Georgia, 2012, “Orbital Debris: Out of Space,” 40 GA. J. INT'L & COMP. L. 585

Many theorists propose that the international community either update and enhance or change space law to specifically address the orbital debris problem. Current proposed theories suggest solutions such as providing (1) a direct financial incentive to states to reduce or eliminate debris, or (2) a requirement that forces state actors to compensate other states in the Space community for spacecraft or satellites damaged by unidentified debris.20 Accordingly, the legal frameworks proposed to support and enforce these solutions include: (1) a new United Nation’s treaty, (2) a code of customary international law, (3) a reformed fault-based liability system, (4) a compensation or liability fund, and (5) a market-share liability system.

While these proposals attempt to assign fault and liability in orbital debris collisions, they fail to provide a practical long-term solution for the entire international space community. Specifically, they rely on the philosophy that “past polluters pay.” As such, these proposals assign the bulk of the bill to the U.S. and Russia, the predominant space players and polluters in the past. The U.S. and Russia will likely refuse any such payments and proposed regime changes because of the number of other space actors who now share the responsibility of maintaining and remediating the space environment. Without the support of the U.S. and Russia, any regime modification would be futile.

As of 2011, sixty actors utilize the space environment, predominantly through the use of satellites. Ten actors have independent orbital launch capabilities25 and five regularly launch spacecraft belonging to other states lacking such capabilities, thus holding significant control and power over the space community. Consequently, this controlling class of actors has the potential to wield effective market power in the space industry, given the substantial and prohibitive cost to non-launch capable states of establishing such capabilities. Market power enables this class of actors to develop and impose a space regime that forces players in the space community to financially contribute to remediating and protecting the space environment and the impact of space activities on Earth.

This Note argues that the class of states with launch capabilities needs to develop a multilateral agreement among themselves, with provisions for entry by new launch-capable states, to self-impose a launch fee system. Proceeds from this fee system will fund the research and development of remediation technology for the space environment, as well as the reduction of prospective orbital debris. This multilateral agreement uses market power as a controlling means to regulate the space environment. Every state that currently utilizes space, either with launch capabilities or by contracting for such capabilities, will contribute to the shared cost of preserving the space environment and benefit from the results of a cleaner and safer environment.

Part II explains the current orbital debris situation, with a discussion of the nature of the space environment, the sources of orbital debris, the limitations on observing and tracking debris, and the estimated amount of orbital debris. Part II provides a scientific analysis of the estimated damage to a spacecraft upon impact with a piece of orbital debris, as well as the likelihood of an orbital debris collision. Additionally, Part II addresses the international community’s response to the orbital debris problem; specifically the scientific solutions to avoid the problem, such as shielding, tracking and avoidance maneuvers around debris, controlling re-entry of debris into the Earth’s atmosphere, and moving satellites into less congested orbits at the end of their mission life. However, the current international response seeks only to avoid orbital debris collisions rather than actually remedy the fundamental problem.

Part III explains why remediation should take place now rather than waiting for a catastrophic event to occur. Part IV explains the current international laws pertaining to space. Part V analyzes several proposed legal solutions and illustrates their respective flaws. Finally, Part VI posits that the most effective solution to the orbital debris problem is a multilateral agreement between launch-capable states with market power in the space community to impose a launch fee system and create a global space remediation fund.

#### The plan demands tons of SSA resources

Sundalh 2000 [Mark Sundalh, J.D. candidate, Hastings College of the Law, 2001; Ph.D. (Classics), Brown University, 2000; B.A., University of California, Los Angeles, 1993.] “Unidentified Orbital Debris: The Case for a Market-Share Liability Regime” Hastings International and Comparative Law Review, Vol. 24, No. 1, Fall 2000 (<https://repository.uchastings.edu/cgi/viewcontent.cgi?article=1532&context=hastings_international_comparative_law_review>) – MZhu

Using a state's contribution to the existing identified debris population as the index for determining liability may create a perverse incentive for states to scale down their debris tracking activities. Since liability would be tied to the number of debris fragments whose ownership is known, states may try to reduce their liability simply by halting their efforts to identify debris. However, because several nations would soon be engaged in debris detection, the desire of each of these states to increase the risk-contribution of other states (and thereby reduce their own contribution) would cause each of them to track each other's debris aggressively. The sum of this multinational effort would easily offset the perverse incentive to reduce tracking one's own objects.

#### That undermines space weather assessment

**Ferguson 15** [Dale Ferguson PhD, “The Space Weather Threat to Situational Awareness, Communications, and Positioning Systems,” <http://ieeexplore.ieee.org/xpls/icp.jsp?arnumber=7070693#authors>]

According to [20] and [21], space situational awareness is a key goal for the U.S. DoD. The DoD must determine, in real time if possible, whether anomalies are due to the space weather or to hostile actions. Also, operations may be affected by efforts to prevent space weather-related outages, so space weather prediction and real-time anomaly resolution are very important to U.S. Security. The military has long relied on long-range communications as have key commercial concerns such as banking. Both the U.S. and German air forces understood the potential impact of space weather on communications during World War II [32]. Indeed, the U.S. Air Force established a Geophysics Directorate soon after it founded its first laboratory, the Air Force Cambridge Research Laboratory, in the late 1940s and then (1952) set up the Sacramento Peak Observatory to study solar effects on the environment relative to Air Force operations. Today these space weather research units have evolved into the Air Force Research Laboratory’s Space Weather Center of Excellence, the Solar Optical Observing Network and the National Solar Observatory. Space weather remains a major concern for all aerospace operations today. But there are several particular aspects of space weather that warrant special attention now. As the military faces increased competition for scarce resources, it has turned to commercial and private sector assets to supplement, and even replace military capabilities. This is particularly true in communications, whether space-based, ground-based, or Internet-based. We are now also relying on civil and commercial space services for crucial data such as imagery. However, these commercial assets seldom have the same degree of protection that military systems do. They tend not to be designed to be as effective as military systems against either man-made or natural threats such as space weather. Additionally, the economy upon which U.S. strength is based is increasingly dependent on, and vulnerable to, space weather effects. It is clear that a major event such as the 1859 Carrington event would devastate civil and military communications, as well as potentially destroy the global economy. It has been estimated that a Carrington event now could blow out thousands of transformers on the nation’s power grid, and it would be months before replacements could be put into place and full electrical power could be restored. And the probability of extreme events is not insignificant. On July 23, 2012, the Sun launched a CME that, had it been directed at earth, is estimated to have been as severe as the 1859 Carrington event [22]. However, there are potentially devastating problems at much lower levels of space environmental disturbances. Schrijver and Rabanal [23] show that commercial users believe they could use space weather data to mitigate more routine, but nonetheless serious impacts to routine services such as GPS positioning and even commercial power. Data now emerging show that many routine outages on such utilities as the power grid are highly correlated with routine space weather activity. Even the rate of lightning strikes during storms has been correlated with space weather activity [24]. This raises an additional concern. Today, routine problems with the communication links such as the Internet are often difficult to distinguish as to origin—is it manmade or natural? A significant attack or degradation in critical services could be masked by space weather disturbances. It may take some time, and a deliberate attack could do significant damage before its true nature was discerned. It is thus crucial to much better understand and predict the specific impact of space weather on routine operations, particularly commercial and civil systems we are increasingly dependent upon.

#### Lack of space weather data causes extinction

Dancer 16 [Benjamin Dancer, Director of Public Relations for the Colorado EMP Task Force on National and Homeland Security, which is the Colorado branch of a Congressional Advisory Board., 5-22-2016 https://www.benjamindancer.com/blog/2016/5/7/space-weather-an-existential-threat]

Could space weather threaten our civilization? It’s not a question most people think about. I started thinking about it for the first time in 2010 when I did the research for my novel Patriarch Run. That research introduced me to a lot of interesting people, and it brought me inside a pretty eclectic community: the small group of experts who understand just how close it is our civilization has chosen to dance to the apocalypse. The sun emitted a mid-level solar flare, peaking at 3:01 p.m. EDT on Oct. 2, 2014. NASA's Solar Dynamics Observatory, which watches the sun 24-hours a day, captured images of the flare. Solar flares are powerful bursts of radiation. Harmful radiation from a flare cannot pass through Earth's atmosphere to physically affect humans on the ground, however -- when intense enough -- they can disturb the atmosphere in the layer where GPS and communications signals travel. This flare is classified as an M7.3 flare. M-class flares are one-tenth as powerful as the most powerful flares, which are designated X-class flares. The Old Man RSS It was that community of experts who invited me in April to the Space Weather Workshop in Broomfield, Colorado. The workshop had three co-sponsors: National Oceanic and Atmospheric Administration (NOAA) Space Weather Prediction Center National Science Foundation (NSF) Division of Atmospheric and Geospace Sciences National Aeronautics and Space Administration (NASA) Heliophysics Division So I got to hang out with the world's foremost experts on the subject of space weather. And let me tell you it was quite surreal to be in a room full of scientists who understood that the factual conversation they were having in the conference hall would be dismissed as the stuff of conspiracy theories if it were to be heard on the street. The gist of what they were talking about is this: over the course of the last century, our civilization has unintentionally evolved to become utterly dependent on an electronic infrastructure that was built without a full understanding of the havoc space weather could wreak on its critical components. In other words, our critical infrastructure is ridiculously vulnerable to the sun's normal weather patterns. Diffuse gas—called plasma—flows outward from the sun as the “solar wind” and carries with it solar magnetic field lines that become entangled with the Earth's own magnetic field lines. Location of "holes" were detected in indicated pink layers, near Earth. One of the most unsettling moments occurred at a talk tucked away in the basement of the hotel given by Bill Murtagh, the Assistant Director of Space Weather for the White House Office of Science and Technology Policy (OSTP). Murtagh summarized what the scientific community currently understands about the impact severe space weather could have on modern civilization. It was a pretty grim analysis. “These space weather events are massive.” Murtagh spread his hands as wide as his arms would allow and said, “If this represents the size of a large coronal mass ejection, the earth would be about the size of a grain of sand between my hands being buffeted by that storm.” Although such events seem rare on a human timescale, the probability is near certainty that the Earth will be hit by very large storms. Such storms could result in economic catastrophe. But it gets worse. A storm large enough could pose an existential threat to the human species. At this point, there are two important questions to answer. 1. How is it that weather from space could threaten electronic systems like the power grid? 2. And how is it that humanity has become so dependent on electricity that the sudden collapse of that infrastructure could threaten systems as rooted in the soil as our food supply? When a coronal mass ejection disturbs the Earth's magnetic field, geomagnetically induced currents (GICs) are created that can fry circuits and melt the windings of heavy-duty transformers. If large transformers at enough substations were to fail, the entire electric grid could go down. A prolonged power outage could last anywhere between a few weeks to forever, depending on the severity of the damage. One of the many issues we'd be facing in such a crisis would be the replacement of the transformers. The windings for these large transformers are handcrafted, and it takes months, if not years, to fulfill an order when the electrical infrastructure is intact. In the event of a crisis, it would be very difficult, if not impossible, to fulfill a large order of replacement transformers. The repair couldn't happen quickly. Meanwhile, if the power is out across the country, a lot of bad things will take place. There is an historical example of this phenomenon. In 1859 the earth was buffeted by a coronal mass ejection known as the Carrington Event. That storm took down the electrical infrastructure of the planet. Fortunately for the people alive in 1859 (and their descendants), civilization wasn't yet dependent on that infrastructure. At this point, I'll transition and answer the second question. If you'd like to learn more about space weather and the mechanisms of destruction to our critical infrastructure, you could read other posts on this blog (there are some great resources at the links in this post) or you could read the intelligence report given to Jack in Patriarch Run. The second question... 100 years ago you didn't need electricity to feed the population. The "pre-electrical" carrying capacity of the planet was less than 2 billion people. Our electrical infrastructure has increased the planet's carrying capacity to 7.5 billion. Before refrigeration, food was grown just outside the urban centers. In other words, everybody ate locally. You can't feed our population of 325 million Americans (and growing) without our electrical infrastructure. The loss of the grid wasn't an existential threat 100 years ago because our grandparents were more self-reliant. They had more agricultural area per capita around their urban centers to meet their needs, as there were only 76 million Americans in 1900. It's just not possible for today's population, which is 4 times as large, to live as close to the land (as locally) as our grandparents did 100 years ago. It is a statement of fact to say that our major metropolitan centers have outstripped their local carrying capacities. To meet the human need we now outsource the production of food and basic goods from around the world. That outsourcing makes us quite vulnerable to an interruption in supply. Moreover, there is a whole list of things we can't do without electricity: irrigate crops, refine fuel, produce fertilizer, produce pesticides, process food, refrigerate food, transport food, etc. So let's examine a worst-case scenario. Without electricity, we could not distribute clean water to our cities or provide sanitation or healthcare. There would be no commerce as we have come to know it. Such a collapse would probably result in widespread starvation, the reintroduction of diseases vanquished by modern sanitation, unprecedented social unrest, and a skyrocketing mortality rate. But what if it's just a little storm? When the big players in Washington, like FEMA, wrapped their heads around the potential catastrophe, they asked Bill Murtagh to answer a couple very important questions. "If we were to prepare for a 100 year storm, what does that look like? What about a 1,000 year storm?" Murtagh's answer. "We don't know. This is a fairly new science, and we don't have enough data yet." The Washington players wanted to know just how big the Carrington Event was? "What do we need to do to prepare for a storm like that?" The answer. "We don't have enough data to know how big that storm was." "Well, then what's the maximum? What's the most the sun can throw at us?" Murtagh's answer. "We don't know." What we do know is that there are critical components to our infrastructure that cannot be easily replaced, which means that there is a damage threshold that if crossed would render the situation unrecoverable.

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#### Counterplan text: states should revise the outer space treaty to ban appropriation of outer space with the exception of proportional liability

The counterplan competes a] the 1ac started the specification debate which means you should force them to defend that the aff is implemented through the ost that includes proportional liability anything else lets the 1ar recontextualize their advocacy in infinite different ways not grounded by their 1ac to moot neg offense b] evaluating competition solely off the plan text is useless since the 1ac offense is based off of the implementation and effects of the advantage which means we should get cps that compete through that since it’s the only way to have reciprocal offense

#### Action on warming is here now and solves

Jules **Kortenhorst 19**, Chief Executive Officer of Rocky Mountain Institute, recognized leader on global energy issues and climate change, “New Report Suggests the Speed of the Energy Transition Is Rapid,” 9/11/19, https://rmi.org/new-report-suggests-the-speed-of-the-energy-transition-is-rapid/

That the world is engaged in a profound transition in the way we use energy is undeniable. The era of carbon-intensive energy derived from the burning of fossil fuels is coming to an end, and a cleaner, more reliable energy future based on renewables like wind and solar will be the new normal. How long this change will take is, however, still a matter of fierce debate. But a new report from the World Economic Forum’s Global Future Council on Energy, The Speed of the Energy Transition offers compelling evidence that stakeholders in the global energy system—which means all of us—must prepare for change urgently, because it is coming fast.

Two Roads Diverge

The report, principally authored by Kingsmill Bond of Carbon Tracker, Angus McCrone of Bloomberg NEF, and myself, examines a key question: will the energy transition be gradual or rapid? A gradual transition means that oil, gas, and coal remain the dominant energy sources even as renewable energy supply increases at a steady but linear rate. And it means that there is growth in energy demand for fossil fuels—with demand for fossil fuels not reaching its peak for a generation or more—allowing the traditional businesses of energy sector incumbents to continue to flourish. In this transition scenario, we miss the climate change goals of the Paris Agreement, but the global energy sector doesn’t face the near-term prospect of wrenching change.

A rapid transition, on the other hand, means that renewables like wind and solar quickly start to supplant fossil fuels as their supply increases at an exponential rate, following the familiar S-curve growth pattern of new technologies like personal computers and mobile phones. It means that renewables supply all the net growth in global electricity demand, displacing oil, gas, and coal —with demand for fossil fuels peaking in the 2020s —and thus seriously disrupting the traditional businesses of the energy sector incumbents. In the rapid transition scenario, the energy sector will face massive change, but humanity has a chance of achieving the goals of the Paris Agreement to limit climate change to well below 2 degrees.

The question of the timing of the energy transition is a critical one: either the tipping point is right before our eyes in the decade to come, or it is far into the future, beyond the planning horizon of most companies. If stakeholders, whether they are governments setting policy, or businesses making investment decisions, assume a gradual transition while the trajectory is actually a rapid one, they will end up making the wrong decisions. Society will bear the costs of uneconomic investments and stranded high-carbon assets. But equally important, humanity will miss an early opportunity to achieve a sustainable world where the risk of catastrophic climate change is limited.

Reading the Signs

The new report describes how the two narratives—gradual and rapid—are distinguished by four main features, and how views on these issues largely determine conclusions on where the energy markets are heading. How one reads the evidence on either side of these questions determines whether one believes the gradual or rapid energy scenario more likely. They are:

At what point do renewables get big enough to impact the incumbency?

It is possible to judge the coming transition by the percentage of total energy supplied by renewable or fossil fuels, and doing so makes the changes seem gradual; solar and wind are said to be only about 1 percent of total energy supply and so too small to have much of an impact. But the key moment of significance in the transition is when renewables make up all the growth in energy supply, and this will likely come in the 2020s, long before fossil fuels lose their dominant share of total energy supply. The effects of the change will be felt by incumbents as market growth turns to decline, and financial markets constrain capital to declining industries, reallocating it to those that are growing.

Is growth in new energy technologies linear or exponential?

Until just a few years ago, solar and wind power were more expensive than fossil-fueled electricity in most places, but cost parity has now arrived. Some argue that renewable costs will stop falling. But the evidence suggests that prices for renewables will drop far below incumbent energy sources, and fast. Consider: solar and wind are already cheaper than fossil fuels for the generation of electricity, and electric vehicles are close to challenging internal combustion engine cars on price. The barriers to growth are soluble for the foreseeable future, and even further waves of change are likely to arrive due to nascent but viable technologies such as green hydrogen.

Will policy change be static—as policymakers remain cautious—or dynamic—as new technologies open up new opportunities to better design markets?

Inertia is a powerful force and existing policies have only gone so far, but history teaches us that change, once it comes, is adopted rapidly everywhere, as with the adoption of laws prohibiting smoking indoors. We live in an era of increasing pressure to change policy related to carbon-intensive fossil fuels. In the face of catastrophic global warming, continuously accelerating innovation, and the huge energy windfall opened up by low renewable costs, change is inevitable. As technology opens up the opportunity to provide better solutions for consumers’ energy needs, policy makers will respond by redesigning markets. Once politicians see that the transition is not expensive and improves competitiveness, they will rapidly change the rules that govern energy markets so as to accelerate the transition.

Will emerging markets follow the fossil fuel path taken by developed markets or will they leapfrog to new energy technologies?

Some in the energy sector are convinced that emerging markets will broadly follow the path taken by developed markets and use more fossil fuels as they get richer and energy demand rises. Nations like China and India do indeed require more energy for their citizens. Close to one billion people around the world still do not have access to electricity. But providing consistent access to sufficient energy does not mean that developing countries have to choose a polluting energy system based on fossil fuels, particularly when the developed world is rapidly shifting to lower-cost, cleaner solutions. Just as mobile phones leapfrogged land-line telephony in much of the developing world, developing and emerging countries can leapfrog to the new energy technologies of the future.

There Is Time to Act but it Is Time to Choose

From the perspective of RMI, the evidence clearly points to a rapid energy transition scenario. The key is to feel the winds of change early and move into position so that it can fill all sails. Electric vehicles had a global market share of just 2 percent in 2018, but the global auto sector has committed $300 billion to a strategic transformation that seeks to ensure that auto industry incumbents from Detroit to Stuttgart will continue their centurylong dominance far into the future. As we published in a report earlier this week, clean energy portfolios now make natural gas-powered generation unprofitable across the United States. Developing countries will opt for the more cost-effective new technologies, rather than adopting solutions from the past. And increasing policy pressure, together with financial markets that reallocate capital, will all drive in the same direction. We can all of us—innovative technology start-ups, global energy incumbents and government policymakers alike—travel together and deliver the benefits of the energy transition profitably. But first recognizing what road we are traveling will make all the difference.

#### Market share liability is currently limited to perfectly fungible products---the plan’s use of proportional share liability for space debris dramatically expands the possible applications of proportional liability

Allen Rostron 4, Associate Professor of Law, UMKC City School of Law, “Beyond Market Share Liability: A Theory of Proportional Share Liability for Nonfungible Products,” 2004, 52 UCLA L. Rev. 151

[DES = diethylstilbestrol, the original market share liability case]

Fungibility thus can mean several different things, only one of which- uniformity of risk-is crucial for market share liability. That products of various manufacturers look the same or can be used interchangeably are just two among many reasons why a product may present inherent and unusually serious identification problems. Manufacturers can be extremely difficult or impossible to identify for many other reasons.93 Uniformity of risk across all manufacturers' products is the only sense in which fungibility is a logical requirement for application of market share liability.

The notion that any kind of fungibility should be required erodes completely as soon as one opens the door to what this Article calls "proportional share liability," a concept that includes but extends beyond market share liability. Market share data is simply one among many conceivable ways in which shares of liability could be apportioned across a group of defendants. Uniformity of risk is not essential if the liability can be allocated in an alternative manner that adequately takes into account the varying levels of risk posed by each manufacturer's products. Courts and commentators alike have cursorily dismissed or ignored this concept and given life to the fungibility requirement by doing so.

The idea of imposing proportional share liability on manufacturers of products that do not pose uniform risks has been lurking in the shadows for years even as market share liability has had the spotlight. In the first few years after the Sindell decision, a flood of writing addressed apportionment of liability in general and market share liability in particular." A small handful of these writers suggested that market share liability represented just one form of a broader approach that could be extended to nonfungible or nonidentical risks. For example, a case comment on Sindell recognized that courts should have "some mechanism for considering evidence reflecting disproportionate harm caused per unit," so that liability could be allocated properly where market share data alone did not adequately reflect the likelihood that each defendant caused the plaintiffs injury.9 Soon after, Professor Glen Robinson raised the same idea in an essay about the larger notion of holding defendants liable in proportion to the amount of risk they create rather than the amount of harm they cause.96 Robinson observed that, despite the excitement and controversy surrounding the DES cases, market share liability was likely to have little impact outside the DES context if it remained applicable only to defendants creating identical risks.97 He suggested that there was "no logical compulsion for the principle to be so limited," if "workable measures of apportionment can be found."98

Among the several approaches to market share liability adopted for DES in different states, Wisconsin's scheme comes closest to providing a way to impose proportional share liability in cases involving nonfungible products.99 Citing Professor Robinson's essay but somewhat cryptically indicating that it did not agree entirely with his reasoning, the Supreme Court of Wisconsin ruled that liability should be allocated among DES manufacturers under the state's comparative negligence statute, based on each defendant's overall share of the causal fault."° Unlike other states requiring apportionment to be based on market share data alone, the Wisconsin court made clear that market share data was just one among many factors to be considered.1' That approach would seem to be flexible enough to accommodate situations where products pose varying degrees of risk, but the opinion did not clearly indicate whether the court intended to go that far, stating only that its approach could apply to other products "factually similar" to DES without explaining what that meant.1°2

Twenty years have passed since the original string of decisions adopting market share liability and the flurry of interest they attracted. Despite the early, scattered scholarly interest in a principle underlying market share liability that could be extended beyond fungible products, the idea went nowhere. While courts have split on whether to adopt market share liability, they essentially have reached a unanimous consensus that market share liability cannot apply unless defendants' conduct poses perfectly uniform risks.' 3 Courts thus regard the fact that a product is "fungible and generic in nature" to be an "absolute predicate" to any application of market share liability to its manufacturers.' Decisions declining to liability because a product is not fungible are legion.' 5 "risk contribution" version of market share liability has apply market share Even Wisconsin's failed to extend its grasp beyond fungible products, as no reported decisions apply market share liability under Wisconsin law to any products other than DES.

The idea that liability could be apportioned among manufacturers of nonfungible products has died in the legal literature as well. Scholars and students writing about market share liability occasionally mention the idea of allocating liability using more than just market share data and cursorily dismiss it,10 6 but more often they simply accept the fungibility requirement without question or discussion.0 7 For example, some have written detailed and persuasive analyses to show that a particular product is not fungible and that market share liability should therefore not apply to it, without even addressing the possibility that liability could be allocated in any way other than using just market share data. 8

Recent drafts of the Restatement (Third) of Torts, still in tentative form, reflect the same disdainful attitude toward the concept. Calling it by the name "risk-adjusted market share liability," the draft comments acknowledge the theoretical possibility of proportional share liability for products that do not pose a uniform risk, but express severe skepticism about the idea." The authors of the Restatement observe that market share liability is attractive from a compensatory and deterrence standpoint "when the product is fungible and therefore poses equivalent risks," but recognize that limiting the theory's application to those products gives it "an exceedingly limited reach" because most toxic substances and other hazardous products do not pose uniform risks."' The draft comments conclude that "[while in theory a risk- adjusted market-share liability system might be attractive, the administrative costs imposed even by a pure market-share system augur against such efforts, and there is virtually no case support for a risk-adjusted market-share theory.'

The authors of those draft comments to the Restatement are correct that little existing judicial precedent exists for imposing proportional share liability on manufacturers of products that do not pose a uniform risk. At the same time, little precedent exists that thoughtfully examines the idea and rejects it. Instead, courts simply have treated market share liability as an isolated concept rather than recognizing it as being just one representation of a more general principle. They have insisted that claims fail if the product is not fungible, without analyzing whether there are other reasons why injuries generally cannot be attributed to particular manufacturers and whether there are means of fairly apportioning liability other than by market shares. The idea of applying proportional share liability merits more serious consideration in cases where it could be utilized.

II. APPLYING PROPORTIONAL SHARE LIABILITY TO NONFUNGIBLE PRODUCTS

In cases where a product poses uniquely severe identification problems for plaintiffs but does not pose a uniform degree of risk, a court could take several different avenues toward imposing proportional share liability."' For example, suppose that several manufacturers produce a new type of drug that, unlike DES, is not chemically identical because each manufacturer has a unique, slightly different formula for producing the drug. The manufacturers negligently disregard indications that the drug will cause severe adverse reac- tions for some who take it. Some of those injured by the drug can identify the manufacturer of the dose they received, while others cannot do so.

If the degree of risk varies among the products, market share liability would not be appropriate, and courts would have to allocate liability in another manner. One possibility would be to take market share data as a starting point but to use product test data to adjust the percentages to take into account the relative risk posed by each product. For example, if each manufacturer performed field studies of its drug and had data on the odds of adverse reactions to the drug, that information could be used to adjust market share data to achieve an allocation of liability that reasonably reflects the likeli- hood of each manufacturer having caused a plaintiff's injury.

Where product test data does not exist, market share data could be adjusted based on expert witnesses' assessments of the relative risk of each product. For example, plaintiffs could offer expert evidence explaining how the differences in chemical formula affected each drug's odds of causing adverse reactions.

Still another approach would be to eschew market share data completely where an alternative set of data exists that takes into account the relative degree of danger presented by each manufacturer's product. For example, data about adverse reactions that can be traced to particular manufacturers' drugs could be used to allocate liability for cases in which the manufacturer cannot be identified. The cases described in this part illustrate these various approaches.

A. Vaccines: Using Product Test Data to Adjust Market Share Data

The case in which a court came closest to articulating a theory of proportional share liability for nonfungible products, Shackil v. Lederle Laboratories involved DPT vaccine. Unlike DES, a synthetic chemical produced according to a standardized formula, DPT vaccine is a biological product that each manufacturer produces via its own proprietary process."4 Alleging that a DPT inoculation caused their infant daughter to suffer severe brain damage from encephalitis, a viral infection of the brain, the Shackils brought a lawsuit claiming that DPT vaccines contain toxins that manufacturers could eliminate with the use of proper technology."5 The Shackils were unable to identify the manufacturer of the vaccine administered to their daughter and sued each of the several manufacturers that supplied vaccine to her pediatrician." 6

The vaccine manufacturers argued that market share liability could not be imposed because their products were not "generic or truly fungible.... 7 The trial judge dismissed the case on that basis, but the intermediate appellate court reversed and remanded for further development of the factual record.

In his opinion for the appellate court, Judge William Dreier first zeroed in on what type of "fungibility" is important to market share liability."8 While the manufacturers emphasized that they use different processes to make the vaccines and that the biological characteristics of the vaccines vary as a result, Judge Dreier essentially recognized that physical indistinguishability and identical methods of production are not prerequisites for market share liability or for any other proportional share liability theory. If any of the vaccines could have caused the injury, lilt makes little difference to a consumer what the internal biological or chemical nature of a product may be.... "" The Shackils' inability to identify a manufacturer stemmed largely from the same factors that plagued DES plaintiffs: passage of time and destruction of the prod- uct as it was used. Almost thirteen years passed after their daughter's inocula- tion before the Shackils became aware of a connection between DPT vaccine and brain damage and filed their suit.12 Judge Dreier observed that differences in the composition of the manufacturers' vaccines "must be considered as irrelevant as the color of the label on the package" if they merely establish that the manufacturers' products were physically distinguishable. 2

At the same time, Judge Dreier recognized that differences among the vaccines would be significant if they affected the likelihood of the vaccines' recipients suffering seriously harmful reactions to the vaccine.12 Pure market share liability would not be a sound way to allocate liability if the vaccines did not pose a uniform risk. For example, defendant manufacturer Eli Lilly asserted that its DPT vaccine contained an "acellular" form of pertussis vaccine produced through a patented centrifugal process that eliminates unwanted cell debris and significantly reduces the chances of adverse reactions as compared to 2 other manufacturers' "whole cell" forms of the vaccine. 1

For most courts, that would have been the end of the story. The product was not fungible, and therefore market share liability could not apply. Judge Dreier looked beyond that to consider whether some form of liability could be imposed on a proportional basis even though the product did not pose a uniform risk. He seized on the crucial fact that data existed from which an allocation of liability could be made that would account for variation in the risk posed by the manufacturers' vaccines. Each manufacturer maintained records concerning the incidence of encephalitic injuries resulting from its vaccinations. Eli Lilly, for example, not only asserted that its vaccine was markedly safer than its competitors' products, but also that it could quantify this difference.'

Judge Dreier's opinion therefore directed the trial judge to employ a "risk-modified market share analysis," in which market share data would provide the starting point for the liability allocation but "proof by a defen- dant of the reduced incidence of encephalitis would result in a proportional lowering of the percentage responsibility for such defendant."'26 Rather than allowing the manufacturers to escape liability altogether simply because their products posed different levels of risk, the court concluded that there was no reason to refrain from imposing proportional share liability "if the differ- ences can be suitably quantified."'27

The New Jersey court aimed for a solution that would balance the need for fairness to the manufacturers with the opportunity for plaintiffs to recover if they could prove injuries caused by a defective product supplied by one of the manufacturers.'28 The court refused to be dissuaded by the inevitability of imperfections in its approach. Discussing details of the work that would be required to determine the manufacturers' proportions of the liability, Judge Dreier offered a reminder that "[t]he aim is not certainty but reasonable approximation."' 9

The case proceeded up to the Supreme Court of New Jersey. Reversing and ordering dismissal of the Shackils' claims, that court inexplicably failed to grapple with the proportional share liability theory actually proposed by the lower appellate court and instead analyzed the case as though pure and unadjusted market share liability were the only theory at issue.' The supreme court began by asking whether DPT vaccine "is a 'generic product' that is uniformly harmful and therefore amenable to a market-share analysis.' 3' Answering in the negative, the court pointed to Eli Lilly's unique method of creating the vaccine and cited scientific literature suggesting that the method significantly lowered the risk of encephalitic reactions.12 Finding that "[t]he products were clearly not identical" because Eli Lilly's vaccine posed a lower risk of harm, the supreme court complained that Judge Dreier's opinion for the lower court nevertheless "swept all producers into one market share" allocation."' The supreme court added that it was "wary" of Eli Lilly's vaccine being included in the allocation "inasmuch as the product may have represented the 'state of the art' in vaccine design at the time of the inoculation."'34

In making these arguments, the Supreme Court of New Jersey did an astonishing job of missing the point. The fact that Eli Lilly's or any other manufacturer's product posed less risk than the other vaccines was exactly what Judge Dreier crafted his risk-adjusted approach to take into account.1 The supreme court seemed unable to let go of an entrenched notion that market share liability is the only possibility when it comes to proportional share liability and that the products therefore must be "fungible" and present identical degrees of risk.

The supreme court's concern about Eli Lilly being liable for a share of the injury despite its vaccine being "state of the art" made even less sense. As that court noted, New Jersey law provides that "state of the art" status is an absolute defense in products liability actions.'36 The court acted as though liability was a foregone conclusion under Judge Dreier's theory and that the only thing left to decide would be each defendant's percentage of the damages, forgetting that the plaintiffs would not bring their claim into the realm of proportional share liability unless they first proved that Eli Lilly's conduct was negligent or its product was defective.37 Indeed, even if the Shackils proved that every other DPT vaccine on the market was defective, a failure to prove a defect in Eli Lilly's product should have enabled a/!manufacturers to avoid liability, not just Eli Lilly, because courts generally hold that principles such as market share liability and alternative liability cannot be imposed unless a plaintiff can prove tortious conduct by all members of the group of actors that could have caused the injury.13

Setting aside Eli Lilly and looking just at the other five manufacturers, who all used similar "whole-cell" processes to produce the vaccine, the supreme court thought market share liability might be a viable theory. It observed that the vaccines were fungible in the sense of being functionally interchangeable'39 and noted that studies found no significant differences in the rates of serious reactions to the vaccines of these five manufacturers, suggesting they were also fungible in the sense of posing a uniform risk. 4

Even for the vaccines that might be regarded as fungible, however, the court ultimately concluded that no form of collective liability should be imposed on DPT vaccine makers because that sort of liability would frustrate "over- arching public-policy and public-health considerations by threatening the continued availability of needed drugs and impairing the prospects of the development of safer vaccines" and because the goal of compensating injured people had already been accomplished by the creation of a federal statutory compensation scheme for vaccine injuries.' The court noted that the federal scheme essentially establishes a collective liability regime for vaccine injuries, because it provides compensation without requiring identification of a manu- facturer.'42 The court emphasized that these policy concerns were unique to the context of vaccines and that its decision "should not be read as forecasting an inhospitable response to the theory of market-share liability in an appropriate context. The effectiveness and fairness of the federal compensation scheme for vaccine injuries have been the subjects of considerable debate.' For exam- ple, the statute caps damages for vaccine-related deaths at $250,000,' and some believe the program "has failed to achieve its purpose of efficiently compensating the small, but significant, number of children who are injured by vaccines." '46 Litigation about DPT vaccine nevertheless waned after Shackil, with potential plaintiffs preferring to seek compensation under the federal statute rather than face the perils of trying to show that the vaccines posed identical risks or trying to persuade a court to apply a novel "risk adjusted" liability theory. Only one reported decision after Shackil raised the issue of manufacturers being held collectively liable for injuries from DPT vaccine; the plaintiff in that case apparently did not attempt to employ any proportional share liability theory and instead asserted that the vaccine was a "generic, 47 fungible" product.

The Supreme Court of New Jersey's decision in Shackil reflects a remarkable determination to frame the case in the familiar terms of fungi- bility and pure market share liability, disregarding what the Shackils sought and how the lower court had ruled. The liability theory advanced by the lower court was a sound response to the availability of data with which the varying degrees of risk posed by the manufacturers' products could be taken into account in making a reasonable allocation of liability. Reversed on grounds unique to the vaccine context, the lower appellate court's decision represents a tentative judicial recognition of the sensibility of proportional share liability recoveries not based strictly on market share.

B. Asbestos Brake Pads: Using Expert Assessment of Products' Relative Risks to Adjust Market Share Data

Litigation concerning asbestos brake products provides an example of how unnecessarily limiting proportional share liability to "fungible" products posing uniform risks forces plaintiffs and courts to stretch the meaning of fungibility beyond its natural limits. Asbestos has long been used as a component of friction brake pads and shoes because it can withstand the extreme heat generated by braking in even the largest vehicles.' Some indi- viduals who install and repair brakes believe that they have contracted diseases from prolonged inhalation of asbestos particles from the brake prod ucts. In Wheeler v. Raybestos-Manhattan,"9 plaintiffs sued several manufacturers of asbestos brake products under a market share liability theory. They argued that people injured by these products inevitably face severe difficulties identifying manufacturers because of the nature of the products and their use. Most of the exposure to asbestos fibers from these products occurs during inspection or replacement of worn pads, when dust or residue from the old pads is blown out of the brake drums.' 0 While the manufacturer of a new pad can be easily identified, the brand markings on an old pad have been obliterated by abrasion by the time a mechanic removes it and suffers exposure to the asbestos dust.'

The arguments made in Wheeler reflect the substantial confusion created by judicial precedents declaring that fungibility is required for market share liability without clearly explaining what that means. The defendants insisted that brake pads are not fungible because they come in many different shapes and sizes designed to fit different vehicles, while the plaintiffs offered to satisfy the fungibility requirement by proving that brake pads are "fungible to the extent that a pad of a given size, regardless of who made it, could be used on a variety of different vehicles."'52 The California Court of Appeal panel that decided Wheeler rightly saw through those superficial notions about fungibility and observed that it isirrelevant whether the pads come in various shapes and sizes unless that somehow affects the level of risk posed by each pad or affects whether an injured person generally will be able to identify the manufacturer of the products that caused the harm.'53

Recognizing that this product presented severe identification problems for injured plaintiffs, the court focused on whether the product was fungible in the sense of posing a uniform degree of risk. The evidence showed that all pads contained a single type of asbestos fiber, chrysotile, but in varying amounts, with the asbestos making up as little as 40 percent or as much as 60 54 percent of the pad's weight.' Such evidence does not meet the standard of perfectly uniform risk required by most courts for market share liability. Nevertheless, the court in Wheeler decided that it was close enough, con- cluding that brake pads are sufficiently fungible "by virtue of containing roughly comparable quantities of the single asbestos fiber chrysotile."'55 Dis- tinguishing a case in which the Supreme Court of Ohio found that duct tape is not fungible because its asbestos content varies from 15 to 100 percent, the Wheeler court observed that the asbestos content of the brake pads is "not identical" but varies only within a "restricted range" of 40 to 60 percent and that the risk of harm posed by each brake pad is therefore "more nearly equivalent."'56 The court realized and was willing to accept that subjecting brake pad manufacturers to market share liability would not result in each defendant's portion of the liability being based on the best estimate of how 57 much harm its product actually cause.

Wheeler successfully withstood a petition for review by the Supreme Court of California, but its validity remains in substantial doubt. In Richie v. Bridgestone/Firestone,Inc., ' a member of the California Court of Appeal who was not on the panel in Wheeler made a forceful attack on the notion that asbestos brake products are sufficiently fungible for market share liability to apply.'59 Justice Carl Anderson argued emphatically that Wheeler was wrongly decided because, unlike DES, brake pads with asbestos content ranging from 40 to 60 percent by weight do not pose identical risks.'60 In Justice Anderson's view, California law requires absolute uniformity of risk, and even a miniscule variance in the asbestos content of brake pads would be enough to prevent application of market share liability.' In addition, Justice Anderson pointed out that the variation in asbestos quantity is not the only thing that prevents brake pads from posing a uniform, fungible risk. For example, brake pads contain asbestos fibers obtained from different geographic sources, which can affect the degree of health hazard posed by the product.'62 Manufacturers of the brake pads also used different bonding agents, a factor that might affect the amount of asbestos released from the pads.'

The Supreme Court of California has yet to rule on these issues,1 64 and Wheeler therefore continues to stand as a precedent, albeit disputed, for the notion that market share liability can be applied when the products pose risks that vary but are within a relatively limited range. Nevertheless, plaintiffs have not had success trying to recover based on Wheeler's approach. Courts have come up with a variety of grounds on which to distinguish Wheeler and to 65 decline to follow it.

Wheeler was a flawed attempt to overcome a bad rule of law. The court rightly felt that there was something wrong with denying recovery merely because a product contains a harmful ingredient in varying amounts and therefore is not fungible in the sense of posing a perfectly uniform level of risk. But the Wheeler court proposed to solve that problem by simply disre- garding the variations in risk among the products. Other courts have balked at that idea because the differences in Wheeler were not de minimis, the variation is even greater in many other cases, and ignoring variations in the risk created by each defendant undermines the logic of market share liability. To paraphrase one of the courts declining to follow Wheeler, it seems obvious that a product containing 60 percent asbestos would create a greater risk of harm than one containing only 40 percent.'"

The solution to that obvious problem is to take the variations in risk into account rather than disregarding them. Contrary to Wheeler's approach, a manufacturer that sells pads containing 60 percent asbestos should bear more of the liability than a manufacturer that has an equal market share but sells pads with only 40 percent asbestos content. At the same time, the mere fact that some pads contain more asbestos than others should not rule out the possibility of recovery any more than the fact that DES pills came in different dosages. 6 Expert evidence obviously will be necessary to quantify the differ- ence in risk posed by brake products containing different amounts of asbestos. The risk created by each manufacturer may be a function of more than just market share and asbestos content if other differences among the products, such as geographic source of asbestos fibers or bonding agents, 6 prove to have a significant effect on the risk posed by the products. 6'9

Is it feasible for courts to arrive at a liability allocation that fairly accounts for the variations in risk posed by different manufacturers' asbestos brake products? That question is impossible to answer with certainty at this point because plaintiffs have not even tried to assert such a theory or to present the evidence it would require. Instead, they continue trying to show that brake products are fungible enough that the differences among them should be ignored. ' Plaintiffs are trying to squeeze a square peg into a round hole because that is the only opening available to them given courts' unduly narrow focus on market share liability to the exclusion of all other imaginable forms of proportional share liability.' Proposing a suitable form of proportional share liability would strengthen a plaintiff's position by making the liability correspond more closely to each defendant's contribution to the risk of injury. At the same time, such an argument would put the plaintiff in the difficult position of urging application of a liability theory to a court unaccustomed to thinking in any terms other than those of pure market share liability.

A massive amount of experimental work has been conducted on asbes- tos toxicity in recent decades.' Considering that depth of knowledge, it is plausible, to say the least, that an expert in that field could render a sound opinion about the relative danger of brake pads containing different amounts of asbestos. Plaintiffs should exploit the information available, while courts should signal their willingness to entertain claims seeking proportional share liability on bases other than simply market share data.

C. Guns: Using Data on Injuries Traced to Specific Manufacturers to Allocate Liability for Untraceable Injuries

Lawsuits against gun manufacturers provide another example of how proportional share liability could be imposed in a form other than market share liability. 7'3 Plaintiffs injured by criminals using guns have brought mar- ket share liability claims against gun manufacturers, but without success. Recognizing that market share liability isnot the exclusive means of imposing proportional share liability would shift the focus in these cases from fungibil- ity to whether liability can be allocated among gun manufacturers in a way that reasonably and fairly reflects each manufacturer's contribution to the risk at issue. For guns, a unique body of data exists that would accomplish that; indeed, it would enable courts to bypass market share data entirely. Every year, the Federal Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) traces hundreds of thousands of guns used in crimes."' The immense database generated by ATF tracing provides comprehensive information about the relative risks of criminal use of every type of gun and a sound means of allocating liability among gun manufacturers when the particular brand of gun used in a crime cannot be identified. In short, data about traced guns provides a way to allocate liability for guns that cannot be traced.

1. Judicial Rejection of Market Share Liability for Guns

The notion of imposing collective liability on gun manufacturers first arose in Hamilton v. Accu-Tek, 75 a suit brought in the Eastern District of New York by victims of shootings involving illegally obtained handguns. Using a local rule providing for assignment of new cases to judges who previously handled "related" cases,'76 plaintiffs' counsel steered the case to Judge Jack Weinstein, who had significant experience with the concept of industry-wide liability. In addition to having developed a theory of "enterprise liability" in litigation against blasting cap manufacturers,77 Weinstein later dealt with other collective liability theories while presiding over mass tort cases involving DES, Agent Orange, and asbestos.178

Judge Weinstein initially permitted the plaintiffs in Hamilton to take discovery limited to issues bearing on potential application of collective liability theories, rather than opening the door to full discovery on the merits of the claims.'79 Denying defense motions for summary judgment, Weinstein suggested that market share liability or other collective liability theories could apply to claims brought by gun violence victims because of the fact that many plaintiffs alleging negligent distribution of guns cannot identify the manufac- turer of the particular gun used to inflict the injury. Weinstein recognized that guns, like DES, are a product posing inherent identification difficulties. For guns, the identification problems do not occur because guns are physically indistinguishable or functionally interchangeable. Instead, guns pose inherent identification problems because they are uniquely likely to be unavailable after injury has occurred."s People who commit crimes with guns have strong incentives not to permit themselves or their weapons to be found and identified. They flee the scenes of their crimes and they generally take their guns with them. In many instances, criminals destroy, discard, or otherwise dispose of guns so that the weapons can never be recovered and identified even if the criminal is apprehended. As Judge Weinstein put it, "[it is the nature of illegal handgun use that the shooter is likely to dispose of the gun so as to minimize the chances of being caught."' 1 According to the plaintiffs' allegations, the manufacturers' tortious conduct creates and fosters the under- ground gun market, exacerbating the identification problems inherent in the nature of the product.

At the same time, Judge Weinstein suggested a second and more radical theory under which collective liability could be imposed on gun manufacturers. He suggested that even a plaintiff who can identify the manufacturer of the gun used to inflict plaintiffs injury could claim that liability for the harm should be imposed on the entire industry, not just one manufacturer.'82 Each manufacturer's negligence is a partial cause of the harm suffered by a plaintiff "[ilf the underlying cause of the injuries is the unchecked growth of the underground handgun market, and not an individual negligent sale of a particular gun by a particular defendant to a particular licensed dealer .... For example, a plaintiff could claim that she was shot with a Beretta pistol obtained from the underground gun market, but that Beretta's negligent supply of that market was only part of the problem. If only Beretta's distribu- tion system was faulty, the underground market would wither. Instead, that market flourishes because Glock, Smith & Wesson, Sturm Ruger, and other manufacturers pour guns into it along with Beretta. Under that view, "only the collective action of the handgun industry makes the individual shootings giving rise to [suits] possible even when the manufacturer of the gun used in the shooting was known."'"

In essence, Judge Weinstein proposed a way to make product identifi- cation problems disappear by redefining the thing that causes harm. This was a familiar move for Judge Weinstein, as it was the key to his theory of "enterprise liability" in the blasting cap cases."' Treating a blasting cap as the cause of the injury inevitably leads to the question of who made the blasting cap and reluctance to impose liability if no one knows the answer to that question. Treating faulty industry standards as the cause of the injury solves that problem and allows the issue of product identification to be brushed aside. Weinstein proposed that plaintiffs might adopt a similar tactic in gun cases by claiming that the underground market was the cause of their injury, turning the identification issue into a question about who is responsible for the underground market rather than who produced the specific firearm used by plaintiffs assailant."6

The Hamilton case went to trial and generated a verdict in early 1999. The jury found that fifteen manufacturers acted negligently and that nine of those proximately caused injury to one or more plaintiffs. However, the jury awarded damages for only one of the shooting victims, Stephen Fox, who was severely wounded by a juvenile with a handgun illegally purchased from someone selling guns from the trunk of a car.187 Police recovered a spent .25 caliber cartridge case from the scene. The bullet remained lodged perma- nently in Mr. Fox's brain, and police never recovered the gun used in the shooting.88 The jury awarded $4 million in damages to Mr. Fox and his mother and assigned liability to three manufacturers found negligent in the case, allocating the damages based on their shares of the .25 caliber handgun market: 0.23 percent to American Arms, 6.03 percent to Beretta, and 6.8 percent to Taurus.189

Denying those three manufacturers' motions to throw out the verdict, Judge Weinstein ruled that the justifications for New York's adoption of market share liability in DES cases supported application of that theory to injuries resulting from unidentified handguns. Handgun plaintiffs face "intractable problems of proof' because a large portion of crime guns are not recovered or otherwise identified.'9 ° Weinstein concluded that guns are sufficiently fungible to warrant imposition of market share liability, suggesting that all handguns are alike from the point of view of criminals as well as shooting victims. T9

The case wound its way up to the Second Circuit and over to the Court of Appeals of New York. Answering certified questions, the state court unanimously rejected Judge Weinstein's application of market share liability to gun manufacturers.'92 The court first attacked the notion that guns are fun- gible in ways that create inherent identification difficulties. Rewriting history, the court asserted that DES was "an identical, generically marketed product" and that therefore "identification of the actual manufacturer that caused the injury to a particular plaintiff was impossible."93 The court apparently had forgotten much about DES since deciding Hymowitz v. Eli Lilly & Co.,'94 the case in which it initially adopted market share liability. While all DES shared the same or a substantially similar chemical formula9 ' and identifying a manufacturer was often impossible, DES pills were not physically identical or indistinguishable and many DES plaintiffs could identify the manufacturer of the product that caused their injury.'96 Compar- ing guns to its somewhat skewed recollection of DES, the court in Hamilton observed that guns are "not identical, fungible products" and that "it is often possible to identify the caliber and manufacturer of the handgun that caused injury to a particular plaintiff." ' The court never addressed the idea that guns pose uniquely severe identification problems for reasons other than physical indistinguishability or generic marketing."'  
The New York court stood on much more solid ground, however, when it pointed out that guns are not fungible in the sense that they do not pose a uniform risk. As the court recognized, the plaintiffs claimed that each manu- facturer negligently distributed guns, but never suggested that every manufacturer's distribution methods were exactly the same. Instead, "[elach manufacturer engaged in different marketing activities that allegedly contributed to the illegal handgun market in different ways and to different extents."'99 Neither plaintiffs nor Judge Weinstein attempted to establish the "relative fault of each manufacturer" and "instead sought to hold them all liable based simply on market share" percentages.2" Market share was a reason- able allocation method for DES, a product posing a uniform risk, because it was "an accurate reflection of the risk" created by each manufacturer's conduct."' In the New York court's view, market share could not result in a fair allocation of liability when applied to the "varied conduct" of gun manufacturers.2"

2. Proportional Share Liability Based on Trace Data

Even if they can prove negligence by gun manufacturers, plaintiffs injured by guns that are not recovered and cannot be identified have no hope if courts think exclusively in terms of market share liability and accompanying notions about fungibility. Guns are easy to distinguish physically, because there are numerous models, with different calibers, ammunition capacities, and designs, and each gun is marked with the manufacturer's name and a unique serial number."3 While certain distribution and marketing practices are common throughout the industry, no two manufacturers' distribution system and methods are exactly the same. Different kinds of guns, ranging from antique black powder muskets to modem high-capacity assault weapons, vary tremendously in the degree to which they are used by criminals and present a safety risk to the public. Market share data alone will not produce a reasonable allocation of liability among gun makers.

Rather than trying to squeeze guns into a theory that does not fit them, the better approach for plaintiffs in cases involving unidentifiable guns is to exploit the fact that an immense body of data provides a better way to allocate liability among gun makers. That data exists because ATF continually traces guns recovered by federal, state, and local law enforce- ment agencies throughout the United States. Police submit trace requests to ATF's National Tracing Center, providing information about the gun to be traced, including the name of its manufacturer and its serial number.04 Federal law provides that police can request traces only in connection with bona fide criminal investigations." If police submit requests for informa- tional purposes unrelated to a criminal investigation, ATF will not conduct the trace.06 Every traced gun is therefore a "crime gun" according to ATF, defined as "any firearm that is illegally possessed, used in a crime, or suspected to have been used in a crime."2 7

The tracing process is cumbersome because firearm transaction records are not maintained in any centralized manner, reflecting fears about creation of anything resembling a national gun registry.08 Instead, records are in the hands of manufacturers, distributors, and dealers dispersed throughout the country. ATF therefore generally begins a trace by contacting the manufac- turer and providing it the serial number of the gun being traced.2" manufacturer looks in its records to determine the distributor or dealer to which it sold the gun and then gives ATF that name and the date of sale. ATF then contacts that distributor or dealer to find out what it did with the gun.Bythatprocess,ATFworksitswaydownthroughthechainofdistribution until it obtains information about the retail sale of the gun. ATF maintains a database of information generated about each gun traced, including the gun's manufacturer, model, and caliber. The database isavailable to the public in computerized form for a nominal fee.210

The number of traces recorded in the database grows every day, with ATF tracing over 230,000 guns in fiscal year 2001 and over 240,000 guns in fiscal year 2002."' Fifty major cities participate in a "comprehensive crime gun tracing" program under which their police departments request traces of all crime guns recovered in the jurisdiction.12 Six states have implemented comprehensive tracing for all guns recovered from criminals statewide. ATF has established a Crime Gun Analysis Branch specifically dedicated to studying the data generated by tracing and publishing reports intended to help law enforcement agencies develop strategies for investigations and to "inform federal licensed firearms dealers of crime gun patterns, allowing them to build sounder and safer businesses."2 '4 The reports contain lists of the guns most frequently traced, the guns that typically move most quickly from retail sale to use in a crime, and the guns most frequently recovered from criminal offenders in specific cities or age groups.2" Researchers have utilized the database to study patterns in gun trafficking and their implications for public policy."

The trace database thus provides reasonable estimates of the extent to which different types of guns are used in crimes. The representation of a particular model or type of gun in the trace database can be dramatically different from its market share measured by sales. For example, while long guns (rifles and shotguns) represent more than one half of all guns sold in the United States every year,217 they account for less than one quarter of traced guns."'

Several writers have severely criticized the idea of using ATF trace data to draw any conclusions about criminal use of guns."9 One compared analyzing trace data to practicing phrenology or examining the entrails of sacrificial animals to forecast the future.220 Notwithstanding that sort of hyper- bole, their objections to analysis of trace data are not compelling, particularly when it comes to using trace data for the limited purpose of estimating the extent to which different types of guns are used in crimes.

These critics point out that the hundreds of thousands of guns traced by ATF every year represent only a small fraction of all guns used in crimes.22' That is true, but it is not a reason to oppose the use of trace data for proportional share liability allocation. Indeed, the fact that not all guns are traced merely underscores the fact that guns used in crimes frequently are not recovered and cannot be identified, a factor weighing in favor of imposing collective liability.

Likewise, the critics of trace data note that most traced guns are not used to commit violent crimes.222 For example, ATF traces large quantities of guns that police recover from people who possess them illegally, such as juveniles and convicted felons. This criticism assumes that the extent to which a particular kind of gun is illegally possessed will not be reasonably representative of the extent to which that kind of gun is illegally used to commit violent crimes, or at least that the degree of correlation between illegal possession and illegal use of particular types of guns is uncertain. Even if one accepts that assertion, this criticism still fails to stand up as an argument against using trace data to apportion liability among gun manufacturers.

First and most important, this criticism of trace data ignores the fact that one of the fields in the trace database contains a code representing the criminal offense associated with the gun. It is therefore possible to determine a par- ticular manufacturer's or gun model's share of traced guns associated with violent crimes in general, or with a particular type of violent crime."3 In other words, if the overall body of data on traced guns is not a fair measure of each manufacturer's contribution to violent criminal use of guns, the solution is to identify the appropriate subset of the data, not to insist that the data should be ignored.

Moreover, the entire trace database clearly would be the best set of data to use in certain cases, even though it includes many guns traced in connection with possession offenses rather than violent crimes. For example, lawsuits brought by cities and counties against the gun industry have sought to recover extra law enforcement and other government costs incurred because of widespread illegal use and possession of firearms."4 These munici- palities incur costs in attempting to remove illegally possessed guns from the streets before they are used to commit crimes, not just responding after a shooting or other violent crime occurs.

The critics also note that a large portion of attempted traces are unsuc- cessful, meaning that ATF isunable to track the gun all the way down to the point of identifying the retail dealer who sold the gun and the customer who purchased it.2"' While that would arguably be a matter of concern for some uses of trace data that depend on information about dealers and retail purchasers, it is not an issue to the extent the data is used to allocate liability among manufacturers. Even "unsuccessful" traces result in identification of the weapon's manufacturer.226

The critics' final assertion is that traced guns may be a biased or unrep- resentative sample of the overall population of guns possessed and used by criminals. 7 For example, these writers contend that police are selective about what types of guns they trace and are much more likely to request traces of guns that are unusual in appearance or that are the subject of politi- cal controversy, such as the type of guns known as "assault weapons.""' Likewise, they point out that ATF generally cannot successfully trace a gun manufactured before 1968, because there were no laws in effect prior to that year requiring dealers to keep records of their disposition of guns." 9

While this bias or unrepresentativeness is by far the strongest criticism of analysis of trace data, it still does not seriously undermine the case for using trace data to apportion liability among gun manufacturers. It overlooks the significance of comprehensive tracing, a measure that ATF has already taken that greatly reduces the potential for sample bias. A large portion of the guns in the trace database comes from cities in which police are comprehensively requesting traces of all crime guns they recover, eliminating selectivity and bias that otherwise might occur."'

Nor does the difficulty of tracing guns manufactured before 1968 severely undermine the use of trace data. Ifan older gun cannot be successfully traced all the way to a retail purchaser, ATF still enters the information it has about the gun, including the manufacturer's identity and the criminal offense associated with the gun, into the trace database."' As a result, the subset of guns that ATF can trace all the way to a retail purchaser may skew toward guns of more recent manufacture, while the larger set of data on all guns for which ATF receives a trace request does not. It is the latter data that is relevant to apportionment of liability among manufacturers.

The critics of ATF trace data essentially demand perfection. They are surely correct that the data is not a perfectly random and representative sample of all guns used in crime. As one put it, "it would simply be a lucky coincidence" if the subset of traced guns looked exactly "the same as the 23' 2 entire population of crime guns." But that degree of perfection is not required in tort law, or in social sciences in which similar data is used.233 For example, criminologists analyze arrest data as a way of discerning information about criminals, even though the subset of criminals arrested is not perfectly representative of the overall universe of criminals.3 The arguments of those critical of trace data analysis do not undermine the fact that trace data could be used to achieve a reasonable-albeit imperfect-allocation of liability among manufacturers of guns used in crimes.

3. Judicial Resistance to Proportional Share Liability

The idea of imposing proportional share liability on gun manufacturers using trace data rather than market share information has been suggested by plaintiffs in a few recent cases, but so far without success. Rather than offering strong reasons to reject it, courts have either failed to comprehend the idea or have simply declared that it is an unrecognizable and unprece- dented theory. The opinions reflect how deeply judges are accustomed to thinking of market share liability as the only possible form of proportional share liability.

The issue has been raised in the cases brought against the gun industry in recent years by cities and counties seeking to recoup costs incurred because of gun violence allegedly attributable to the manufacturers' negligent distribution of guns and defective product designs. " In one of these cases, brought by the city of Boston, a Massachusetts trial court issued a detailed decision rejecting the application of market share liability to gun manufactur- ers."' Largely repeating the same conclusions reached by the New York appellate court in Hamilton, the Massachusetts judge found that "it is essential for the plaintiff to prove that the product at issue is fungible or generic" and 2'37 that guns are not "a single, fungible product presenting a singular risk." The city of Boston tried to argue that guns are fungible or interchangeable products from the standpoint of criminals, as Judge Weinstein had suggested 23 in Hamilton. In response, the court pointed out that the varied risks posed by different types of guns are reflected in Massachusetts laws banning certain weapons, as well as in Boston's own complaint, which alleged that handguns posed a particular threat to safety within the city.239 If different guns pose different amounts of risk, using market shares to allocate damages will not result in a reasonable correspondence between each manufacturer's respon- sibility for the harm and its liability.24 The Boston court also suggested that the identification of gun manufacturers is not as difficult as the identifica- tion of DES manufacturers, despite the presence of evidence indicating that Boston police can identify a manufacturer for less than 5 percent of firearm- related incidents to which the city's police respond.4

While arguing that market share liability could apply to gun manufac- turers, the city of Boston also advanced the idea of using trace data as an alternative means of apportioning liability. The city's brief emphasized to the court how this form of liability allocation would overcome the problem of gun manufacturers' conduct posing risks that are not uniform in degree, because "manufacturers' shares of liability would take into account the types of guns made by each manufacturer and the degree to which they were mar- keted and distributed in ways promoting criminal use. 242

The court devoted only two short paragraphs in its twenty-five page opinion to rejecting the idea of allocating liability based on trace data. Failing even to acknowledge that the city of Boston proposed a form of relief other than market share liability, the court insisted on characterizing Boston as proposing that data about recovered and traced guns should be used "to define market share for purposes of market share liability." ' The court noted that it could find no precedent "in which the definition of mar- ket share has been anything other than market share."2" While precedent for proportional share liability in any form other than market share liability is indeed scarce, that alone is not a reason to reject the argument. If the law were that rigid, Boston would have brought suit under a writ for "tres- pass on the case" rather than under a claim of negligence. Indeed, there was no precedent for market share liability until just a few decades ago.

The court concluded its terse rejection of the city's argument by add- ing that the proposed method of allocation would result in "a truly perverse application of the .market-share liability theory," as it would entail the manufacturer of a recovered and identified firearm being held liable under a theory based on the premise that the product cannot be identified.245 Again, the court erred in insisting that the city's theory was a form of market share liability. Moreover, contrary to what the court suggested, the city did not illogically propose that manufacturers be held liable for selling identified firearms based on a theory developed for unidentifiable products. The theory of proportional share liability proposed by the city would be used only to impose liability for unidentifiable guns.2" If anything is anomalous about using trace data to apportion liability for unidentifiable guns, it is merely that the existence of the data confirms that the manufacturer of a gun used in a crime often can be identified. That simply means, however, that some potential plaintiffs in gun cases can identify a manufacturer, while many others cannot. The same is true for DES and every other product to which market share liability can be applied.

A case brought by the District of Columbia and several individual victims of shootings provides an even more striking example of judicial reluctance to accept that market share liability is not the only possible form of proportional share liability.24 The District's complaint included a count broadly phrased to allege "collective liability" and did not even mention the concept of 248 market share liability. In opposing dismissal of its claims, the District emphasized that this count encompassed any form of collective liability, from nonproportional theories like "alternative liability" to proportional alloca- tions based on data about recovered guns.

Disregarding other collective liability theories or the distinctions among them, the trial judge insisted that all references in the District's complaint and briefs to different forms of collective liability were merely different ways of referring to just one thing: market share liability.249 Hav- ing denied the existence of any means of imposing collective liability, the judge proceeded as though market share liability was the sole issue and ruled that it cannot be imposed on gun manufacturers. Largely parroting the reasoning of the New York appellate court in Hamilton, the judge concluded that it is "virtually impossible" to impose market share liability on manu- 2 facturers of "non-fungible or non-generic products."" ' That is doubtless why the District proposed another theory, only to have it ignored by the court with its single-minded focus on market share liability.

Guns are not a fungible product, because some guns are much more likely to be used by criminals than others. The virtue of using trace data to allocate liability for unidentified guns is that trace data accounts for the relative risk of criminal use of different types of guns. The trace data reflects the varying extent to which each type of gun is likely to be used in crime. The fact that a product is not fungible should not stand as an obstacle to imposing proportional share liability if the measure used to allocate liability takes into account the relative risk of the product in a way that market share data does not.2"'

D. Outer Space Debris: Proportional Share Liability Masquerading as Market Share Liability

The issue of potential liability for violence involving unidentifiable guns has a remarkable analogue in the problem of harm caused by unidentifiable debris in outer space. The orbital paths used most frequently by satellites and other spacecraft contain various types of human trash, from paint chips to rocket fragments, discarded hand tools, and abandoned nuclear reactors. Operational spacecraft can be damaged or destroyed if they collide with such debris. While major collisions have been rare to date, the number of them is likely to increase as the amounts of debris and spacecraft traffic in these orbits grow.53

Space surveillance systems operated by the United States and Russia identify and track thousands of the largest pieces of debris, making it possible in some instances to identify the source of the debris involved in a collision. An international treaty provides that a nation can be held liable for damage caused by debris if a claimant can identify that nation as the source of the 25 debris and can prove fault.

The majority of orbital debris is too small to be tracked by the American or Russian surveillance systems. As a result, that debris cannot be identified and attributed to the particular source that produced it, and the international 256 treaty provides no means of recovering damages for harm that it causes. Over the years, a number of those analyzing this problem have proposed that liability should be allocated among space-faring nations in situations where a spacecraft collides with unidentifiable orbital debris, with each nation paying for a portion of the harm equal to the percentage of the total debris population for which that nation is responsible.257 In the most recent and complete elaboration of this idea, Mark Sundahl proposed that liability for damage done by unidentifiable debris should be allocated based on each nation's share of the pool of larger debris items that have been identified and tracked. For example, the United States produced 52.9 percent of the total population of identified debris fragments, as of the end of 1997, and would therefore be liable for 52.9 percent of the harm resulting from unidentifiable debris under Sundahl's proposed scheme."'

While Sundahl and others making similar proposals have consistently used the term "market share liability" to describe the liability regime they advo- cate, they are in truth proposing a form of proportional share liability based on something other than market share. Setting aside the semantic difficulties of treating debris as a product with a "market," the simple fact is that no one has information equivalent to market share data for unidentifiable orbital debris. In other words, no one actually knows what portion of the unidentifiable debris each nation produced. The closest data available is the information about each nation's share of the pool of larger debris fragments that have been identified and tracked. Sundahl therefore proposed using the data on larger, identified debris as a proxy for the information that is not available about the population of smaller, unidentifiable debris fragments, much as data about crime guns that police recover and trace could be used to apportion liability for crime guns that are not recovered and cannot be identified. Just as it is reasonable to think that a gun maker producing a large percentage of traced crime guns is responsible for a similarly large percentage of unidentifiable crime guns, Sundahl and others find it reasonable to believe that a nation producing "a large portion of the known body of large debris" is also "responsible for creating an equal portion of the unidentified debris fragments." That belief gathers support from the fact that small debris isoften created by collisions of larger debris, which suggests a strong correlation between the amount of each nation's responsibility for the larger debris and the smaller debris." On the other hand, to the extent that smaller debris results from phenomena that do not produce larger debris, such as explosions,26' it is possible that each nation's proportion of the larger debris does not fairly reflect the proportion of the smaller debris for which it should bear liability.

Sundahl and others making similar proposals also overlook several characteristics of orbital debris, such as velocity and orbital level, that make it a nonfungible commodity posing varying degrees of risk. For example, debris that is moving extremely fast through a highly trafficked orbital level is far more dangerous than debris moving slowly through an orbit seldom used by satellites or other spacecraft.262 The data about large, identified debris that Sundahl and others propose to use to allocate liability for small, uniden- tified debris does not take into account these characteristics. For example, two nations with the same number of debris fragments tracked by the space surveillance systems, but with different distributions of the debris across orbital levels, may pose substantially different levels of risk to space traffic, and yet be held liable for the same share of harm when a spacecraft collides with unidentified debris.

#### Proportional liability opens the door to climate suits by relaxing the definition of causation in tort suits even more than market share liability

Eduardo M. Penalver 98, JD Candidate, Yale Law School, “Acts of God or Toxic Torts? Applying Tort Principles to the Problem of Climate Change,” Fall 1998, https://scholarship.law.cornell.edu/facpub/730/

Adoption of a probabilistic understanding of causation in tort law would open the way for claims based on accidents "caused" (in the probabilistic sense) by global climate change. Under the deterministic notion of causation, victims could only recover if the accidents that injured them were of the type whose incidence is expected to double due to climate change.124 Only if the incidence of say, tornadoes, doubled as a result of climate change would it be possible to claim that it was more probable than not that a particular tornado was "caused" (in the deterministic sense) by climate change.

If courts were to adopt a probabilistic conception of causation, however, victims of any type of accident whose likelihood increased as a result of climate change would be able to recover something. Causation could be established by evidence indicating that climate change merely increased the risk of the type of harm suffered by the plaintiffs. Plaintiffs would not, however, be required to show that, more probably than not, their injury was somehow mechanistically caused by climate change. Thus, plaintiffs would have a claim even if, as will likely often be the case, the risk of the type of accident from which they suffered did not actually double.125

2. The Goals of Tort Law and Deterministic Causation

Calabresi has rightly pointed out that the question of causation in tort law is not simply a philosophical issue, and so must not only be scrutinized for philosophical validity, but also explored in terms of the goals of tort law.126 More important than metaphysical accuracy, Calabresi argues, is whether the notion of "cause" in tort law allows human beings effectively to control the frequency of accidents in the ways suggested by the goals of tort theory.127 Thus, in addition to criticizing the but for requirement in toxic torts from the position of philosophical validity, it is necessary to consider the extent to which it serves the two goals of tort law discussed above in Part III.

a. Reducing the Costs of Accidents

Given the fact that most toxic torts rely upon statistically based evidence to prove causation, it is easily demonstrated that the but for, deterministic notion of causation frustrates the goal of reducing the costs of accidents by internalizing the costs to the actors in the best position to carry out the cost-benefit analysis between accidents and accident prevention.128 An example will demonstrate why this is the case. Imagine a situation in which three factors (for example, smoking, asbestos, and air pollution) all contributed to a single effect (for example, lung cancer), that also occurred naturally (that is, among people who were not exposed to any of the three suspect factors). Pretend that each cause raised the chances of acquiring lung cancer by 40 percent. The plaintiff in this hypothetical is a long-time smoker who has also been repeatedly exposed to asbestos and air pollution.

If courts adhered rigidly to the rule that a plaintiff must demon strate, more likely than not, that one of the indicated factors caused his case of cancer (rather than any of the others, or rather than being one of the background cases that would have occurred anyway), then the plaintiff will not be able to recover at all (indeed, he would not be able to recover even if each factor more than doubled the risk of lung cancer vis-à-vis the background risk). As a result of this failure to recover (barring some regulatory action by the state, and assuming that, as in the real world, victims do not have perfect knowledge and cannot easily organize to pay producers to make products safer), cancers caused by these three factors will likely stand as externalities. Because people will over-consume the products in question (asbestos, cigarettes, and products causing air pollution), these externalities will produce significant misallocation costs.129

The same problem occurs if one of the causal factors (say, cigarettes) predominates over the others such that a plaintiff who is exposed to all three has a 60 percent chance of having acquired his cancer from cigarettes, as opposed to asbestos, air pollution, or background causes. In this situation (ignoring issues of contributory negligence), everyone exposed to cigarettes who develops lung cancer will be able to recover from tobacco companies, and no one will be able to recover from asbestos companies or producers of air pollution. Cigarette producers would have to pay for all the cases of lung cancer among the exposed group, even though cigarettes are really only responsible for 60 percent of the cases of lung cancer in that group. For the same reason as above, from the point of view of economics, the result will be an inefficient burdening of cigarette manufacturers and overconsumption of the other products, with the corresponding misallocation costs.

Thus, the all-or-nothing approach to causation mandated by mechanistic notions of but for cause fails to serve the goal of accident cost reduction in the case of toxic torts, where only statistical evidence over large populations is available. The solution is therefore to allow for recovery even when a causal factor causes a particular effect less than 50 percent of the time.130 The problem with this solution is that it seems to violate notions of fairness that stand behind the second goal of tort law.

b. Corrective Justice

Notions of justice in tort law are often considered to operate at the level of individuals.131 Thus, awarding damages to a plaintiff who failed to prove, more likely than not, that a given defendant caused his particular injury seems to some to violate the principles of corrective justice that underlie tort law.132 But such a conclusion ignores the nature of toxic torts.

Because of the complex and drawn out nature of the causal problem in toxic torts, the question of whether or not a particular causal factor caused (in the mechanistic sense) a particular case of disease is one to which no possible answer can be given. We simply cannot know whether smoking caused this particular case of lung cancer.133 From the perspective of the plaintiff, then, requiring him to answer a question that is unanswerable in order to recover seems particularly unjust. Further, as Rosenberg observes, the effect of forcing the plaintiff to answer this question is to shield clear wrongdoers from liability and to place the full cost of the victim's injuries on the victim himself.134 From the perspective of the plaintiff, at least, it is not the rejection of the notion of but for causation, but its requirement, that is a source of injustice.

From the perspective of the defendant, two arguments for the injustice of foregoing the notion of but for causation present themselves. First, a defendant would likely argue that it is unfair to hold him responsible for an injury to an individual plaintiff that he might not have caused. As discussed above, however, this argument ignores the nature of toxic torts, which makes proof of such individual causation an impossibility. Thus, for the plaintiff to recover from the defendant without having proved something that cannot be proven can hardly be said to be unfair to the defendant, who is undoubtedly responsible for some injuries. If the heart of the justice goal in tort law is reflected in the notion that victims should be compensated and injurers should pay, then it does not seem to matter that the two are not necessarily joined to each other in the same proceeding.135

A second argument by the defendant would be more sound, however. The defendant could argue that it would be wrong for him to be held liable in cases where the plaintiff could not prove specific causation, because then the defendant could be held liable to all exposed plaintiffs who suffer from the same injury, even though the scientific evidence only indicates that he is responsible for x percent of the cases of that injury. Th objection, although certainly sound, goes to the issue of the extent of defendant's liability, rather than to the fact of liability itself, the issue of concern here. Suffice it for now to say that theories of proportional liability (that is, where the defendant is held liable for only a portion of plaintiff's damages in proportion to his causal contribution to injuries the plaintiff's type) would resolve this objection.

B. Determining Who Should Pay and How Much

1. Two Splitting Rules

The foregoing discussion of the extent of the defendant's liability leads naturally into a discussion of the second major problem with a tort analysis of global climate change: determining the specific identity of the responsible parties and how much they should pay. As was discussed above in Part ID, the cost-reducing goal of tort law indicates that courts should seek to hold liable those parties who are in the best position to make the price of products that lead to global climate change reflect their true costs (that is, to include the costs of accidents produced by global climate change within the prices of products whose manufacture and use contributes to the problem of climate change). The second, justice-based, goal of tort law indicates that the parties held liable should be those who have negligently failed to address the threat of climate change and who have taken actions to prevent other people from dealing appropriately with this threat.

Given these goals, it is justifiable to hold liable the companies located at the earliest stages in the process of producing and marketing the fossil fuels resulting in greenhouse gas emissions. By holding fossil fuel companies liable, the prices of all products dependent upon greenhouse gas producing processes will be affected as well.

Because of the concentration in the energy markets, this allocation of liability will not entail an unwieldy number of players. Just 15 companies, for example, account for 91 percent of the American market for gasoline, the largest market in the world.137 In the coal industry, just 11 companies account for over two thirds of American output, which is second only to China.138 This concentration in the coal industry is expected to increase in the future.139 But once it is determined that oil, natural gas, and coal companies (and possibly companies responsible for deforestation) can and should be held liable for the costs produced by global climate change, it becomes necessary to develop a theory by which the liability of each individual actor can be allocated.

Two liability-splitting rules seem particularly appropriate in making this determination. The first is the theory of market-share liability, a theory that developed in the context of mass torts and was first applied in the di-ethylstilbestrol (DES) litigation.140 Applied to the context of global climate change, defendants would be held liable for damages in the same proportion as their share of the global market for fossil fuels. This could be accomplished by giving each fossil fuel a CO2 equivalent value. The carbon equivalents of all fossil fuels produced worldwide would be totaled, and defendants would be held liable for damages caused by global climate change in the same proportion as their share of the global CO2 market. If one defendant were responsible for producing and selling 5 percent of the world's CO2 equivalent in fossil fuels, it would be responsible for 5 percent of the costs of global climate change.1

A second liability-splitting rule would also be required. As discussed above in subsection IV.A.2.b, it would be unfair to hold a defendant responsible for all instances of an injury that its product caused only some of the time, although there is no way to determine which particular injuries it caused. Thus, relaxing the causation requirement in toxic torts would only be consistent with principles of corrective justice if it were coupled with a simultaneous adoption of a rule of proportional liability.142 Under a system of proportional liability, the defendant's total liability, determined according to a market share theory, would be discounted by its percentage of causal contribution to the total occurrence of the injury in question. Thus, if it were determined with a high degree of certainty that anthropogenic climate change was responsible for a 100 percent increase in hurricane damage on the west coast of the United States, an individual defendant's liability for damage caused by hurricanes on the west coast would be discounted 50 percent to account for the fact that half the hurricanes on the west coast would have occurred even without climate change, although it is impossible to know which half.

#### Climate suits crush global coordination necessary to solve climate change

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But that being said, if the Second Circuit was implying that such claims are justiciable in part because they are relatively costless, it was wrong again. In the wake of the recent Copenhagen climate negotiations, America is at a crossroads regarding its energy policy. At Copenhagen, the world—for the first time including both the United States and China—took a tremulous first step towards a comprehensive and truly global solution to climate change.44 By securing a modicum of international consensus—albeit not yet with binding commitments—President Obama laid the foundation for what could eventually be a groundbreaking congressional overhaul of American energy policy, an effort that will undoubtedly be shaped by considerations as obviously political as our energy independence from hostile and unreliable foreign regimes and that will both influence and be influenced by the delicate state of international climate negotiations.45

Against this backdrop, courts would be wise to heed the conclusion of one report that what “makes climate change such a difficult policy problem is that decisions made today can have significant, uncertain, and difficult to reverse consequences extending many years into the future."46 This observation is even more salient given that America—and the world—stand at the precipice of major systemic climate reform, if not in the coming year then in the coming decade. It would be disastrous for climate policy if, as at least one commentator has predicted,47 courts were to “beat Congress to the punch” and begin to concoct common law “solutions” to climate change problems before the emergence of a legislative resolution. Not only does judicial action in this field require costly and irreversible technological change on the part of defendants, but the prior existence of an ad hoc mishmash of common law regimes will frustrate legislators’ attempts to design coherent and systematic marketbased solutions.48 Indeed, both emissions trading regimes and carbon taxes seek to harness the fungibility of GHG emissions by creating incentives for reductions to take place where they are most efficient. But if courts were to require reductions of randomly chosen defendants—with no regard for whether they are efficient reducers— they would inhibit the effective operation of legislatively-created, market-based regimes by prematurely and artificially constricting the size of the market. And as one analyst succinctly put it before Congress, “[a]n insufficient number of participants will doom an emissions trading market.”49

There is no doubt that the “Copenhagen Accord only begins the battle” against climate change, as diplomats, bureaucrats, and legislators all now begin the lengthy struggle to turn that Accord’s audacious vision into concrete reality.50 But whatever one’s position in the debate between emissions trading and carbon taxes, or even in the debate over the extent or indeed the reality of anthropogenic climate change, one thing is clear: legislators, armed with the best economic and scientific analysis, and with the capability of binding, or at least strongly incentivizing, all involved parties, are the only ones constitutionally entitled to fight that battle.

CONCLUSION

Some prognosticators opine that the political question doctrine has fallen into disrepute and that it no longer constitutes a viable basis upon which to combat unconstitutional judicial overreaching.51 No doubt the standing doctrine could theoretically suffice to prevent some of the most audacious judicial sallies into the political thicket, as it might in the climate change case, where plaintiffs assert only undifferentiated and generalized causal chains from their chosen defendants to their alleged injuries. But when courts lose sight of the important limitations that the political question doctrine independently imposes upon judicial power–even where standing problems are at low ebb, as with the Motor Fuel case–then constitutional governance, and in turn the protection of individual rights and preservation of legal boundaries, suffer. The specter of two leading circuit courts manifestly losing their way in the equally real thicket of political question doctrine underscores the urgency, perhaps through the intervention of the Supreme Court, of restoring the checks and balances of our constitutional system by reinforcing rather than eroding the doctrine’s bulwark against judicial meddling in disputes either expressly entrusted by the Constitution to the political branches or so plainly immune to coherent judicial management as to be implicitly entrusted to political processes. It is not only the climate of the globe that carries profound implications for our future; it is also the climate of the times and its implications for how we govern ourselves.

#### Warming causes extinction.

Sears 21 (, N., 2021. Great Powers, Polarity, and Existential Threats to Humanity: An Analysis of the Distribution of the Forces of Total Destruction in International Security. [online] ResearchGate. Available at: <https://www.researchgate.net/publication/350500094> [Accessed 22 November 2021] Nathan Alexander Sears is a PhD Candidate in Political Science at The University of Toronto. Before beginning his PhD, he was a Professor of International Relations at the Universidad de Las Américas, Quito. His research focuses on international security and the existential threats to humanity posed by nuclear weapons, climate change, biotechnology, and artificial intelligence. His PhD dissertation is entitled, “International Politics in the Age of Existential Threats”)-re-cut rahulpenu

Climate Change Humanity faces existential risks from the large-scale destruction of Earth’s natural environment making the planet less hospitable for humankind (Wallace-Wells 2019). The decline of some of Earth’s natural systems may already exceed the “planetary boundaries” that represent a “safe operating space for humanity” (Rockstrom et al. 2009). Humanity has become one of the driving forces behind Earth’s climate system (Crutzen 2002). The major anthropogenic drivers of climate change are the burning of fossil fuels (e.g., coal, oil, and gas), combined with the degradation of Earth’s natural systems for absorbing carbon dioxide, such as deforestation for agriculture (e.g., livestock and monocultures) and resource extraction (e.g., mining and oil), and the warming of the oceans (Kump et al. 2003). While humanity has influenced Earth’s climate since at least the Industrial Revolution, the dramatic increase in greenhouse gas emissions since the mid-twentieth century—the “Great Acceleration” (Steffen et al. 2007; 2015; McNeill & Engelke 2016)— is responsible for contemporary climate change, which has reached approximately 1°C above preindustrial levels (IPCC 2018). Climate change could become an existential threat to humanity if the planet**’s** climate reaches a “Hothouse Earth” state (Ripple et al. 2020). What are the dangers? There are two mechanisms of climate change that threaten humankind. The direct threat is extreme heat. While human societies possesses some capacity for adaptation and resilience to climate change, the physiological response of humans to heat stress imposes physical limits—with a hard limit at roughly 35°C wet-bulb temperature (Sherwood et al. 2010). A rise in global average temperatures by 3–4°C would increase the risk of heat stress, while 7°C could render some regions uninhabitable, and 11–12°C would leave much of the planet too hot for human habitation (Sherwood et al. 2010). The indirect effects of climate change could include, inter alia, rising sea levels

affecting coastal regions (e.g., Miami and Shanghai), or even swallowing entire countries (e.g., Bangladesh and the Maldives); extreme and unpredictable weather and natural disasters (e.g., hurricanes and forest fires); environmental pressures on water and food scarcity (e.g., droughts from less-dispersed rainfall, and lower wheat-yields at higher temperatures); the possible inception of new bacteria and viruses; and, of course, large-scale human migration (World Bank 2012; Wallace-Well 2019; Richards, Lupton & Allywood 2001). While it is difficult to determine the existential implications of extreme environmental conditions, there are historic precedents for the collapse of human societies under environmental pressures (Diamond 2005). Earth’s “big five” mass extinction events have been linked to dramatic shifts in Earth’s climate (Ward 2008; Payne & Clapham 2012; Kolbert 2014; Brannen 2017), and a Hothouse Earth climate would represent terra incognita for humanity. Thus, the assumption here is that a Hothouse Earth climate could pose an existential threat to the habitability of the planet for humanity (Steffen et al. 2018., 5). At what point could climate change cross the threshold of an existential threat to humankind? The complexity of Earth’s natural systems makes it extremely difficult to give a precise figure (Rockstrom et al. 2009; ). However, much of the concern about climate change is over the danger of crossing “tipping points,” whereby positive feedback loops in Earth’s climate system could lead to potentially irreversible and self-reinforcing “runaway” climate change. For example, the melting of Arctic “permafrost” could produce additional warming, as glacial retreat reduces the refractory effect of the ice and releases huge quantities of methane currently trapped beneath it. A recent study suggests that a “planetary threshold” could exist at global average temperature of 2°C above preindustrial levels (Steffen et al. 2018; also IPCC 2018). Therefore, the analysis here takes the 2°C rise in global average temperatures as representing the lower-boundary of an existential threat to humanity, with higher temperatures increasing the risk of runaway climate change leading to a Hothouse Earth. The Paris Agreement on Climate Change set the goal of limiting the increase in global average temperatures to “well below” 2°C and to pursue efforts to limit the increase to 1.5°C. If the Paris Agreement goals are met, then nations would likely keep climate change below the threshold of an existential threat to humanity. According to Climate Action Tracker (2020), however, current policies of states are expected to produce global average temperatures of 2.9°C above preindustrial levels by 2100 (range between +2.1 and +3.9°C), while if states succeed in meeting their pledges and targets, global average temperatures are still projected to increase by 2.6°C (range between +2.1 and +3.3°C). Thus, while the Paris Agreements sets a goal 6 that would reduce the existential risk of climate change, the actual policies of states could easily cross the threshold that would constitute an existential threat to humanity (CAT 2020).

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#### Text – Private Appropriation of Outer Space except for Space Elevators is Unjust.

#### Space Elevators constitute Appropriation – they impede orbits.

Matignon 19 Louis de Gouyon Matignon 3-3-2019 "LEGAL ASPECTS OF THE SPACE ELEVATOR TRANSPORTATION SYSTEM" <https://www.spacelegalissues.com/space-law-legal-aspects-of-the-space-elevator-transportation-system/> [PhD in space law (co-supervised by both Philippe Delebecque, from Université Paris 1 Panthéon-Sorbonne, France, and Christopher D. Johnson, from Georgetown University || regularly write articles on the website Space Legal Issues so as to popularise space law and public international law]//Elmer

An Earth-based space elevator would consist of a cable with one end attached to the surface near the equator and the other end in space beyond geostationary orbit. An orbit is the curved path through which objects in space move around a planet or a star. The 1967 Treaty’s regime and customary law enshrine the principle of non-appropriation and freedom of access to orbital positions. Space Law and International Telecommunication Laws combined to protect this use against any interference. The majority of space-launched objects are satellites that are launched in Earth’s orbit (a very small part of space objects – scientific objects for space exploration – are launched into outer space beyond terrestrial orbits). It is important to precise that an orbit does not exist: satellites describe orbits by obeying the general laws of universal attraction. Depending on the launching techniques and parameters, the orbital trajectory of a satellite may vary. Sun-synchronous satellites fly over a given location constantly at the same time in local civil time: they are used for remote sensing, meteorology or the study of the atmosphere. Geostationary satellites are placed in a very high orbit; they give an impression of immobility because they remain permanently at the same vertical point of a terrestrial point (they are mainly used for telecommunications and television broadcasting). A geocentric orbit or Earth orbit involves any object orbiting Planet Earth, such as the Moon or artificial satellites. Geocentric (having the Earth as its centre) orbits are organised as follow: 1) Low Earth orbit (LEO): geocentric orbits with altitudes (the height of an object above the average surface of the Earth’s oceans) from 100 to 2 000 kilometres. Satellites in LEO have a small momentary field of view, only able to observe and communicate with a fraction of the Earth at a time, meaning a network or constellation of satellites is required in order to provide continuous coverage. Satellites in lower regions of LEO also suffer from fast orbital decay (in orbital mechanics, decay is a gradual decrease of the distance between two orbiting bodies at their closest approach, the periapsis, over many orbital periods), requiring either periodic reboosting to maintain a stable orbit, or launching replacement satellites when old ones re-enter. 2) Medium Earth orbit (MEO), also known as an intermediate circular orbit: geocentric orbits ranging in altitude from 2 000 kilometres to just below geosynchronous orbit at 35 786 kilometres. The most common use for satellites in this region is for navigation, communication, and geodetic/space environment science. The most common altitude is approximately 20 000 kilometres which yields an orbital period of twelve hours. 3) Geosynchronous orbit (GSO) and geostationary orbit (GEO) are orbits around Earth at an altitude of 35 786 kilometres matching Earth’s sidereal rotation period. All geosynchronous and geostationary orbits have a semi-major axis of 42 164 kilometres. A geostationary orbit stays exactly above the equator, whereas a geosynchronous orbit may swing north and south to cover more of the Earth’s surface. Communications satellites and weather satellites are often placed in geostationary orbits, so that the satellite antennae (located on Earth) that communicate with them do not have to rotate to track them, but can be pointed permanently at the position in the sky where the satellites are located. 4) High Earth orbit: geocentric orbits above the altitude of 35 786 kilometres. The competing forces of gravity, which is stronger at the lower end, and the outward/upward centrifugal force, which is stronger at the upper end, would result in the cable being held up, under tension, and stationary over a single position on Earth. With the tether deployed, climbers could repeatedly climb the tether to space by mechanical means, releasing their cargo to orbit. Climbers could also descend the tether to return cargo to the surface from orbit.

#### Private Companies are pursuing Space Elevators.

Alfano 15 Andrea Alfano 8-18-2015 “All Of These Companies Are Working On A Space Elevator” <https://www.techtimes.com/articles/77612/20150818/companies-working-space-elevator.htm> (Writer at the Tech Times)//Elmer

Space elevators are solid proof that any mundane object sounds way cooler if you stick the word "space" in front of it. But there's much more than coolness at stake when building a space elevator – this technology has the potential to revolutionize space transportation, and the Canadian private space company Thoth Technology that was recently awarded a patent for its space elevator design isn't the only company in the game. One of the other major players is a U.S.-based company called LiftPort Group, founded by space entrepreneur Michael Laine in 2003. Its plan for a space elevator is vastly different from the one for which Thoth received a patent, however. Whereas Thoth's plans entail tethering a 12-mile-high inflatable space elevator to the Earth, LiftPort is shooting for the moon. Originally, LiftPort had planned to build an Earth elevator, too, but it abandoned the idea in 2007 in favor of building a lunar elevator. The basic design for a lunar elevator is an anchor in the moon that is attached to a cable that extends to a space station situated at a very special point. Known as a Lagrange Point, this is the gravitational tipping point between the Earth and the moon, where their gravitational pulls essentially cancel one another out. A robot could then travel up and down the tether, ferrying cargo between the moon and the station. Out farther in space, a counterweight would balance out the system. Both types of space elevator are intended to increase space access, but in very different ways. Thoth's Earth elevator aims to make launches easier by starting off 12 miles above the Earth's surface. LiftPort's space elevator aims to increase access to the moon in particular, because it is much easier to launch a rocket to the Lagrange Point and dock it at a space station than it is to get to the moon directly. There's a third major company based in Japan called Obayashi Corp. whose plans look like a hybrid of Thoth's and LiftPort's. Obayashi is not a space company, however – it's actually a construction company. Like Thoth, Obayashi plans to build an Earth elevator. But its Earth elevator would consist of a cable tethered to the blue planet, a robotic cargo-carrier, a space station, and a counterweight. It essentially looks like LiftPort's plans, but stuck to the Earth instead of to the moon.

#### Yes Space Elevators – NASA confirms.

Snowden 18 Scott Snowden 10-2-2018 "A colossal elevator to space could be going up sooner than you ever imagined" <https://www.nbcnews.com/mach/science/colossal-elevator-space-could-be-going-sooner-you-ever-imagined-ncna915421> (Scott has written about science and technology for 20 years for publications around the world. He covers environmental technology for Forbes.)//Elmer

For more than half a century, rockets have been the only way to go to space. But in the not-too-distant future, we may have another option for sending up people and payloads: a colossal elevator extending from Earth’s surface up to an altitude of 22,000 miles, where geosynchronous satellites orbit. NASA says the basic concept of a space elevator is sound, and researchers around the world are optimistic that one can be built. The Obayashi Corp., a global construction firm based in Tokyo, has said it will build one by 2050, and China wants to build one as soon as 2045. Now an experiment to be conducted soon aboard the International Space Station will help determine the real-world feasibility of a space elevator. “The space elevator is the Holy Grail of space exploration,” says Michio Kaku, a professor of physics at City College of New York and a noted futurist. “Imagine pushing the ‘up’ button of an elevator and taking a ride into the heavens. It could open up space to the average person.”

#### Regardless of completion, Elevators spur investment in Nanotechnology

Liam O’Brien 16. University of Wollongong. 07/2016. “Nanotechnology in Space.” Young Scientists Journal; Canterbury, no. 19, p. 22.

Nanotechnology is at the forefront of scientific development, continuing to astound and innovate. Likewise, the space industry is rapidly increasing in sophistication and competition, with companies such as SpaceX, Blue Origin and Virgin Galactic becoming increasingly prevalent in what could become a new commercial space race. The various space programs over the past 60 years have led to a multitude of beneficial impacts for everyday society. Nanotechnology, through research and development in space has the potential to do the same. Potential applications of nanotechnology in space are numerous, many of them have the potential to capture and inspire generations to come. One of these applications is the space elevator. By using carbon nanotubes, a super light yet strong material, this concept would be an actual physical structure from the surface of the Earth to an altitude of approximately 36 000 km. The tallest building in the world would fit into this elevator over 42 000 times. The counterweight, used to keep the elevator taught, is proposed to be an asteroid. This would need to be at a distance of 100 000 km, a quarter of the distance to the moon. The benefits of such a structure would be enormous. 95% of a space shuttle's weight at take-off is fuel, costing US$ 20 000 per kilogram to send something into space. However, with a space elevator the cost per kilogram can be reduced to as little as US$ 200. Exploration to other planets can begin at the tower, and travel to and from the moon could become as simple as a morning commute to work. Solar sails provide the means to travel large distances and incredible speeds. Much like sails on a boat use wind, the solar sail uses light as a source of propulsion. Ideally these sails would be kilometres in length and only a few micrometres in thickness. This provides us with the ability to travel at speeds previously unheard of. Using carbon nanotubes once again, a solar sail has the capability to travel at 39 756 km/s which is 13% of the speed of light! This sail could reach Pluto in an astonishing 1.7 days, and Alpha Centauri in just 32 years. Space travel to other planets, other stars, could be possible with solar sails. The Planetary Society is funding for a space sail of itself, and has successfully launched one into orbit. NASA has also sent a sail into orbit, allowing it to burn up in the atmosphere after 240 days. Investing time and resources into nanotechnology for space exploration has benefits for society today. Materials such as graphene are being used in modern manufacturing at an increasing rate as the applications become utilised. Carbon nanotubes will change the way we think about materials and their strength. These nanotubes have a tensile strength one hundred times that of steel, yet are only a sixth of the weight. Imagine light weight vehicles using less petrol and energy as well as being just as strong as regular vehicles. With potentials to revolutionize the way we think about space travel, nanotechnology has a bright future. As a new field of science, it has the capability to push the human race to the outer reaches of our galaxy and hopefully one day to other stars. It will inspire generations of explorers and dreamers to challenge themselves and advance the human race into the next era. As Richard Feynman said in his 1959 talk 'There's Plenty of Room at the Bottom' "A field in which little has been done, but in which an enormous amount can be done. There is still plenty more to achieve.

#### Nano tech solves warming

Bhavya Khullar. September 4, 2017. Nanomaterials Could Combat Climate Change and Reduce Pollution. https://www.scientificamerican.com/article/nanomaterials-could-combat-climate-change-and-reduce-pollution/

The list of environmental problems that the world faces may be huge, but some strategies for solving them are remarkably small. First explored for applications in microscopy and computing, nanomaterials—materials made up of units that are each thousands of times smaller than the thickness of a human hair—are emerging as useful for tackling threats to our planet’s well-being. Scientists across the globe are developing nanomaterials that can efficiently use carbon dioxide from the air, capture toxic pollutants from water and degrade solid waste into useful products. “Nanomaterials could help us mitigate pollution. They are efficient catalysts and mostly recyclable. Now, they have to become economical for commercialization and better to replace present-day technologies completely,” says [Arun Chattopadhyay](http://www.iitg.ac.in/arun/), a member of the chemistry faculty at the Center for Nanotechnology, Indian Institute of Technology Guwahati. To help slow the climate-changing rise in atmospheric CO2levels, researchers have developed nanoCO2 harvesters that can suck atmospheric carbon dioxide and deploy it for industrial purposes. “Nanomaterials can convert carbon dioxide into useful products like alcohol. The materials could be simple chemical catalysts or photochemical in nature that work in the presence of sunlight,” says Chattopadhyay, who has been working with nanomaterials to tackle environmental pollutants for more than a decade. Many research groups are working to address a problem that, if solved, could be a holy grail in combating climate change: how to pull CO2 out of the atmosphere and convert it into useful products. Chattopadhyay isn’t alone. Many research groups are working to address a problem that, if solved, could be a holy grail in combating climate change: how to pull CO2 out of the atmosphere and convert it into useful products. Nanoparticles offer a promising approach to this because they have a large surface-area-to-volume ratio for interacting with CO2 and properties that allow them to facilitate the conversion of CO2into other things. The challenge is to make them economically viable. Researchers have tried everything from metallic to carbon-based nanoparticles to reduce the cost, but so far they haven’t become efficient enough for industrial-scale application. One of the most recent points of progress in this area is work by scientists at the CSIR-Indian Institute of Petroleum and the Lille University of Science and Technology in France. The researchers developed a nanoCO2 harvester that uses water and sunlight to convert atmospheric CO2 into methanol, which can be employed as an engine fuel, a solvent, an antifreeze agent and a diluent of ethanol. Made by wrapping a layer of modified graphene oxide around spheres of copper zinc oxide and magnetite, the material looks like a miniature golf ball, captures CO2 more efficiently than conventional catalysts and can be readily reused, according to Suman Jain, senior scientist of the Indian Institute of Petroleum, Dehradun in India, who developed the nanoCO2harvester. Jain says that the nanoCO2 harvester has a large molecular surface area and captures more CO2 than a conventional catalyst with similar surface area would, which makes the conversion more efficient. But due to their small size, the nanoparticles have a tendency to clump up, making them inactive with prolonged use. Jain adds that synthesizing useful nanoparticle-based materials is also challenging because it’s hard to make the particles a consistent size. Chattopadhyay says the efficiency of such materials can be improved further, providing hope for useful application in the future. CLEANSING WATER Most toxic dyes used in textile and leather industries can be captured with nanoparticles. “Water pollutants such as dyes from human-created waste like those from tanneries could get to natural sources of water like deep tube wells or groundwater if wastewater from these industries is left untreated,” says Chattopadhyay. “This problem is rather difficult to solve.” An international group of researchers led by professor Elzbieta Megiel of the University of Warsaw in Poland reports that nanomaterials have been widely studied for removing heavy metals and dyes from wastewater. According to the research team, adsorption processes using materials containing magnetic nanoparticles are highly effective and can be easily performed because such nanoparticles have a large number of sites on their surface that can capture pollutants and don’t readily degrade in water. Chattopadhyay adds that appropriately designed magnetic nanomaterials can be used to separate pollutants such as arsenic, lead, chromium and mercury from water. However, the nanotech-based approach has to be more efficient than conventional water purification technology to make it worthwhile. In addition to removing dyes and metals, nanomaterials can also be used to clean up oil spills. Researchers led by Pulickel Ajayan at Rice University in Houston, Texas, have developed a reusable nanosponge that can remove oil from contaminated seawater.

#### Nanotech solves every existential threat

**Miller 17,** Gina Miller, She has written articles and provided interviews on the subject of nanotechnology and created digital artwork, videos and animations to illustrate future applications. Her work has been featured in various media including the History Channel, Japanese television, international documentaries, Wired, PC Magazine, Fast Company, and various books such as “Nanofuture” by J. Storrs Hall, the inventor of the “utility fog” concept. Miller has collaborated with other nanotechnology pioneers such as Robert A. Freitas Jr., author of “Nanomedicine,” and is a frequent collaborator of the Foresight Institute co-founded by K. Eric Drexler the “founding father of nanotechnology”.. 2-26-2017, accessed on 1-28-2021, Nanotechnology Industries, "Nanotechnology, the real science of miracles, the end of disease, aging, poverty and pollution - Nanotechnology Industries", http://nanoindustries.com/nanotechnology\_science\_of\_miracles/ //Adam

The current status of disease and death is staggering. We do know that in the documented world 56 million people die every year. Dissecting the statistics of disease provided by the World Health Organization is overwhelming to weed through. There is a solution. Or there may be in the future. One day there could be a cure for all disease, and you may be able to live forever, in a healthy youthful state. One day it may be possible that scientists will be able to create nanorobots using nanotechnology. Nanotechnology is the ability to see and move atoms around. Everything is made of atoms, the chair you are sitting in, your food, your body, the air we breathe, everything. Atoms are so small they cannot be seen by the human eye. Atoms are on the nanoscale, that's a teeny, tiny size. There are 25,400,000 nanometers in an inch, a sheet of newspaper is 100,000 nanometers thick, human hair is about 80,000 nanometers in diameter. Atoms are the building blocks. Different atoms, arranged in different ways, make molecules that make the different things you see and experience. In the human body atoms come together to make many things, for example water, fats, hair, bones, and DNA. DNA and other molecules build cells; sometimes cells malfunction and cause disease. Where does nanotechnology fit in? That's a self realizing question, that's how, it fits in! Think of it this way, if you were King Kong, could you grab one grain of sand easily? Your hands would be too big. That's how medicine is currently treating disease. Nanotechnology is on the same size and scale as disease. A nanorobot can grab a cell and repair it. This will allow us to cure diseases that have never been cured before. Nanorobots could be released into the blood stream via pill or injection to find and repair damage and then break down and disintegrate. Or nanorobots could remain in the body at all times, perpetually monitoring, identifying and repairing problems immediately, without any external treatment. Nanorobots would cure the aliment so early on that you would never even know you were going to get sick. Chemotherapy releases toxic chemicals throughout the entire body rather than just the affected area, such as a tumor. This process destroys the cancer but also the immune system. Chemotherapy makes patients very sick, and there is risk of permanent damage or death from the treatment itself. There is also a risk of the cancer returning. A nanorobot could have radiation inside of it, locate the tumor, inject it and destroy it directly. Molecular nanorobots wouldn't leave one cancerous cell behind. That's one of the benefits of getting down to the molecular level. Doctors cannot see on the molecular level and could easily miss some cancer cells, which is often the case and the cancer returns. A nanotech gene therapy has successfully killed ovarian cancer in mice; if successful in human clinical trials it could save the lives of 15000 women a year. But it doesn't stop with cancer. Every disease is made out of the same atoms that everything else is. All medical conditions are a result of atoms being out of place; a nanorobot could put them back where they belong, thus immediately alleviating the problem without the side effects that current day medication and treatments cause. What else can be repaired in the human body? EVERYTHING. From cancer to the common cold. There is nothing that nanotechnology could not repair. The injuries or illnesses you have right now will have the capability to be repaired or cured by nanotechnology. Nanotechnology could eliminate diseases, disabilities, and illnesses such as diabetes, malaria, HIV, cardiovascular disease, damage from injuries and accidents, heal wounds, reduce child mortality, regenerate limbs and organs, eliminate inflammatory/infectious diseases, and so on and so forth. Nanotechnology offers hope to people suffering from Alzheimer’s, Parkinson's, brain injuries, tumors and neurological disorders. Nanoconstructs could deliver neuroprotective molecules directly to the brain to recover or protect nerve cells from damage or degeneration. Nanotechnology has been emerging in this field in the form of nanoengineered scaffolds that could one day result in a tool for rewiring the intricate neuronal network. Research by Dr. Samuel I. Stupp designed molecules using nanomaterials and injected them into mice who were paralyzed due to spinal cord injury. After 6 weeks the mice regained the ability to walk. Research like this could one day evolve into real cures for people. 65 billion dollars is wasted every year due to low bioavailability. Meaning that the drug or treatment used is not absorbed into or accessed by the body properly due to a multitude of reasons. For example drug interactions, different molecular arrangements and manufacturing processes by different brands. Drugs with more moisture may form lumps in the stomach which decreases absorption, and a highly compressed pill will slow absorption. Different level changes in the body at any given time may cause drug toxicity. Metabolism, age, activity, stress, previous surgery and syndromes are also factors. These are huge challenges that can be alleviated by using nanotechnology to target the specific areas. Nanorobots can take their cues from mother nature; she is the first nanotechnologist. She is an expert at creating molecular machines. Geneticists have been taking advantage of viruses for use in gene therapy for some time. They modify a virus by removing the viral gene so it doesn't cause disease. They replace it with healthy genes to transport to the faulty cell and cure diseases. This strategy of hacking viruses could be exploited by nanotech. Viruses are biological molecular machines that could be modified into becoming nanorobots or they could become transportation for a nanorobot. Another means is a nanorobot could attach itself to a traveling white blood cell and ride shotgun to assist in the tissue repair of injured tissue. Nanotechnology could even be involved in tissue engineering, creating scaffolds for artificial organs and implants. Tissue from your own body could be used to make new tissue, which assures that your body doesn't reject it. The surgeries of today are painful, costly, can leave scars and can even be life threatening. Repairing nanorobots would eliminate the need for surgeries, incisions, side effects and recovery time. According to the American Academy of Periodontology there are links to poor dental health and stroke, heart disease, respiratory disease, osteoporosis, some cancers and diabetes. Nanorobots as nanodentistry could repair damage without large needles or drills. Nanorobots could also constantly and invisibly maintain and clean your teeth to avoid any dental problems. Hygiene is important for good health; your skin and hair could be cleaned by nanorobots eliminating the need for showers. Spider bites and ticks carrying lyme disease would be detected by nanorobots, blocking penetration. Other skin problems such as eczema would be repaired by dermal nanorobots. Is aging a disease? Could aging be cured? Yes. Since nanorobots would be able to repair single cells on the molecular level they would be able to repair damages created by aging. It's all the same to a nanorobot. Nanotechnology could repair damaged cells. Dead cells are the primary reason for aging and death; nanorobots could replace senescent (old) cells with non-senescent cells, or reprogram cells so they do not senescensce, which would keep the body from aging. Not only would the inside of your body never get sick or age, but neither will the outside. Your skin will be young, elastic, dewy and wrinkle-free. Your hair will be thick, without gray, and intact. Your hearing, your eyesight and memory will be in perfect shape. You wouldn't get arthritis, turkey neck, or saggy parts. You could go out dancing when you are 93 and not worry about sore feet, low energy or suffering any consequences. Unless you party too hard, but that's on you, not the nano. So if you never get sick and never get old could you live forever? Yes. nanorobots could be programmed to rebuild older cells into younger copies on a regular basis thereby the human body could become immortal. You could live a disease-free youthful life, forever. Of course immortality isn't for everyone and everyone should have the right to decide what they want or don't want for their own body. Death will be a choice rather than a requirement. There are well funded countries that have access to researchers and high tech equipment that would love to figure out how to create the nanotechnology that will repair bodies and end disease. In the US despite having a lot of financial resources it's not always easy to get funding. If you are at a university, you need to write a grant, go through a lot of red tape, and there are a lot more near-term projects that seem to get prioritized when it comes to funding. For companies looking for investors, unfortunately not all investors can foresee the amazing future that nano will have because they are used to funding things they can see. For example a company that makes desks seeking an investor can show the investor the money they need for each piece of wood, bolt, and the quantity of desks that will be manufactured within a specific time frame. Nanotechnology is in development and isn't readily available like a piece of wood, the piece of wood has to be built. And the individual processes of each emerging development will have their own variables. Once the recipe has been figured out and formulated, the investment we have made will then be very inexpensive and easy to reproduce. Third world countries would have easy access to nanomedicine. Mother nature puts atoms together all the time and it doesn't cost her anything. The raw materials for making nanorobots would be essentially cost-free because they will be made mostly of carbon. Because nanotechnology would be created on the very small atomic level, traveling to provide treatment would not require large equipment. The size and portability would make treatment easily accessible across the world. The environment and living conditions also impact health. Since nanotechnology is on the atomic level and atoms are everywhere, it can be beneficial to the world all around us, as well as our bodies. Nanotechnology could enrich depleted soil in places like Africa, which is currently facing a food crisis. Vitamins, nutrients and minerals could be delivered to rebuild soil to a fertile state and thus have the ability to grow food. Hunger could one day be a solvable problem. Nanotechnology would make it possible to provide meat and animal products inexpensively without killing animals. E.coli and other pathogens could be detected in soil and eliminated so that food is not harmful. Currently nanomaterials are in development to release fertilizers for plants and nutrients for livestock, nano sensors for monitoring the health of crops and farm animals, and magnetic nanoparticles to remove soil contaminants. According to water.org 750 million people around the world lack access to safe water; approximately one in nine people. 840,000 people die each year from water-related disease. A portable non-chemical nano-filtration water purification device has been developed by Micheal Pritchard. It creates safe and sterile water out of dirty water and would make the cost of water per household an estimated 3 dollars a year. His company has provided clean water to countries who have gone through natural disasters, such as Haiti and the Philippines. In the future nanotechnology particles could destroy bacteria that often cause fatal disease. Pollution in general, global warming, nuclear waste, oil spills, smog, and acid rain, could be remedied and prevented by nanotechnological advances. Large quantities of nanorobots could come together to remove pollutant atoms from the atmosphere, earth and water. These groups of nanorobots could swim in contaminated waters and be released into the polluted atmosphere to destroy or remove contaminating molecules. Nanorobots could pull apart the bad molecules and reassemble the atoms into good molecules for other positive purposes. As a first indicator of the possibility, Brian Mercer created a new pollution control technology using nanofibres that greatly reduce industrial pollution by trapping and removing the pollutants. Currently nanotech is being used to reduce emissions from car fuels. Since nanotechnology builds atom by atom; the process is pollution free. Nanotechnology will not be manufactured in the way we use manufacturing plants today. There will be no chemical by product, no emission, hazardous waste and no pollution.

#### Space Elevators solve unsafe launches

Forgan 19, Duncan H. Solving Fermi's Paradox. Vol. 10. Cambridge University Press, 2019. (Associate Lecturer at the Centre for Exoplanet Science at the University of St Andrews, Scotland, founding member of the UK Search for Extra-terrestrial Intelligence (SETI) research network and leads UK research efforts into the search)//Elmer

All objects in HEO reside beyond the geostationary orbit (GEO). The orbital period at GEO (w'hich is aligned with the Earth's equator) is equal to the Earth’s rotational period. As a result, from a ground observer’s perspective the satellite resides at a fixed point in the sky, with clear advantages for uses such as global communication. Activities at HEO are considerably less than at LEO and MEO. Earth's orbital environment does contain a natural component - the meteoroids. These pose little to no threat to space operations - the true threat is self-derived. The current limitations of spacefaring technology ensure that every launch is accompanied by substantial amounts of space debris. This debris ranges in size from dust grains to paint flecks to large derelict spacecraft and satellites. According to NASA’s Orbital Debris Program Office, some 21.000 objects greater than 10 cm in size are currently being tracked in LEO. with the population below 10 cm substantially higher. Most debris produced at launch tends to be deposited with no supplemental velocity - hence these objects tend to follow the initial launch trajectory, which often orbits with high eccentricity and inclination. However, these orbits do intersect with the orbits of Earth’s artificial satellite population, resulting in impacts w'hich tend to produce further debris. The vast majority of the low-size debris population is so-called fragmentation debris. This is produced during spacecraft deterioration, and in the most abun- dance during spacecraft break-up and impacts. The first satellite-satellite collision occurred in 1961. resulting in a 400% increase in fragmentation debris (Johnson et al.. 2008). Most notably, a substantial source of fragmentation debris was the deliberate destruction of the Fengyun 1C satellite by the People’s Republic of China, which created approximately 2.000 debris fragments. As with collisions of ‘natural debris’, debris-debris collisions tend to result in an increased count of debris fragments. Since the late 1970s, it has been understood that man-made debris could pose an existential risk to space operations. Kessler and Cour-Palais (1978) worked from the then-population of satellites to extrapolate the debris production rate over the next 30 years. Impact rates on spacecraft at any location. /, can be calculated if one knows the local density of debris p, the mean relative velocity vrei\* and the cross-sectional area ct: [[EQUATION 13.5 OMITTED]] Each impact increases p without substantially altering vrel or o. We should there- fore expect the impact rate (and hence the density of objects) to continue growing at an exponential rate: [[EQUATION 13.6 OMITTED]] Kessler and Cour-Palais (1978) predicted that by the year 2000, p would have increased beyond the critical value for generating a collisional cascade. As new collisions occur, these begin to increase ^jjp, which in turn increases resulting in a rapid positive feedback, with p and I reaching such large values that LEO is rendered completely unnavigable. This has not come to pass - LEO remains navigable, partially due to a slight overprediction of debris produced by individual launches. The spectre of a collisional cascade (often referred to as Kessler syndrome) still looms over human space exploration, as debris counts continue to rise. Without a corresponding dedicated effort to reduce these counts, either through mitigating strategies to reduce the production of debris during launches, or through removal of debris fragments from LEO. we cannot guarantee the protection of the current flotilla of satellites, leaving our highly satellite-dependent society at deep risk. What strategies can be deployed to remove space debris? Almost all debris removal techniques rely on using the Earth’s atmosphere as a waste disposal sys- tem. Most debris is sufficiently small that atmospheric entry would result in its complete destruction, with no appreciable polluting effects. Atmospheric entry requires the debris fragments to be decelerated so that their orbits begin to intersect with lower atmospheric altitudes. Once a critical altitude is reached, atmospheric drag is sufficiently strong that the debris undergoes runaway deceleration and ultimately destruction. There are multiple proposed techniques for decelerating debris. Some mechani- cal methods include capturing the debris using either a net or harpoon, and applying a modest level of reverse thrust. These are most effective for larger fragments, and especially intact satellites (Forshaw et al., 2015). Attaching sails to the debris is also a possibility if the orbit is sufficiently low for weak atmospheric drag. The Japanese space agency JAXA’s Kounotori Integrated Tether Experiment (KITE) will trail a long conductive cable. As a current is passed through the cable, and the cable traverses the Earth’s magnetic field, the cable experiences a magnetic drag force that will de-orbit the spacecraft. Orbiting and ground-based lasers can decelerate the debris through a variety of means. For small debris fragments, the radiation pressure produced by the laser can provide drag. A more powerful laser can act on larger debris fragments through ablation. As the laser ablates the debris, the resulting recoil generated by the escaping material produces drag and encourages de-orbit. A more lateral solution is to ensure that launches and general space-based activity no longer generate debris. These approaches advocate lower-energy launch mechanisms that do not rely on powerful combustion. The most famous is the space elevator (see Aravind. 2007). Originally conceived by Tsiolkovsky, the ele- vator consists of an extremely durable cable extended from a point near the Earth’s equator, up to an anchor point located at GEO (most conceptions of the anchor point envision an asteroid parked in GEO). ‘Climber’ cars can then be attached to the cable and lifted to LEO, MEO and even GEO by a variety of propulsion methods. Most notably, the cars can be driven to GEO without the need for chemical rockets or nuclear explosions - indeed, a great deal of energy can be saved by having coupled cars, one ascending and one descending. Space elevators would solve a great number of problems relating to entering (and leaving) Earth orbit, substantially reducing the cost of delivering payload out of the Earth's atmosphere. The technical challenges involved in deploying a cable tens of thousands of kilometres long are enormous, not to mention the material science required to produce a cable of sufficient tensile strength and flexibility in the first place. The gravitational force (and centrifugal force) felt by the cable will vary significantly along its length. As cars climb the cable, the Coriolis force will move the car (and cable) horizontally also, providing further strain on the cable material. The relatively slow traversal of the biologically hazardous Van Allen Belt on the route to GEO is also a potential concern for crewed space travel. Whatever the means, a spacefaring civilisation (or at least, a civilisation that utilises its local orbital environment as we do) must develop a non-polluting solution to space travel, whether that is via the construction of a space elevator, a maglev launch loop, rail gun, or some other form of non-rocket acceleration. If it cannot perform pollution-free spacecraft launches (or fully clean up its pollution), then it will eventually succumb to Kessler syndrome, with potentially drastic consequences for future space use, with likely civilisation-ending effects (Solution C.13).

#### 1AR theory is skewed towards the aff – a) the 2NR must cover substance and over-cover theory, since they get the collapse and persuasive spin advantage of the 3min 2AR, b) their responses to my counter interp will be new, which means 1AR theory necessitates intervention. Implications – a) drop the arg to minimize the chance the round is decided unfairly, b) use reasonability with a bar of defense or the aff always wins since the 2AR can line by line the whole 2NR without winning real abuse. C) if intervention is inevitable on theory then intervene and vote on substance since it’s the only portable impact we get from debate

#### Infinite abuse claims are wrong- A] Spikes solve-you can just preempt paradigms in the 1AC B] Functional limits- 1nc is only 7 minutes long

#### Pics are good they encourage innovative research that avoids stale debates and bridges different parts of the literature. Our PIC directly engages the literature base of the AC

#### Condo is good proving a CP is bad doesn’t prove the plan is good, a logical policy maker can always choose not to act. Logic outweighs – it’s the basis of all rational arguments.

## Case

### 1NC---AT: Solvency

#### To clarify – these solvency deficits are based off the idea of proportional fees and liability which the 1ac has specified they will defend

#### Countries will blow up their satellites to get cash

Taylor 06 [Michael Taylor, faculty of law at McGill University.] “Orbital Debris: Technical and Legal Issues and Solutions” August 2006 (<https://fas.org/spp/eprint/taylor.pdf>) – MZhu

Proposals for a compensation fund suffer from similar shortcomings. A damage compensation fund would pay for damage to satellites from unidentified debris. Essentially, these proposals all attempt to correlate the amount of money a State will have to pay into the fund with the amount of debris created.438 Suggestions for how to infuse cash into the compensation fund include basing a State’s contributions on the debriscreating potential of the satellite,439 a set amount per launch,440 or a set percentage of the launch cost.441 In order to quickly fill the coffers of the proposed fund, States that were active in space in the past (the US and USSR primarily) might have to make catch-up payments based on older orbital debris.442

Such a fund would be punitive in the sense that it would discourage the creation of new orbital debris through a fine or a tax. Once created, the fund would essentially be insurance for satellites against damage caused by unidentified debris. Space-faring States would likely be unwilling to enter into such an arrangement. With private insurance for satellites readily available on the market, few States would see it as being in their best interest to create their own system of insurance. Another problem is maintaining the funding at an adequate level to pay out claims. At least the market-share system would only require States to pay as damage actually occurs. The proposals for funds would have to balance the amount of revenue needed to offset potential claims; this would be a very difficult task. Finally, this proposal has the potential to permit fraud. A dishonest State could place a self-destruct device on a satellite. Near the end of the satellite’s useful life, the State could destroy it and claim reimbursement from the fund.

#### Debris share liability is counter-productive.

-small states won’t mitigate/remediate even if held liable because their costs are so low

-U.S./Russia won’t agree/comply—disproportionate costs and doesn’t cover the cost of their damages

-no incentive for U.S./Russia mitigation since it doesn’t reduce their liability from existing debris

Plantz 12 (Meghan, J.D., University of Georgia, B.A., Ohio University, “ORBITAL DEBRIS: OUT OF SPACE,” 2012, <https://digitalcommons.law.uga.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1015&context=gjicl>, DOA: 9-14-2019) //Snowball

However, many drawbacks exist in a market-share liability system that would inhibit its acceptance by the international community. Some states may choose not to adopt or improve mitigation measures because their portion of liability would remain small regardless of their actions.244 The main reason why market-share liability could fail to be adopted is that, once again, the U.S. and Russia will probably reject this proposal.245 Under this regime, both countries will never recover more than two-thirds of the value of their damaged or destroyed spacecraft.246 Furthermore, increased mitigation techniques will not reduce their amount of liability because of past pollution; only debris removal will reduce their contribution.247 Lastly, and most importantly, if a significant amount of collisions by unidentified debris occurred, the U.S. and Russia would easily owe millions of dollars.248 Since the U.S. and Russia are the major actors in the space community, their support is vital for the adoption of this regime.249 It is highly unforeseeable that they would support a regime that imposes such a high burden of liability on them.

#### Market share liability fails

Taylor 06 Michael W. Taylor Institute of Air and Space Law Faculty of Law, McGill University, Montreal August 2006 Orbital Debris: Technical and Legal Issues and Solutions https://fas.org/spp/eprint/taylor.pdf

a) Modifications to Liability Regime

Turning to proposals which are narrowly focused on the topic of orbital debris, the most frequently mentioned ideas are (1) to create a damage compensation fund,424 (2) to apportion damages based on a theory of market-share liability,425 and (3) to modify the fault-based standard for damages in space.426

These three proposals have been suggested so often that a brief comment on their merits is warranted, beginning with market-share liability. There are several reasons why a market-share liability regime will not work in outer space. First, in space the pool of potential claimants is the same as the pool of potential respondents. In the usual marketshare liability regime, a group of manufacturers create a fungible product that causes injury to persons or property, but the manufacturers themselves will never be a plaintiff. Under the law governing the use of space, all rights and responsibilities flow through States, not private entities, making the States both the claimants and respondents. To illustrate how this presents a problem for a market-share liability, consider the following hypothetical: In unrelated events, both a US satellite and an Indian satellite, each valued at $5 million, are destroyed by unidentified debris. The US is responsible for about 42 percent of the total amount of orbital debris and India for about 1.5 percent.427 Under the market-share regime, the US could only recover $2.9 million for the value of its satellite (since the US would be responsible for bearing 42 percent of its own loss) but at the same time would have to pay $2.1 million for the US share of the Indian satellite. India, on the other hand, would only have to pay $75,000 for its share of the damage to the US satellite and would recover $4.9 million for its own satellite.428 Thus, a claimant’s damages will always be offset by the proportion of debris for which it is responsible, defeating the purpose of the market-share regime.

A second problem is identifying the proportion of debris for which each State is responsible. This is why the market-share liability regime developed in the first place. The theory was first applied to manufacturers of a synthetic form of estrogen.429 Because the substance was fungible, pharmacists routinely filled prescriptions for it from any of the many manufacturers.430 Thus, the plaintiffs were unable to identify any one company which caused the harm to them. The California courts created a new theory of liability, premised upon the idea that each manufacturer would be liable in proportion to its share of the market. 431 Market share for pharmaceutical companies is relatively easy to determine based upon financial records. Orbital debris is much more complicated. Since the theory will only be applied to damage caused by unidentified debris,432 what is the best way to create liability for an unknown quantity? The most plausible answer is to determine liability based on the known, trackable debris,433 but this is not a satisfactory solution.

There may not be a relationship between the amount of known and unknown debris created from a satellite breakup. 434 For example, a rocket stage that explodes may create three pieces of trackable debris and 1,000 pieces of small debris or it could create 500 pieces of trackable debris and 1,000 pieces of small debris. In the latter case, the launching State would be held disproportionately liable under a market-share liability system, without regard to fault or the due care they exhibit.435 The potential risk also varies with altitude. Debris at 900 kilometers altitude poses a much greater risk than debris in GEO. And perhaps most significantly, multiple States may be liable for each piece of debris. The SSN catalog identifies only one State responsible for each piece of debris. In reality, four or more States could be equally liable.436 The proposed marketshare regime fails to take these variables into account.

A third problem with the proposal is its failure to make an allowance for damage caused by natural orbital debris. For the market-share liability regime to apply, the identity of the object causing the damage must be unknown. Since the identity is not known, the debris is most likely small and untrackable, thus the possibility that natural debris (or for that matter, a malfunction unrelated to debris)437 caused the damage cannot be ruled out. Compensation for damage that cannot be definitively associated with some type of artificial debris is well beyond strict liability. Such a proposal is more analogous to insurance for satellites underwritten by all States, primarily those States conducting the most launches. For all of these reasons, the proposal has no chance of being accepted by either the US or the Russian Federation. Without support from all the major space-faring nations, a market-share liability regime will never succeed.

### 1NC---AT: Debris

#### Squo debris thumps

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Earth orbit is getting more and more crowded as the years go by. Humanity has launched about 12,170 satellites since the dawn of the space age in 1957, [according to the European Space Agency](https://www.esa.int/Safety_Security/Space_Debris/Space_debris_by_the_numbers) (ESA), and 7,630 of them remain in orbit today — but only about 4,700 are still operational. That means there are nearly 3,000 defunct spacecraft zooming around Earth at tremendous speeds, along with other big, dangerous pieces of debris like upper-stage rocket bodies. For example, orbital velocity at 250 miles (400 kilometers) up, the altitude at which the ISS flies, is about 17,100 mph (27,500 kph). At such speeds, even a tiny shard of debris can do serious damage to a spacecraft — and there are huge numbers of such fragmentary bullets zipping around our planet. ESA estimates that Earth orbit harbors at least 36,500 debris objects that are more than 4 inches (10 centimeters) wide, 1 million between 0.4 inches and 4 inches (1 to 10 cm) across, and a staggering 330 million that are smaller than 0.4 inches (1 cm) but bigger than 0.04 inches (1 millimeter). These objects pose more than just a hypothetical threat. From 1999 to May 2021, for example, the ISS conducted 29 debris-avoiding maneuvers, including three in 2020 alone, [according to NASA officials](https://www.nasa.gov/mission_pages/station/news/orbital_debris.html). And that number continues to grow; the station performed [another such move in November 2021](https://www.space.com/space-station-dodging-chinese-space-junk-spacex-crew-3), for example. Many of the smaller pieces of space junk were spawned by the explosion of spent rocket bodies in orbit, but others were more actively emplaced. In January 2007, for instance, China intentionally destroyed one of its defunct weather satellites in a much-criticized test of anti-satellite technology that generated [more than 3,000 tracked debris objects](https://swfound.org/media/9550/chinese_asat_fact_sheet_updated_2012.pdf) and perhaps 32,000 others too small to be detected. The vast majority of that junk remains in orbit today, experts say. Spacecraft have also collided with each other on orbit. The most famous such incident occurred in February 2009, when Russia's defunct Kosmos 2251 satellite slammed into the operational communications craft Iridium 33, producing [nearly 2,000 pieces of debris](https://swfound.org/media/6575/swf_iridium_cosmos_collision_fact_sheet_updated_2012.pdf) bigger than a softball. That 2009 smashup might be evidence that the Kessler Syndrome is already upon us, though a cataclysm of "Gravity" proportions is still a long way off. "The cascade process can be more accurately thought of as continuous and as already started, where each collision or explosion in orbit slowly results in an increase in the frequency of future collisions," [Kessler told Space Safety Magazine in 2012](http://www.spacesafetymagazine.com/space-debris/kessler-syndrome/don-kessler-envisat-kessler-syndrome/).

#### Debris creates deterrence by raising the bar for conflict – international norms fail

Miller 7/31 [(Gregory, Chair of the Department of Space Power at the Air Command and Staff College, Ph.D. in Political Science from The Ohio State University) “Deterrence by Debris: The Downside to Cleaning up Space,” Space Policy, 7/31/2021] JL

The danger of kinetic strikes increasing orbital debris is a common theme in the literature, but the positive deterrent effects of some debris are often overlooked. The debris resulting from destroyed satellites, or other space objects, creates a deterrent effect on actors who might otherwise violate international norms and strike at objects in space, either to test their capabilities or as an act of hostilities. This is not deterrence in the traditional sense, of one actor publicly threatening punishment in response to another actor’s unwanted actions. It is not deterrence by denial since the attacker is not damaged and may even achieve its objective. Nor is it deterrence by punishment because the debris itself does not threaten to punish the attacker’s country. But debris can increase the future costs to the aggressor, even if their initial attack succeeds, and thus it has a similar restraining effect on certain behavior. Like the automated response of the U.S. tripwire in West Germany, the threat that debris can pose to state interests acts as a form of deterrence, at least to prevent some actors from taking certain types of actions. Removing the danger of debris will weaken that restraint and thus weaken deterrence, making ASAT tests and hostile actions in space more likely.

Several factors may deter a state from launching kinetic tests or striking against an adversary’s interests in space. For one thing, if a state’s adversary has similar capabilities to destroy objects in space, deterrence would be a function of not wanting to escalate tensions. Although international law only explicitly prohibits states from placing weapons of mass destruction in orbit, international space law, like the Outer Space Treaty [30], does provide a framework for addressing the activities of one state that lead to the damage of another state’s property. Likewise, there are international norms (informal but expected rules of behavior) against the weaponization of space. But these norms seem to be in decline [31], and such norms only deter a state from engaging in certain types of behavior if the state cares about following norms, if it cares about how states perceive its behavior, or if it believes other states are willing to enforce the norms. The beauty of debris as a deterrent is that it does not rely on the enforcement of norms or the credibility of states to succeed.

#### No Escalation over Satellites:

#### 1] Planning Priorities

Bowen 18 Bleddyn Bowen 2-20-2018 “The Art of Space Deterrence” <https://www.europeanleadershipnetwork.org/commentary/the-art-of-space-deterrence/> (Lecturer in International Relations at the University of Leicester)//Elmer

Space is often an afterthought or a miscellaneous ancillary in the grand strategic views of top-level decision-makers. A president may not care that one satellite may be lost or go dark; it may cause panic and Twitter-based hysteria for the space community, of course. But the terrestrial context and consequences, as well as the political stakes and symbolism of any exchange of hostilities in space matters more. The political and media dimension can magnify or minimise the perceived consequences of losing specific satellites out of all proportion to their actual strategic effect.

### 1NC---AT: Space Exploration

#### Colonization doesn’t reduce existential risk – Earth-bound threats outweigh even in long term risk management

* Short- and long-term risk assessment should focus on protecting earth
* Earth gets riskier as tech advances which raises the risk that our impact happens before colonization
* Even if tech gets there, future social and economic context prevents missions
* Risk Dynamics Paradox – existential risks are rooted in human psychology, so they’ll follow us to space – Bostrom agrees!

Szocik 19 [Konrad Szocik, University of Information Technology and Management in Rzeszow, Department of Philosophy and Cognitive Science. Should and could humans go to Mars? Yes, but not now and not in the near future. Futures Volume 105, January 2019, Pages 54-66. https://www.sciencedirect.com/science/article/pii/S001632871830199X]

I argue, following other authors (Baum, 2009; Baum, Denkenberger, & Haqq-Misra, 2015; Jebari, 2015; Sandberg, Matheny, & Ćirković, 2008; Turchin & Green, 2017) that human space settlement is not able to reduce and/or to exclude the risk of human extinction. For this reason, it should not be perceived in terms of space refuge. In terms of both short-term and long-term perspectives of risk assessment, it would be better to protect humans on Earth.5 I reject the supportive role which could be played by human space settlement after a catastrophe on Earth, i.e., a recovery coordination mission. Due to so-called the paradox of technological progress discussed in the last section, further putative progress in space technology will be counterbalanced by increasing anthropogenic risks including, among others, overpopulation and limited resources (these anthropogenic threats are unavoidable in near future, in contrast to other risks that are only more or less probable but not unavoidable). Permanent lack of strong rationale for human mission to Mars – both now and in the near future – leads to paradoxical situation. Even if in some point in the future the minimum level of advancement in human deep-space technologies will be achieved, social, political, and economic contexts will gradually decrease the chances for real preparation of this mission. Another paradox, let’s call it the risk dynamics paradox, is that the most probable threats in the near future are, as Bostrom and Cirkovic (2008) argue, anthropogenic threats caused by civilizational and technological progress. The paradox lies in the fact that humans are not able to run from these kinds of risks that are rooted in their way of thinking, style of life, and population dynamics, risks implied by Malthus’ law. The human species can try to protect against natural disaster but not against deleterious effects of its own technological progress. In regard to possible future existential risks, I assume that their deleterious power is a little bit exaggerated, and, in any event, human space settlement is not a right way to cope with them. However, in any case, it is hard to speculate if any human space settlement must repeat the same path of human expansion as it was the case on Earth. It is unclear if human technological expansion and exploration must always lead to deleterious and self-destructive effects. In this paper, I do not discuss ethical and moral concerns which are traditionally considered when discussing the human place in space. They include such topics as the human right to explore space (it means both right to intervene in any extraterrestrial object, and human duty and rationale for space expansionism, mostly in the context of the idea of space refuge and possible catastrophic scenarios on Earth), or the value of human life and space objects.

### 1NC---AT: Grids

#### This ev doesn’t have a warrant just asserts its critical for existential risks – hold the line from 1ac cards to 1ar and 2ar impact calc because all of this ev is just so underwarranted and highlighted

### 1NC---AT: Astronomy

#### This greene card says nothing – just says that it allows you to understand more information about medical science and climate change but is not even close to being definitive about solving any of these

#### The aff is a double turn – says that satellites hurt astronomy which means the debris scenario is offense for us – we read blue

TURNER 21. Ben is a U.K. based staff writer at Live Science. He covers physics and astronomy, among other topics like weird animals and climate change. He graduated from University College London with a degree in particle physics before training as a journalist. When he's not writing, Ben enjoys reading literature, playing the guitar and embarrassing himself with chess. 4/29/21. [Live Science, “Space junk is blocking our view of the stars, scientists say,” <https://www.livescience.com/space-junk-blocks-view-of-cosmos.html>] Justin

The night sky is becoming increasingly filled with shiny satellites and space junk that pose a significant threat to our view of the cosmos, as well as astronomical research, a new study warns. The researchers found that the more than 9,300 tons (8,440 metric tons) of space objects orbiting Earth, including inoperative satellites and chunks of spent rocket stages, increase the overall brightness of the night sky by more than 10% over large parts of the planet. Such an increase would mean large swathes of the planet are considered light polluted, making it increasingly difficult for astronomers to take accurate measurements, and increasing the likelihood that they will miss significant discoveries altogether, the researchers said in the journal Monthly Notices of the Royal Astronomical Society.

"We expected the sky brightness increase would be marginal, if any, but our first theoretical estimates have proved extremely surprising and thus encouraged us to report our results promptly," lead study author Miroslav Kocifaj, a senior researcher at the Slovak Academy of Sciences, said in a statement. The researchers calculated the change in brightness by developing a model that takes into account the average size and brightness of each piece of debris. According to the researchers, satellites and space garbage ruin astronomical images by scattering reflected sunlight, producing bright streaks that are indistinguishable from — and often brighter than — objects of astrophysical interest, making it difficult if not impossible for them to get a clear picture. The researchers found that this effect is most pronounced when viewing the cosmos with low-resolution detectors, such as the human eye, resulting in a diffuse brightness across all of the night sky. Telescopes with high angular resolution and high sensitivity may also have part of their images ruined by the light pollution, although they can likely resolve the junk-reflected light into smears. Nevertheless, this could potentially obscure astronomical sights, such as the glowing clouds of stars along the disk of the Milky Way, wherever in the world star-gazers happen to be.

"Unlike ground-based light pollution, this kind of artificial light in the night sky can be seen across a large part of the Earth's surface," study co-author John Barentine, director of public policy for the International Dark-Sky Association, said in the statement. "Astronomers build observatories far from city lights to seek dark skies, but this form of light pollution has a much larger geographical reach." And the night sky could get even junkier and brighter, especially with the ongoing installation of “mega-constellations,” — large arrays of commercial satellites that aim to provide global internet access. At least 12 operators, including Amazon, SpaceX and OneWeb, have plans to launch new mega-constellation satellites or expand existing networks. SpaceX's Starlink currently has 1,200 satellites in orbit, but the company intends to increase its fleet to 42,000 in the coming decades — roughly 14 times the number of operational satellites in orbit today.