# Cal RR R4 Neg vs HWL IC

# 1NC

### 1

#### Interpretation – the aff must specify what type of Private Actor Appropriation they affect.

#### Appropriation is extremely vague – no legal precedent means no normal means

Pershing 19, Abigail D. "Interpreting the Outer Space Treaty's Non-Appropriation Principle: Customary International Law from 1967 to Today." Yale J. Int'l L. 44 (2019): 149. (Robina Fellow at European Court of Human Rights. European Court of Human Rights Yale Law School)//Elmer

Though the Outer Space Treaty flatly prohibits national appropriation of space,150 it leaves unanswered many questions as to what actually counts as appropriation. As far back as 1969, scholars wondered about the implications of this article.151 While it is clear that a nation may not claim ownership of the moon, other questions are not so clear. Does the prohibition extend to collecting scientific samples?152 Does creating space debris count as appropriation by occupation? While the answers to these questions are most likely no, simply because of the difficulties that would be caused otherwise, there are some questions that are more difficult to answer, and more pressing. As commercial space flight becomes more and more prevalent,153 the question of whether private entities can appropriate property in space becomes very important. Whereas once it took a nation to get into space, it will soon take only a corporation, and scholars have pondered whether these entities will be able to claim property in space.154 Though this seems allowable, since the treaty only prohibits “national appropriation,”155 allowing such appropriation would lead to an absurd result. This is because the only value that lies in recognition of a claim is the ability to have that claim enforced.156 If a nation recognized and enforced such a claim, this enforcement would constitute state action.157 It would serve to exclude members of other nations and would thus serve as a form of national appropriation, even though the nation never attempted to directly appropriate the property.158 Furthermore, the Outer Space Treaty also requires that non-governmental entities must be authorized and monitored by the entities’ home countries to operate in space.159 Since a nation cannot authorize its citizens to act in contradiction to international law, a nation would not be allowed to license a private entity to appropriate property in space.160 While this nonappropriation principle is great for allowing free access to space, thereby encouraging research and development in the field, it makes it difficult to create or police a solution to the space debris problem. A viable solution will have to work without becoming an appropriation. There is, however, very little substantive law on what actually counts as appropriation in the context of space.161 So, the best way to see what is and is not allowed is to look both at the general international law regarding appropriations and to look at the past actions of space actors to see what has been allowed (or at least tolerated) and what has been prohibited or rejected.

#### Violation: they don’t

#### Standards:

#### a] Shiftiness – vague plan wording wrecks Neg Ground since it’s impossible to know which DAs link or which CPs are competitive since different types of appropriation like Space Mining, Space Col, and Satellites – the 1AR can squirrel out of links by saying they don’t affect a certain type of appropriation, or they don’t reduce private appropriation enough to trigger the link.

#### b] Topic Ed – nuanced debates about private property in Outer Space requires spec since each form of appropriation has specific issues related to it so generalization disincentivizes in-depth research – o/w since we only debate the topic for two months.

### 2

#### CP: The appropriation of outer space by private entities for asteroid material collection for scientific study is just. The appropriation of outer space by private entities for other space acticity is unjust.

#### Space samples are appropriated for scientific study—it’s uncontroversial as customary law but the plan bans it

**Pershing 19** (Abigail D., J.D. from Yale Law School. Robina Fellow at the Europcean Court of Human Rights. “Interpreting the Outer Space Treaty's Non-Appropriation Principle: Customary International Law from 1967 to Today,” 44 *Yale Journal of International Law* 149 2019)DR 22

The earliest hint of a change in customary international law relating to the interpretation of the non-appropriation clause came in 1969, when the United States first sent astronauts to the moon. As part of his historic journey, astronaut Neil **Armstrong** collected moonrocks that he brought back with him to Earth and promptly handed off to the National Aeronautics and Space Administration (NASA) as U.S. property.5 4 Later, the USSR similarly claimed lunar material as government property, some of which was eventually sold to private citizens.55

**These** first instances of space resource appropriation did not draw much attention, but they presented a distinct shift marking the beginning of a new period in State practice. Having previously been limited by their technological capabilities, States could now establish new practices with respect to celestial bodies. This was the beginning of a pattern of appropriation that slowly unfolded over the next few decades and has since solidified into the general and consistent State practice necessary to establish the existence of customary international law.

Currently, the U.S. government owns 842 pounds of lunar material.56 There is little question that NASA and the U.S. government consider this material, as well as other space materials collected by American astronauts, to be government property.5 7 In fact, NASA explicitly endorses U.S. property rights over these moon rocks, stating that "[1]unar material retrieved from the Moon during the Apollo Program is U.S. government property."

#### Private extraction key to study of space samples—costs

**OSI ND** (Outer Space Institute, network of world-leading space experts united by their commitment to highly innovative, transdisciplinary research that addresses grand challenges facing the continued use and exploration of space. http://outerspaceinstitute.ca/resources.html. No date but is referencing asteroid probes from 2021.)DR 22

Public-private partnerships are fostering the development of ISRU technology. NASA contracted [four private companies](https://www.nasa.gov/press-release/nasa-selects-companies-to-collect-lunar-resources-for-artemis-demonstrations/) to collect samples of regolith from the Moon’s south pole. Once collected, ownership of the samples will be [transferred to NASA in-situ](https://www.nasa.gov/press-release/nasa-selects-companies-to-collect-lunar-resources-for-artemis-demonstrations) as a move to kick-start space commerce and incentivize further investment in the development of ISRU technology. Additionally, [NASA awarded SpaceX](https://www.nasa.gov/press-release/as-artemis-moves-forward-nasa-picks-spacex-to-land-next-americans-on-moon) a $2.9 billion contract to build a human landing system that will carry astronauts to the lunar surface.

China has also made significant progress on the technological front with the success of their [Chang’e 5 spacecraft,](https://spaceflightnow.com/2021/01/01/chinese-mission-returned-nearly-4-pounds-of-lunar-samples/) which extracted a four-pound sample of lunar regolith and returned it to Earth.

The sample-return missions underway by [NASA](https://www.nasa.gov/osiris-rex) and [JAXA](https://www.hayabusa2.jaxa.jp/en/) serve as technological demonstrations of the possibilities, challenges, and dangers when interacting with asteroids. Other teams planning to do the same in the near future, some of which are commercial actors, will learn greatly from these missions

Mining asteroids could also become a very real prospect decades from now. New sample and return technology, namely the probes deployed by [JAXA](https://www.hayabusa2.jaxa.jp/en/) and [NASA,](https://www.nasa.gov/mission_pages/osiris-rex/about) have extracted material from the asteroids Ryugu and Bennu, respectively, and are returning it to Earth. Meanwhile, commercial launch companies, such as SpaceX, are drastically lowering the cost of launching equipment into space, making it accessible to a wider range of actors.

Despite[the declining investment into asteroid mining start-ups,](https://www.technologyreview.com/2019/06/26/134510/asteroid-mining-bubble-burst-history/) some ambitious companies remain waiting for a future date when it becomes economically feasible. In the meantime, they undertake other space activities, such as operating Earth imaging satellites, to maintain revenue streams.

Mining space resources, such as the Moon and asteroids, could greatly expand humanity’s knowledge about the origins of the solar system, the Earth, the abundance of water, and the origin of life. Ice and water-bearing minerals could be used to produce rocket fuel; fuel that, being sourced in space, will not need to be lifted – at great expense – out of Earth’s heavy gravity. Studying material from asteroids may also prove to be vital in humanity's defence against potential major impactors.

#### Specifically, SpaceX’s Starship enables sample collection at an unprecedented rate.

Heldmann et al 21 “Accelerating Martian and Lunar Science through SpaceX Starship Missions” May 2021 Jennifer L. Heldmann [NASA Ames Research Center, Division of Space Sciences & Astrobiology, Planetary Systems Branch], other authors listed in the article <https://surveygizmoresponseuploads.s3.amazonaws.com/fileuploads/623127/5489366/111-381503be1c5764e533d2e1e923e21477_HeldmannJenniferL.pdf> SM

Given the Starship’s anticipated low cost, high payload capacity, and potential for high flight cadence, the opportunities presented for planetary science missions have the potential to dramatically increase our progress towards NASA Planetary Science & Astrobiology goals and objectives. Building upon the NASA CLPS paradigm (Bussey et al. 2019), use of SpaceX Starships will allow for increased flights for science experiments, technology demonstrations, and capability development to enable human spaceflight missions through NASA partnership and purchase of flight payload accommodation. High priority science objectives as outlined in the Decadal Survey and NASA Strategic Plan for the Moon and Mars can uniquely be achieved through flights to lunar/Martian orbit and/or to the surface of these planetary bodies. In addition, Starship has the ability to deploy orbiters on approach. This capability would provide the opportunity to deliver either relatively large orbital assets with sophisticated remote sensing instrumentation and/or many smaller satellites that could serve a variety of purposes, including development of communications or meteorology networks.

Starship is designed to lift off from its planetary destination and return to Earth, thereby allowing not only the return of crew members but also the return of unprecedented quantities of lunar and Martian samples to Earth for scientific analysis. Because Starship can return tens of tons of payload from the surface of the Moon, the return sample mass of lunar samples from a single mission would dwarf the combined total returned mass of all lunar samples from all sample return missions to date. Many samples with greater sample variety will allow for more scientifically robust analytical studies in laboratories on Earth. Removing the need to severely high-grade and down-select samples on the Moon and Mars will also enable opportunistic science from returned samples to degrees previously not achievable. Never before has the science or exploration community had the potential to send such payload capacity to these destinations and return as much sample material as can be accommodated by Starship. The scientific progress achieved would be unprecedented.

#### Asteroid samples key to planetary defense

**Grove and Powell 20** (Phil Groves, producer of the award-winning documentary *Asteroid Hunters*. Corey Powell, reporter for discover magazine “We're Coming for the Asteroids. Are the Asteroids Coming for Us?” [https://www.discovermagazine.com/the-sciences/were-coming-for-the-asteroids-are-the-asteroids-also-coming-for-us November 30](https://www.discovermagazine.com/the-sciences/were-coming-for-the-asteroids-are-the-asteroids-also-coming-for-us%20November%2030), 2020)DR 22

Groves: The way I internalize that sort of thinking is an ounce of prevention is worth a pound of cure. You have a house. You buy a fire extinguisher, and the expense of that fire extinguisher relative to the overall cost of the house is pretty small. The amount of money that you would have to spend to send up a space telescope to look for asteroids so that we can find it before they find us, is pretty small compared to the overall economy of the world. When you go to sleep at night, you lock your front door. The chances of someone invading your house in the middle of the night is pretty minuscule as well, but you do it. This is the same thing, just on a grander scale.

And it doesn't even cost that much! NASA's budget for finding asteroids is probably less than what it costs to make **one** Hollywood asteroid-disaster movie.

Groves: That might be generous, by the way. NASA's budget for planetary defense in this past year is about 150 million bucks. Just about every Marvel movie made out there cost more than that. And this is the only natural disaster you can actually prevent from happening. You can't cork a volcano. You can't throw a net over a hurricane. You can't glue shut a fault line to stop earthquakes. But this we can stop.

What do you find most scientifically exciting about asteroids?

Groves: The coolest fact that I learned along the way [making Asteroid Hunters] is that the asteroid belt is a planet that never came to be because of this big gravitational bully called Jupiter. It jealously prevented a planet from ever taking shape because of its gravitational influences on planetesimals, which is what asteroids are. They're the leftover materials of construction of the planets of the solar system. The big gap between Mars and Jupiter is because of Jupiter's huge influence. It was the first planet to form, and it's the biggest. It kept things stirred up, gravitationally speaking, in that area, so the asteroids were never given a chance to come together and form a planet.

Then over the four-and-a-half billion years, most of the asteroids have either been sent packing outside of the solar system or sent inward, where they become impactors of the Moon and the Earth, not to mention Venus, Mercury, and Mars. Some also fall into the Sun. The asteroid belt today is maybe 1 percent of what it used to be. All of this stuff, it's a big ammo belt, just being flung outward and inward over the course of the eons.

It's an exciting time in **asteroid exploration**, with Hayabusa2 and OSIRIS-REx bringing asteroid samples back to Earth. Any thoughts **on these missions?**

Groves: They'll help us get an understanding of **the construction** of our solar system and maybe even the formation of life itself. A lot of these asteroids carry with them organic compounds. You want to know: Did they bring water to Earth and Mars and perhaps other planets?

What's also interesting about OSIRIS-REx is the asteroid it's investigating, Bennu, is one of these potentially hazardous asteroids I was referencing earlier. It's going to pass close to Earth in 2035. It's not going to hit then, but Earth's gravity could have some influence on its orbit around the Sun. After that, Bennu may become a real risk to our planet, and it's a pretty big asteroid. It’s about 500 meters across, more than 1,500 feet.

The images of Bennu are amazing. It's a diamond-shaped hunk of gravel.

Groves: It's a rubble pile, and **knowing that is an** important aspect of planetary defense. How you would mitigate the threat could depend on your understanding of the asteroid structure. Is it mostly metallic, like a big cannon ball? Or is it a rubble pile, where if you whack it too hard, it'll break apart? Then you'd have a pile of buckshot, which could be just as bad.

#### Core to deflection—poorly planned deflection makes collision more likely

**Andrews 21** (Robin George Andrews is a volcanologist and science writer based in London. His upcoming book Super Volcanoes: What They Reveal about Earth and the Worlds Beyond will be released in November 2021.“NASA’s DART Mission Could Help Cancel an Asteroid Apocalypse” <https://www.scientificamerican.com/article/nasas-dart-mission-could-help-cancel-an-asteroid-apocalypse/> November 18, 2021)DR 22

Mission planners are reasonably confident that DART’s hushed demise will successfully convey a billiardlike kick to Dimorphos, which seems hefty enough to be sufficiently squeezed by gravity’s clutches. But in the case of a slightly less substantial object, a kinetic impactor could just shoot right through, like a bullet through a cake, blowing it into small but still dangerous chunks. A successful deflection for such threats could require multiple, more gentle impacts rather than a one-and-done wallop.

Another huge unknown is Dimorphos’s appearance. It could be shaped like a potato, a dog bone, a rubber duck, [two bowling balls stuck together](https://www.scientificamerican.com/article/new-horizons-may-have-solved-planet-formation-cold-case/), or something else entirely. A colleague recently gifted Adams a donut-shaped fridge magnet, a wink to how often asteroids surprise scientists once unveiled up close by some deep-space robotic emissary. A near-spherical or even potatolike shape would be optimal for a clean hit, whereas the uneven distribution of mass from more **complex morphologies** would raise the chance of a glancing blow, one that could just “spin up the moonlet and not actually change its orbit,” says Olivier de Weck, a systems engineering researcher at the Massachusetts Institute of Technology.

In the specific and benign case of Dimorphos, all these uncertainties are mostly academic. But in the event of a deflection attempt for a true city-killer, they could prove critical. We could, for instance, **successfully deflect** a potentially hazardous asteroid only to inadvertently put it on a new orbit that makes it more likely to hit Earth in the long run. There are points in space around our planet known as gravitational keyholes, wherein Earth’s pull on the asteroid sets the errant space rock on an assuredly destructive journey. “Once you go through a keyhole, the probability of hitting the Earth is virtually 100 percent,” says de Weck. This, to put it mildly, constitutes a major hurdle for any preemptive strikes against nascent impact threats.

FOREWARNED IS FOREARMED

The emerging calculus is formidable indeed: Protecting ourselves from the most numerous and tricky (and thus most dangerous) space rocks requires more than making shots in the dark, especially when each “shot” is a multimillion-dollar deflection attempt. Ensuring **success** requires first scouting out the threat to learn any given space rock’s exact mass and ability to absorb a weighty impact.

Some of that work [can be done from Earth](https://www.scientificamerican.com/article/are-we-doing-enough-to-protect-earth-from-asteroids/), but as Dimorphos is deviously demonstrating, **tiny objects** are hard targets for remote studies. It is far better—albeit more difficult—to get up close and personal with any adversarial asteroid before trying to hit it at all. This was, in fact, ESA’s original plan, before schedule slips ensured that its reconnaissance spacecraft would arrive only after DART’s dramatic impact. In the future, miniaturized kinetic impactors could even be sent alongside scientific scouting missions, meant to merely nudge target asteroids to estimate how they would respond to more powerful deflective blows. “We have to go and characterize them better **before** we rest humanity’s fate in that one golden shot,” de Weck says.

#### Asteroid collisions cause extinction and nuclear miscalc

Baum 19 (Executive director of the Global Catastrophic Risk Institute, “Risk-Risk Tradeoff Analysis of Nuclear Explosives for Asteroid Deflection,” *Risk Analysis*, vol. 39, no. 11 (November 2019), p.2427-2442)DR 22

The most severe asteroid collisions and nuclear wars can cause global environmental effects. The core mechanism is the transport of particulate matter into the stratosphere, where it can spread worldwide and remain aloft for years or decades. Large asteroid collisions create large quantities of dust and large fireballs; the fire heats the dust so that some portion of it rises into the stratosphere. The largest collisions, such as the 10km Chicxulub impactor, can also eject debris from the collision site into space; upon reentry into the atmosphere, the debris heats up enough to spark global fires (Toon, Zahnle, Morrison, Turco, & Covey, 1997). The fires are a major impact in their own right and can send additional smoke into the stratosphere. For nuclear explosions, there is also a fireball and smoke, in this case from the burning of cities or other military targets.

While in the stratosphere, the particulate matter blocks sunlight and destroys ozone (Toon et al., 2007). The ozone loss increases the amount of ultraviolet radiation reaching the surface, causing skin cancer and other harms (Mills, Toon, Turco, Kinnison, & Garcia, 2008). The blocked sunlight causes abrupt cooling of Earth’s surface and in turn reduced precipitation due to a weakened hydrological cycle. The cool, dry, and dark conditions reduce plant growth. Recent studies use modern climate and crop models to examine the effects for a hypothetical India Pakistan nuclear war scenario with 100 weapons (50 per side) each of 15KT yield. The studies find **ag**riculture declines in the range of approximately 2% to 50% depending on the crop and location.11 Another study compares the crop data to existing poverty and malnourishment and estimates that the crop declines could threaten starvation for two billion people (Helfand, 2013). However, the aforementioned studies do not account for new nuclear explosion fire simulations that find approximately five times less particulate matter reaching the stratosphere, and correspondingly weaker global environmental effects (Reisner et al., 2018). Note also that the 100 weapon scenario used in these studies is not the largest potential scenario. Larger nuclear wars and large asteroid collisions could cause greater harm. The largest asteroid collisions could even **reduce sunlight below the minimum needed for vision** (Toon et al., 1997). Asteroid risk analyses have proposed that the global environmental disruption from large collisions could cause one billion deaths (NRC, 2010) or the death of 25% of all humans (Chapman, 2004; Chapman & Morrison, 1994; Morrison, 1992), though these figures have not been rigorously justified (Baum, 2018a).

The harms from asteroid collisions and nuclear wars can also include important secondary effects. The **food shortages** from severe global environmental disruption could lead to infectious disease outbreaks as public health conditions deteriorate (Helfand, 2013). Law and order could be lost in at least some locations as people struggle for survival (Maher & Baum, 2013). Today’s complex global political-economic system already shows fragility to shocks such as the 2007- 2008 financial crisis (Centeno, Nag, Patterson, Shaver, & Windawi, 2015); an asteroid collision or nuclear war could be an extremely large shock. The systemic consequences of a nuclear war would be further worsened by the likely loss of major world cities that serve as important hubs in the global economy. Even a single detonation in nuclear terrorism would have ripple effects across the global political-economic system (similar to, but likely larger than, the response prompted by the terrorist attacks of 11 September 2001).

It is possible for asteroid collisions to cause nuclear war. An asteroid explosion could be misinterpreted as a **nuclear attack**, prompting nuclear attack that is believed to be retaliation. For example, the 2013 Chelyabinsk event occurred near an important Russian military installation, prompting concerns about the event’s interpretation (Harris et al., 2015)

#### 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) reject 1AR theory since it can’t be a legitimate check for abuse, b) drop the arg to minimize the chance the round is decided unfairly, c) 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

### Case

#### Tech innovation undergirded by profit motives are driving the Second Machine Age, which dematerializes capitalism and makes growth a sustainable necessity

This ev is v v v long but it’s amazing – answers basically every aff arg

McAfee, 19—cofounder and codirector of the MIT Initiative on the Digital Economy at the MIT Sloan School of Management, former professor at Harvard Business School and fellow at Harvard’s Berkman Center for Internet and Society (Andrew, “Looking Ahead: The World Cleanses Itself This Way,” *More from Less: The Surprising Story of How We Learned to Prosper Using Fewer Resources—and What Happens Next*, Chapter 14, pg 278-292, Kindle, dml)

The decreases in resource use, pollution, and other exploitations of the earth cataloged in the preceding chapters are great news. But are they going to last? It could be that we're just living in a pleasant interlude between the Industrial Era and another rapacious period during which we massively increase our footprint on our planet and eventually cause a giant Malthusian crash.

It could be, but I don't think so. Instead, I think we're going to take better care of our planet from now on. I'm confident that the Second Machine Age will mark the time in our history when we started to progressively and permanently tread more lightly on the earth, taking less from it and generally caring for it better, even as we humans continue to become more numerous and prosperous. The work of Paul Romer, who shared the 2018 Nobel Prize in economics, is one of the sources of this confidence.

Growth Mindset

Romer's largest contribution to economics was to show that it's best not to think of new technologies as something that companies buy and bring in from the outside, but instead as something they create themselves (the title of his most famous paper, published in 1990, is "Endogenous Technological Change"). These technologies are like designs or recipes; as Romer put it, they’re "the instructions that we follow for combining raw materials." This is close to the definitions of technology presented in chapter 7.

Why do companies invent and improve technologies? Simply, to generate profits. They come up with instructions, recipes, and blueprints that will let them grow revenues or shrink costs. As we saw repeatedly in chapter 7, capitalism provides ample incentive for this kind of tech progress.

So far, all this seems like a pretty standard argument for how the first two horsemen work together. Romer's brilliance was to highlight the importance of two key attributes of the technological ideas companies come up with as they pursue profits. The first is that they're nonrival, meaning that they can be used by more than one person or company at a time, and that they don't get used up. This is obviously not the case for most resources made out of atoms—I can't also use the pound of steel that you've just incorporated into the engine of a car—but it is the case for ideas and instructions. The Pythagorean theorem, a design for a steam engine, and a recipe for delicious chocolate chip cookies aren't ever going to get "used up" no matter how much they're used.

The second important aspect of corporate technologies is that they're partially excludable. This means that companies can kind of prevent others from using them. They do this by keeping the technologies secret (such as the exact recipe for Coca-Cola), filing for patents and other intellectual-property protection, and so on. However, none of these measures is perfect (hence the words partially and kind of). Trade secrets leak. Patents expire, and even before they expire, they must describe the invention they're claiming and so let others study it.

Partial excludability is a beautiful thing. It provides strong incentives for companies to create useful, profit-enhancing new technologies that they alone can benefit from for a time, yet it also ensures that the new techs will eventually "spill over"—that with time they’ll diffuse and get adopted by more and more companies, even if that's not what their originators want.

Romer equated tech progress to the production by companies of nonrivalrous, partially excludable ideas and showed that these ideas cause an economy to grow. What's more, he also demonstrated that this idea-fueled growth doesn't have to slow down with time. It's not constrained by the size of the labor force, the amount of natural resources, or other such factors. Instead, economic growth is limited only by the idea-generating capacity of the people within a market. Romer called this capacity "human capital" and said at the end of his 1990 paper, "The most interesting positive implication of the model is that an economy with a larger total stock of human capital will experience faster growth."

This notion, which has come to be called "increasing returns to scale," is as powerful as it is counterintuitive. Most formal models of economic growth, as well as the informal mental ones most of us walk around with, feature decreasing returns—growth slows down as the overall economy gets bigger. This makes intuitive sense; it just feels like it would be easier to experience 5 percent growth in a $1 billion economy than a $1 trillion one. But Romer showed that as long as that economy continued to add to its human capital—the overall ability of its people to come up with new technologies and put them to use—it could actually grow faster even as it grew bigger. This is because the stock of useful, nonrivalrous, nonexcludable ideas would keep growing. As Romer convincingly showed, economies run and grow on ideas.

The Machinery of Prosperity

Romer's ideas should leave us optimistic about the planetary benefits of digital tools—hardware, software, and networks—for three main reasons. First, countless examples show us how good these tools are at fulfilling the central role of technology, which is to provide "instructions that we follow for combining raw materials." Since raw materials cost money, profit-maximizing companies are particularly keen to find ways to use fewer of them. So they use digital tools to come up with beer cans that use less aluminum, car engines that use less steel and less gas, mapping software that removes the need for paper atlases, and so on and so on. None of this is done solely for the good of the earth—it's done for the pursuit of profit that's at the heart of capitalism—yet it benefits the planet by, as we've seen, causing us to take less from it.

Digital tools are technologies for creating technologies, the most prolific and versatile ones we've ever come up with. They're machines for coming up with ideas. Lots of them. The same piece of computer-aided design software can be used to create a thinner aluminum can or a lighter and more fuel-efficient engine. A drone can be used to scan farmland to see if more irrigation is needed, or to substitute for a helicopter when filming a movie. A smartphone can be used to read the news, listen to music, and pay for things, all without consuming a single extra molecule.

In the Second Machine Age, the global stock of digital tools is increasing much more quickly than ever before. It's being used in countless ways by profit-hungry companies to combine raw materials in ways that use fewer of them. In advanced economies such as America's, the cumulative impact of this combination of capitalism and tech progress is clear: absolute dematerialization of the economy and society, and thus a smaller footprint on our planet.

The second way Romer's ideas about technology and growth are showing up at present is via decreased excludability. Pervasive digital tools are making it much easier for good designs and recipes to spread around the world. While this is often not what a company wants—it wants to exclude others from its great cost-saving idea— excludability is not as easy as it used to be.

This isn't because of weaker patent protection, but instead because of stronger digital tools. Once one company shows what's possible, others use hardware, software, and networks to catch up to the leader. Even if they can't copy exactly because of intellectual-property restrictions, they can use digital tools to explore other means to the same end. So, many farmers learn to get higher yields while using less water and fertilizer, even though they combine these raw materials in different ways. Steve Jobs would certainly have preferred for Apple to be the only provider of smartphones after it developed the iPhone, but he couldn't maintain the monopoly no matter how many patents and lawsuits he filed. Other companies found ways to combine processors, memory, sensors, a touch screen, and software into phones that satisfied billions of customers around the world.

The operating system that powers most non-Apple smartphones is Android, which is both free to use and freely modifiable. Google's parent company, Alphabet, developed and released Android without even trying to make it excludable; the explicit goal was to make it as widely imitable as possible. This is an example of the broad trend across digital industries of giving away valuable technologies for free.

The Linux operating system, of which Android is a descendant, is probably the best-known example of free and open-source software, but there are many others. The online software repository GitHub maintains that it's "the largest open source community in the world" and hosts millions of projects. The Arduino community does something similar for electronic hardware, and the Instructables website contains detailed instructions for making equipment ranging from air-particle counters to machine tools, all with no intellectual-property protection. Contributors to efforts such as these have a range of motivations (Alphabet's goals with Android were far from purely altruistic—among other things, the parent of Google wanted to achieve a quantum leap in mobile phone users around the world, who would avail themselves of Google Search and services such as YouTube), but they're all part of the trend of technology without excludability, which is great news for growth.

As we saw in chapter 10, smartphone use and access to the Internet are increasing quickly across the planet. This means that people no longer need to be near a decent library or school to gain knowledge and improve their abilities. Globally, people are taking advantage of the skill-building opportunities of new technologies. This is the third reason that the spread of digital tools should make us optimistic about future growth: these tools are helping human capital grow quickly.

The free Duolingo app, for example, is now the world's most popular way to learn a second language. Of the nearly 15 billion Wikipedia page views during July of 2018, half were in languages other than English. Google's chief economist, Hal Varian, points out that hundreds of millions of how-to videos are viewed every day on YouTube, saying, "We never had a technology before that could educate such a broad group of people anytime on an as-needed basis for free."

Romer's work leaves me hopeful because it shows that it's our ability to build human capital, rather than chop down forests, dig mines, or burn fossil fuels that drives growth and prosperity. His model of how economies grow also reinforces how well capitalism and tech progress work together, which is a central point of this book. The surest way to boost profits is to cut costs, and modern technologies, especially digital ones, offer unlimited ways to combine and recombine materials—to swap, slim, optimize, and evaporate—in cost-reducing ways. There's no reason to expect that the two horsemen of capitalism and tech progress will stop riding together anytime soon. Quite the contrary. Romer's insights reveal that they're likely to gallop faster and farther as economies grow.

Our Brighter, Lighter Future

The world still has billions of desperately poor people, but they won't remain that way. All available evidence strongly suggests that most will become much wealthier in the years and decades ahead. As they earn more and consume more, what will be the impact on the planet?

The history and economics of the Industrial Era lead to pessimism on this important question. Resource use increased in lockstep with economic growth throughout the two centuries between James Watt's demonstration of his steam engine and the first Earth Day. Malthus and Jevons seemed to be right, and it was just a question of when, not if, we'd run up against the hard planetary limits to growth.

But in America and other rich countries something strange, unexpected, and wonderful happened: we started getting more from less. We decoupled population and economic growth from resource consumption, pollution, and other environmental harms. Malthus's and Jevons's ideas gave way to Romer's, and the world will never be the same.

This means that instead of worrying about the world's poor becoming richer, we should instead be helping them upgrade economically as much and as quickly as possible. Not only is it the morally correct thing to do, it's also the smart move for our planet. As today’s poor countries get richer, their institutions will improve and most will eventually go through what Ricardo Hausmann calls "the capitalist makeover of production." This makeover doesn't enslave people, nor does it befoul the earth.

As today’s poor get richer, they'll consume more, but they'll also consume much differently from earlier generations. They won't read physical newspapers and magazines. They'll get a great deal of their power from renewables and (one hopes) nuclear because these energy sources will be the cheapest. They’ll live in cities, as we saw in chapter 12; in fact, they already are. They'll be less likely to own cars because a variety of transportation options will be only a few taps away. Most important, they'll come up with ideas that keep the growth going, and that benefit both humanity and the planet we live on.

Predicting exactly how technological progress will unfold is much like predicting the weather: feasible in the short term, but impossible over a longer time. Great uncertainty and complexity prevent precise forecasts about, for example, the computing devices we’ll be using thirty years from now or the dominant types of artificial intelligence in 2050 and beyond.

But even though we can't predict the weather long term, we can accurately forecast the climate. We know how much warmer and sunnier it will be on average in August than in January, for example, and we know that global average temperatures will rise as we keep adding greenhouse gases to the atmosphere. Similarly, we can predict the "climate" of future technological progress by starting from the knowledge that it will be heavily applied in the areas where it can affect capitalism the most. As we've seen over and over, tech progress supplies opportunities to trim costs (and improve performance) via dematerialization, and capitalism provides the motive to do so.

As a result, the Second Enlightenment will continue as we move deeper into the twenty-first century. I'm confident that it will accelerate as digital technologies continue to improve and multiply and global competition continues to increase. We’ll see some of the most striking examples of slim, swap, evaporate, and optimize in exactly the places where the opportunities are biggest. Here are a few broad predictions, spanning humanity's biggest industries.

Manufacturing. Complex parts will be made not by the techniques developed during the Industrial Era, but instead by three- dimensional printing. This is already the case for some rocket engines and other extremely expensive items. As 3-D printing improves and becomes cheaper, it will spread to automobile engine blocks, manifolds and other complicated arrangements of pipes, airplane struts and wings, and countless other parts. Because 3-D printing generates virtually no waste and doesn't require massive molds, it accelerates dematerialization.

We'll also be building things out of very different materials from what we're using today. We're rapidly improving our ability to use machine learning and massive amounts of computing power to screen the huge number of molecules available in the world. Well use this ability to determine which substances would be best for making flexible solar panels, more efficient batteries, and other important equipment. Our search for the right materials to use has so far been slow and laborious. That's about to change.

So is our ability to understand nature's proteins, and to generate new ones. All living things are made out of the large biomolecules known as proteins, as are wondrous materials such as spiders' silk. The cells in our bodies are assembly lines for proteins, but we currently understand little about how these assembly lines work—how they fold a two-dimensional string of amino acids into a complicated 3-D protein. But thanks to digital tools, we're learning quickly. In 2018, as part of a contest, the AlphaFold software developed by Google DeepMind correctly guessed the structure of twenty-five out of forty-three proteins it was shown; the second-place finisher guessed correctly three times. DeepMind cofounder Demis Hassabis says, "We [haven't] solved the protein-folding problem, this is just a first step... but we have a good system and we have a ton of ideas we haven't implemented yet." As these good ideas accumulate, they might well let us make spider-strength materials.

Energy. One of humanity's most urgent tasks in the twenty-first century is to reduce greenhouse gas emissions. Two ways to do this are to become more efficient in using energy and, when generating it, to shift away from carbon-emitting fossil fuels. Digital tools will help greatly with both.

Several groups have recently shown that they can combine machine learning and other techniques to increase the energy efficiency of data centers by as much as 30 percent. This large improvement matters for two reasons. First, data centers are heavy users of energy, accounting for about 1 percent of global electricity demand. So efficiencies in these facilities help. Second, and more important, these gains indicate how much the energy use of all our other complicated infrastructures— everything from electricity grids to chemical plants to steel mills—can be trimmed. All are a great deal less energy efficient than they could be. We have both ample opportunity and ample incentive now to improve them.

Both wind and solar power are becoming much cheaper, so much so that in many parts of the world they're now the most cost-effective options, even without government subsidies, for new electrical generators. These energy sources use virtually no resources once they're up and running and generate no greenhouse gases; they're among the world champions of dematerialization.

In the decades to come they might well be joined by nuclear fusion, the astonishingly powerful process that takes place inside the sun and other stars. Harnessing fusion has been tantalizingly out of reach for more than half a century—the old joke is that it's twenty years away and always will be. A big part of the problem is that it's hard to control the fusion reaction inside any human- made vessel, but massive improvements in sensors and computing power are boosting hope that fusion power might truly be only a generation away.

Transportation. Our current transportation systems are chronically inefficient. Most vehicles aren't used much of the time, and even when they’re in use, they're not nearly full. Now that we have technologies that let us know where every driver, passenger, piece of cargo, and vehicle is at all times, we can greatly increase the utilization and efficiency of every element of transportation.

Renting instead of owning transportation is a likely consequence of this shift. Instead of owning cars, which typically sit idle more than 90 percent of the time, more people will choose to access transportation as needed. We're already seeing this with car-hailing companies such as Uber and Lyft. These services are quickly spreading around the world, and expanding to cover more modes of transportation, from motorbikes to bicycles to electric scooters. They're also moving into commercial applications such as long- and short-haul trucking. As this shift continues, we’ll need fewer tons of steel, aluminum, plastic, gasoline, and other resources to move the world's people and goods around.

We might also experience less congestion and gridlock as we try to get around. Bikes and scooters take up little space compared to cars, so streets can accommodate many more of them. Technology also gives us the ability to implement many forms of "congestion pricing," which has been shown to reduce gridlock by making car access to busy streets expensive enough that people use other options. The most intriguing future transportation platform of all might be the sky. The same technologies that power today's small drones can be scaled up to build "air taxis" with as many as eight propellers and no pilot. Such contraptions sound like science fiction today, but they might be carrying us around by midcentury.

Agriculture. As we saw in chapter 5, leading farms have demonstrated an ability to increase their tonnage of output year after year while decreasing their use of inputs such as land, water, and fertilizer. This trend toward optimization will continue thanks to a set of innovations under the label precision agriculture. The precision comes from many sources, including better sensors of plant and animal health, soil quality and moisture, and so on; the ability to deliver fertilizer, pesticides, and water just where they're needed; and machinery that adapts itself to each plant or animal. All these varieties of precision will combine to allow traditional farms to generate more from less.

So will changes to the genomes of plants and animals. DNA modifications will increase disease and drought tolerance, expand where crops can be grown, and allow us to get more of what we want from each crop or herd. As we saw in chapter 9, they'll also allow us to take better care of vulnerable populations such as infants in poor countries by creating golden rice and other nutrition enhancers. We'll also be able to make much more precise and targeted genetic modifications thanks to a new crop of gene-editing tools that are large improvements over their more scattershot predecessors. Opposition to genetically modified organisms is fierce in some quarters, but isn't based on reason or science. This opposition will, one hopes, fade.

Throughout human history, just about all farming has been done in fields. For some crops, this is now changing. Agriculture has moved indoors, where parameters such as light, humidity, fertilizer, and even the composition of the atmosphere can be precisely monitored and controlled. In everything from urban buildings to shipping containers, crops are now being grown with progressively less labor and fewer material inputs. These completely contained farms will spread and help reduce the planetary footprint of our agriculture.

These examples aren't intended to be comprehensive, and I don't have precise estimates of how likely each innovation is, or when it's most likely to occur. I offer them only to indicate how broad and exciting are the possibilities offered by the two horsemen of capitalism and technological progress, and how they’ll continue to dematerialize our consumption and let us increase our prosperity while treading more lightly on our planet.

#### Globalization and economic growth are the only ethical systems supported by empirical evidence.

Economist 16—[“Why they’re wrong,” *The Economist*, 2016, <http://www.economist.com/news/leaders/21707926-globalisations-critics-say-it-benefits-only-elite-fact-less-open-world-would-hurt>, accessed 4 Dec 2016]

The backlash against trade is just one symptom of a pervasive anxiety about the effects of open economies. Britain’s Brexit vote reflected concerns about the impact of unfettered migration on public services, jobs and culture. Big businesses are slammed for using foreign boltholes to dodge taxes. Such critiques contain some truth: more must be done to help those who lose out from openness. But there is a world of difference between improving globalisation and reversing it. The idea that globalisation is a scam that benefits only corporations and the rich could scarcely be more wrong.

The real pro-poor policy

Exhibit A is the vast improvement in global living standards in the decades after the second world war, which was underpinned by an explosion in world trade. Exports of goods rose from 8% of world GDP in 1950 to almost 20% a half-century later. Export-led growth and foreign investment have dragged hundreds of millions out of poverty in China, and transformed economies from Ireland to South Korea.

Plainly, Western voters are not much comforted by this extraordinary transformation in the fortunes of emerging markets. But at home, too, the overall benefits of free trade are unarguable. Exporting firms are more productive and pay higher wages than those that serve only the domestic market. Half of America’s exports go to countries with which it has a free-trade deal, even though their economies account for less than a tenth of global GDP.

Protectionism, by contrast, hurts consumers and does little for workers. The worst-off benefit far more from trade than the rich. A study of 40 countries found that the richest consumers would lose 28 [percent] of their purchasing power if cross-border trade ended; but those in the bottom tenth would lose 63 [percent]. The annual cost to American consumers of switching to non-Chinese tyres after Barack Obama slapped on anti-dumping tariffs in 2009 was around $1.1 billion, according to the Peterson Institute for International Economics. That amounts to over $900,000 for each of the 1,200 jobs that were “saved”.

Openness delivers other benefits. Migrants improve not just their own lives but the economies of host countries: European immigrants who arrived in Britain since 2000 have been net contributors to the exchequer, adding more than £20 billion ($34 billion) to the public finances between 2001 and 2011. Foreign direct investment delivers competition, technology, management know-how and jobs, which is why China’s overly cautious moves to encourage FDI disappoint (see article).

What have you done for me lately?

None of this is to deny that globalisation has its flaws. Since the 1840s advocates of free trade have known that, though the great majority benefit, some lose out. Too little has been done to help these people. Perhaps a fifth of the 6m or so net job losses in American manufacturing between 1999 and 2011 stemmed from Chinese competition; many of those who lost jobs did not find new ones. With hindsight, politicians in Britain were too blithe about the pressures that migration from new EU member states in eastern Europe brought to bear on public services. And although there are no street protests about the speed and fickleness in the tides of short-term capital, its ebb and flow across borders have often proved damaging, not least in the euro zone’s debt-ridden countries.

As our special report this week argues, more must be done to tackle these downsides. America spends a paltry 0.1% of its GDP, one-sixth of the rich-country average, on policies to retrain workers and help them find new jobs. In this context, it is lamentable that neither Mr Trump nor Mrs Clinton offers policies to help those whose jobs have been affected by trade or cheaper technology. On migration, it makes sense to follow the example of Denmark and link local-government revenues to the number of incomers, so that strains on schools, hospitals and housing can be eased. Many see the rules that bind signatories to trade pacts as an affront to democracy. But there are ways that shared rules can enhance national autonomy. Harmonising norms on how multinational firms are taxed would give countries greater command over their public finances. A co-ordinated approach to curbing volatile capital flows would restore mastery over national monetary policy.

These are the sensible responses to the peddlers of protectionism and nativism. The worst answer would be for countries to turn their backs on globalisation. The case for openness remains much the same as it did when this newspaper was founded to support the repeal of the Corn Laws. There are more—and more varied—opportunities in open economies than in closed ones. And, in general, greater opportunity makes people better off. Since the 1840s, free-traders have believed that closed economies favour the powerful and hurt the labouring classes. They were right then. They are right now.

#### No limits to growth---their models ignore key feedback effects.

Lynch 16—President of Strategic Energy and Economic Consulting, Director of Asian Energy and Security at the Center for International Studies at MIT, and a Lecturer at Tufts and Vienna University [Michael, *The “peak oil” scare and the coming oil flood*, p. 63-74]

More recently, there has been a clamor about "peak everything" based on the idea that, well, everything is finite and we 're using it up, so it is "running out." Or at least, production must peak. Or, as one physicist [END OF PAGE 63] points out, eventually human energy production will generate as much heat as the sun does-eventually being 1400 years.

Flat Earth

Colin Campbell, in the famed (well, famous in the IEA's offices) debate at the IEA in 1997, compared resource optimists to the conservative Spanish court that opposed the visionary, Columbus, and has since referred to those, like Adelman and me, who disagreed with him as "flat-earth economists." Albert Bartlett later explained that the term actually meant that economists thought the earth had two dimensions and thus was infinite, containing equivalently infinite resources.

But this description ignores two important variables: capital and knowledge. Additional investment can often increase the production of renewables like agricultural products and nonrenewables like minerals and oil in the same amount of space, as can better technology. Neo-Malthusians tend to ignore this factor and argue that the rate of technological advance (and greater scientific knowledge) has diminished or disappeared, as described in Chapter 7.

The argument is somewhat specious and relies in part the question of the finiteness of resources, discussed earlier-or a static measure of resources and dynamic view of consumption, as in The Limits to Growth.

HOW LONG?

Perhaps the most important factor that raises skepticism is the fact that at least some exponential alarmists fear the distant future. Any number of pundits have looked at long-term forecasts of economic and/or technological development and characterized them as foolish. We have no flying cars, nuclear power is not too cheap to meter, and no one is eating Soylent Green. On the other hand, most of these were not serious forecasting efforts, but rather off-the-cuff remarks (or the equivalent), and those making them were not particularly serious about achieving them within a specific time frame. And we do eat Soylent Green already; only we call it tofu and vegemite. (Read the book, it wasn't people.)

NEWTON'S FIRST LAW

The biggest mistakes have come from an apparent source: extrapolation of a trend endlessly, as if there were no feedback or other variables [END PAGE 64] involved. Jay Forrester, the inventor of Systems Dynamics, which was used in The Limits to Growth model (and which I have used), reportedly once said that feedback effects tend to overwhelm the initial stimuli, which is probably true in many cases. Yet, many neo-Malthusians and especially peak oil advocates tend to extrapolate a given trend endlessly, assuming no feedback effect whatsoever.

Indeed, the first wave of peak oil advocates explicitly argued that no feedback effect would occur: prices didn't affect production or consumption levels. Technological advances were either unimportant or had ceased and so could not increase the resource base.

An important element of the fear of exponential growth is the analysts' choice of particularly high growth rates. As Figure 4.1 showed, Ehrlich chose the highest observed growth in the 20th century for his calculations, even though it represented the post-World War II baby boom and should have been considered an exception, not the norm. Similarly, Bartlett, writing in 1998, talks about the growth in oil demand from the 1950s and 1960s at 7 [percent] a year, which causes a doubling of use every decade, 25 which sounds alarming, given the arguments about the difficulty of making a speedy energy transition, until you realize that consumption growth dropped to 3% per year in the 1970s (a doubling time of 24 years), and under 1 [percent] per year in the 1980s (a doubling period of 75 years), before recovering to 1.5% in the seven years before his talk (48 years).

This emphasizes the lack of feedback mechanism used in these simplistic models and how important they are in the real world.

REAL SCARCITY

Indeed, the subtext of the fear of resource scarcity is that renewable resources have repeatedly been the source of problems. In Tainter's The Collapse of Complex Societies, he talks about resources as causing the fall of a number of (mostly) ancient civilizations; nearly all suffered from problems like lengthy droughts and salt buildup in irrigated farmland. 26

And similar problems continue today, especially if you consider endangered species, from rhinos to tuna. In all cases, these are renewable resources, the very ones that are NOT finite, that are sustainable, that we can rely on for all eternity-in theory. No lasting shortage of nonrenewable resources minerals and energy-has occurred since the advent of the global economy.

#### It's try or die for CCS - only way to stay below 2 degrees but it requires growth and innovation

Sognnaes and Peters 20 [Ida Sognnaes is a senior researcher. Glen Peters is a research director] “Carbon Capture and Storage is necessary to keep global warming below 2C,” Cicero Oslo, January 14, 2020, <https://cicero.oslo.no/no/posts/nyheter/carbon-capture-and-storage-is-necessary-to-keep-global-warming-below-2c> TG

Scenarios indicate that Carbon Capture and Storage (CCS) is critical to meet the Paris Agreement’s goal of limiting global warming to ‘well below 2°C’. But, at what scale?

Achieving the Paris Agreement’s goal of limiting global warming to ‘well below 2°C above preindustrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels’ necessitates rapid reductions in greenhouse gas emissions.

There are now hundreds of emission scenarios showing different evolutions of the energy system consistent with the goals of the Paris Agreement. CCS plays a crucial role in nearly all these emission scenarios.

There is a physical reason why CCS is crucial. CO2 emissions have a cumulative effect on the climate, and therefore CO2 emissions [must be net-zero](https://cicero.oslo.no/no/posts/klima/beyond-carbon-budgets)to stop temperatures from increasing further. CCS helps achieve net-zero emissions in two ways:

1. To help reduce direct emissions from the burning of fossil fuels or from industrial processes, and
2. To help create negative emissions, such as in combination with bioenergy (BECCS), direct air capture, or other technologies to remove CO2 from the atmosphere.

Nearly all emissions scenarios use CCS in both these ways, and sometimes at a [troubling scale](https://science.sciencemag.org/content/354/6309/182).

The following figure highlights this.

CCS is used to help reduce emissions from fossil fuel use, which happens in addition to conventional mitigation, such as consuming less energy, deploying solar, or using electric vehicles, But, most scenarios are not able to get fossil emissions completely to zero, or find it too expensive, and end with ‘residual emissions’ (brown in the figure above).

To get to net-zero emissions, the [residual emissions](https://www.nature.com/articles/s41558-018-0198-6) must be [counteracted](https://cicero.oslo.no/no/posts/nyheter/carbon-capture-and-storage-is-necessary-to-keep-global-warming-below-2c) by [CO2 removal](https://www.mcc-berlin.net/en/research/policy-briefs/negativeemissions.html) to achieve net zero emissions (dark green). Most models do this with afforestation or bioenergy with CCS (BECCS). Non-CO2 greenhouse gas emissions (such as methane) add to the residual emissions (not shown).

Further CO2 removal (light green), are used to bring temperatures down after peaking. The temperature is a maximum when the net emissions reach zero (black line), but then the temperature declines with net negative emissions to bring the temperature down from its peak to safer levels by 2100.

#### Economic decline causes nuclear war.

Tønnesson 15—Research Professor at the Peace Research Institute Oslo; Leader of East Asia Peace program, Uppsala University [Stein, “Deterrence, interdependence and Sino–US peace,” International Area Studies Review, 2015, Vol. 18, No. 3, p. 297-311]

Several recent works on China and Sino–US relations have made substantial contributions to the current understanding of how and under what circumstances a combination of nuclear deterrence and economic interdependence may reduce the risk of war between major powers. At least four conclusions can be drawn from the review above: first, those who say that interdependence may both inhibit and drive conflict are right. Interdependence raises the cost of conflict for all sides but asymmetrical or unbalanced dependencies and negative trade expectations may generate tensions leading to trade wars among interdependent states that in turn increase the risk of military conflict (Copeland, 2015: 1, 14, 437; Roach, 2014). The risk may increase if one of the interdependent countries is governed by an inward-looking socio-economic coalition (Solingen, 2015); second, the risk of war between China and the US should not just be analysed bilaterally but include their allies and partners. Third party countries could drag China or the US into confrontation; third, in this context it is of some comfort that the three main economic powers in Northeast Asia (China, Japan and South Korea) are all deeply integrated economically through production networks within a global system of trade and finance (Ravenhill, 2014; Yoshimatsu, 2014: 576); and fourth, decisions for war and peace are taken by very few people, who act on the basis of their future expectations. International relations theory must be supplemented by foreign policy analysis in order to assess the value attributed by national decision-makers to economic development and their assessments of risks and opportunities. If leaders on either side of the Atlantic begin to seriously fear or anticipate their own nation’s decline then they may blame this on external dependence, appeal to anti-foreign sentiments, contemplate the use of force to gain respect or credibility, adopt protectionist policies, and ultimately refuse to be deterred by either nuclear arms or prospects of socioeconomic calamities. Such a dangerous shift could happen abruptly, i.e. under the instigation of actions by a third party – or against a third party.

Yet as long as there is both nuclear deterrence and interdependence, the tensions in East Asia are unlikely to escalate to war. As Chan (2013) says, all states in the region are aware that they cannot count on support from either China or the US if they make provocative moves. The greatest risk is not that a territorial dispute leads to war under present circumstances but that changes in the world economy alter those circumstances in ways that render inter-state peace more precarious. If China and the US fail to rebalance their financial and trading relations (Roach, 2014) then a trade war could result, interrupting transnational production networks, provoking social distress, and exacerbating nationalist emotions. This could have unforeseen consequences in the field of security, with nuclear deterrence remaining the only factor to protect the world from Armageddon, and unreliably so. Deterrence could lose its credibility: one of the two great powers might gamble that the other yield in a cyber-war or conventional limited war, or third party countries might engage in conflict with each other, with a view to obliging Washington or Beijing to intervene.

#### Neoliberal globalization reduce the frequency and severity of wars by a factor of ten.

Mooney 14 – Loren, Stanford Graduate School of Business, summarizing Matthew O. Jackson, the William D. Eberle Professor of Economics at Stanford, and earned his PhD in economics from Stanford GSB in 1988. (“Matthew O. Jackson: Can Trade Prevent War?” May 28, 2014https://www.gsb.stanford.edu/insights/matthew-o-jackson-can-trade-prevent-war)

While there is considerable existing research on the effects of trade and war, much of it has looked at bilateral relationships. This model focuses on multilateral interactions and considers various incentives for countries to attack, form alliances with, and trade with one another. In an attempt to understand what's necessary to achieve a stable network with no incentive for war, Jackson and Nei first explored an alliance scenario based solely on military defense considerations, excluding trade. "The fundamental difficulty we find is that alliances are costly to maintain if there's no economic incentive," says Jackson. So networks remain relatively sparse, a condition in which even a few shifting allegiances leaves some countries vulnerable to attack. "Stability is not just a little bit elusive; it's very elusive."

Economic trade, however, makes a significant difference. "Once you bring in trade, you see network structures densify," he says. Nations form a web of trading alliances, which creates financial incentive not only to keep peace with trading partners, but also to protect them from being attacked so as not to disrupt trade. "In the context of the alliances we have analyzed, trade motives are essential to avoiding wars and sustaining stable networks," the authors wrote in their paper, Networks of Military Alliances, Wars, and International Trade.

Their findings coincide with two major global trends since World War II: From 1950 to 2000, the incidence of interstate war has decreased nearly tenfold compared with the period from 1850 to 1949. At the same time, since 1950 international trade networks have increased nearly fourfold, becoming significantly more dense. "In the period before World War II, it was hard to find a stable set of alliances," says Jackson. The probability of a lasting alliance was about 60%. "You have almost a coin-flip chance that the alliance won't still be there in five years," he says. In Europe in the 1870s, for example, German chancellor Otto von Bismarck sought peace with "balance of power" diplomacy, which crumbled leading up to World War I. "Then in the past 50 years or so, there's been a surprising global stability." The impact of economic interdependence is especially apparent in Europe, Jackson says, where the Eurozone has promoted not only peace and increased trade among nations, but also labor mobility.

Very costly wars still occur, of course, but Jackson notes that the most war-torn places in recent history have tended to be those with fewer global trade alliances. For example, the Second Congo War from 1998 to 2003 and beyond, which killed more than four million people and is the deadliest war since World War II, involved eight African nations with relatively few trade ties. "Then look at the Kuwait situation," says Jackson, referring to U.S. intervention in the first Gulf War to protect oil supplies. "Economic interest drives a lot of what goes on in terms of where nations are willing to exercise military strength."

There are other real-world factors that have no doubt influenced war and trade trends since World War II, among them the proliferation of nuclear weapons — "Changing military technology can help maintain stable arrangements," says Jackson — the Cold War, an increase in worldwide wealth levels, and the introduction of container shipping in the 1960s, which has helped facilitate low-cost, long-range trade.

Still, Jackson and Nei's theoretical model suggests that trade alliances play a critical role. And in fact economic allies may be the most worth striving for in developing areas. "Maybe wars like the Second Congo War won't be occurring in the future if there's more trade with African nations," says Jackson. "Economic interests can really help us have a more peaceful world than we already have."