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#### Their ev says the WTO SHOULD combat climate change not that it will – giving it more influence won’t change its current agenda – Sage Reads Green

**AC Meyer 21** David Meyer [Senior writer at Fortune Magazine], June 18, 2021, "The WTO's survival hinges on the COVID-19 vaccine patent debate, waiver advocates warn," <https://fortune.com/2021/06/18/wto-covid-vaccines-patents-waiver-south-africa-trips/> // ash

Reforming the WTO also means looking forward to address challenges unimaginable in 1947 when countries signed the General Agreement on Tariffs and Trade, an international agreement that served as a precursor to the WTO. Chief among them is the warming planet and all of the attendant challenges. Climate change isn’t officially included as part of the WTO’s mandate, but the agency could take on outsized importance for the global climate agenda as a growing number of countries consider trade barriers for high-carbon products from countries without a comprehensive climate program.

#### Global trade and growth exacerbate warming

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As the previous chapters have shown, economic growth is regarded as a prime policy aim by policy makers and economists because it is thought to be essential for reducing poverty and generating rising living standards and stable levels of employment (Ben-Ami 2010: 19–20). More generally, support for economic growth is usually intertwined with advocating social progress based on scientific rationality and reason and hence with an optimistic view of humans’ ingenuity to solve problems (ibid.: 17, 20, Chap. 5). Growth criticism thus tends to be portrayed as anti-progress and inherently conservative (ibid.: Chap. 8). While it is important to acknowledge and discuss this view, it needs to be emphasised that growth criticism is formulated with long-term human welfare in mind which advocates alternative types of social progress (Barry 1998). This chapter first outlines ecological and social strands of growth critiques and then introduces relevant concepts of and positions within the postgrowth debate. Ecological Critiques of G rowth Generally speaking, two types of growth criticism can be distinguished: the first focuses on limitations of GDP as a measure of economic performance; the second goes beyond this by highlighting the inappropriateness of growth as the ultimate goal of economic activity and its negative implications for environment and society. Since GDP measures the monetary value of all final goods and services in an economy, it excludes the environmental costs generated by production. For instance, as long as there is no cost associated with emitting greenhouse gases , the cost for the environmental and social damage following from this is not reflected in GDP figures. Worse even, GDP increases as a consequence of some types of environmental damage: if deforestation and timber trade increase or if natural disasters or industrial accidents require expenditures for clean-up and reconstruction, GDP figures will rise (Douthwaite 1999: 18; Leipert 1986). Several critics of GDP as a measure of progress have proposed alternative indicators of welfare such as the Genuine Progress Indicator, Green GDPs or other approaches which factor in environmental costs (see Chap. 5 for more details), but they do not necessarily object to economic growth being the primary goal of economic activity (van den Bergh 2011). In contrast, the idea of ecological limits to growth goes beyond the critique of GDP as a measure of economic performance. Instead, it maintains that economic growth should not, and probably cannot, be the main goal of economic activity because it requires increasing resource inputs, some of which are non-renewable, and generates wastes, including greenhouse gases, that disturb various ecosystems, severely threatening human and planetary functioning in the short and long term. 4 CRITIQUES OF GROWTH 41 Resources are regarded as non-renewable if they cannot be naturally replaced at the rate of consumption (Daly and Farley 2011: 75–76). Examples include fossil fuels, earth minerals and metals, and some nuclear materials like uranium (Daly and Farley 2011: 77; Meadows et al. 2004: 87–107). Based on work by Georgescu-Roegen (1971), many ecological economists also assume that non-renewable resources cannot be fully recycled because they become degraded in the process of economic activity. Historically speaking, economic growth is a fairly recent phenomenon (Fig. 2.1). Since its onset in the late seventeenth century in Europe and mid-eighteenth century in the US (Gordon 2012), it has gone hand in hand with an exponentially increasing use of non-renewable resources such as fossil fuels (Fig. 4.1). While we are not yet close to running out of non-renewable resources, over time they will become more difficult and hence more expensive to recover. This idea is captured by the concept of “energy returned on energy invested” (EROEI). In relation to oil for instance, it has been shown that the easily recoverable fields have been targeted first and that therefore greater energy (and hence financial) inputs will be required to produce more oil. Over time, the ratio of energy returned on energy invested will decrease, reducing the financial incentive to invest further in the recovery of these non-renewable resources (Dale et al. 2011; Brandt et al. 2015: 2). Relevant to this is also the debate about peak oil—a concept coined by Shell Oil geologist Marion King Hubbert in the 1950s—the point at which the rate of global conventional oil production reaches its maximum which is expected to take place roughly once half of global oil reserves have been produced. There is still controversy about whether global peak oil will occur, and if so when, as it is difficult to predict, or get reliable data on, the rate at which alternative types of energy will replace oil (if this was to happen fast enough, peak oil might not be reached, if it has not yet occurred), the size of remaining oil reserves and the future efficiency of oil extraction technologies (Chapman 2014). However, it is plausible to assume that oil prices will rise in the long term if conventional oil availability diminishes, while global demand for oil increases with continuing economic and population growth. Since economic growth in the second half of the twentieth century required increasing inputs of conventional oil, higher oil prices would have a negative impact on growth unless alternative technologies are developed that can generate equivalent liquid fuels at lower prices (Murphy and Hall 2011). Some scholars have criticised the focus on physical/energy resource limitations as initially highlighted in the “limits to growth” debate (Meadows et al. 1972) and state that instead catastrophic climate change is likely to be a more serious and immanent threat to humanity (Schwartzman 2012). The main arguments here are first that much uncertainty remains about the potential and timing of peak oil, future availability of other fossil fuels and development of alternative low energy resources, while the impacts of climate change are already immanent and may accelerate within the very near future. Second, even if peaks in fossil fuel production occurred in the near future, remaining resources could still be exploited to their maximum. However, this would be devastating from a climate change perspective as, according to the latest IPCC scenarios, greenhouse gas emissions need to turn net-zero by the second half of this century for there to be a good chance to limit global warming to 2° Celsius (and ideally, below that) (Anderson and Peters 2016). It is telling that some of the more recent debates about ecological limits to growth put much more emphasis on environmental impacts of growth, rather than on peak oil or other resource limitations (Dietz and O’Neill 2013). Differently put, limits of sinks, especially to absorb greenhouse gases, and to the regeneration of vital ecosystems are now attracting greater concern, compared to limits of resources. Growing economic production generates increasing pressures on the environment due to pollution of air, water and soil, the destruction of natural habitats and landscapes, for instance, through deforestation and the extraction of natural resources. Therefore, growth often also threatens the regeneration of renewable resources such as healthy soil, freshwater and forests, as well as the functioning of vital ecosystems and ecosystems services such as the purification of air and water, water absorption and storage and the related mitigation of droughts and floods, decomposition and detoxification and absorption of wastes, pollination and pest control (Meadows et al. 2004: 83–84). Recent research on planetary boundaries has started to identify thresholds of environmental pollution or disturbance of a range of ecosystems services beyond which the functioning of human life on earth will be put at risk. Rockström and colleagues have identified nine such “planetary boundaries”—“climate change; rate of biodiversity loss (terrestrial and marine); interference with the nitrogen and phosphorus cycles; stratospheric ozone depletion; ocean acidification; global freshwater use; change in land use; chemical pollution; and atmospheric aerosol loading” (Rockström et al. 2009: 472). They also present evidence according to which three of these boundaries—climate change, rate of biodiversity loss and the nitrogen cycle—have already reached their limits (Rockström et al. 2009). Of those three thresholds, climate change has received most attention. The 5th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2014) concluded that global temperatures have risen by an average of 0.85° since the 1880s (while local temperature increases can be much higher than that) and that the concentration of greenhouse gases in the atmosphere has reached unprecedented levels over the last 800,000 years—that of CO2 has now reached 405.6 parts per million (NASA, January 2017, Fig. 4.2), far surpassing the level of 350 ppm which is considered safe by many scientists (Rockström et al. 2009). The IPCC report also maintained that humans very likely contributed to at least 50% of global warming that occurred since the 1950s (IPCC 2014: 5). A range of climate change impacts can already be observed, including a 26% increase of ocean acidification since industrialisation; shrinking of glaciers, Greenland and Antarctic ice sheets, as well as arctic sea ice; and the rise of sea levels of 19 cm since 1901. This is projected to increase by an additional 82 cm by the end of this century at current levels of greenhouse gas emissions (ibid.: 13). Climate change impacts are already felt with increased occurrences of heat waves, heavy rain fall, increased risk of flooding and impacts on food and water security in a number of regions around the world. It is projected that with a rise of 2° of global temperatures, 280 million people worldwide (with greatest numbers in China, India and Bangladesh) would be affected by sea level rise, escalating to a projected 627 million people under a 4° scenario (Strauss et al. 2015: 10). At the 21st Conference of Parties of the United Nations Framework Convention on Climate Change in Paris in 2015, representatives agreed that action should be taken to limit rise of global temperatures to 2° and Fig. 4.2 Concentration of CO2 in the atmosphere. Source NASA, available from https://climate.nasa.gov/vital-signs/carbon-dioxide/. The CO2 levels have been reconstructed from measures of trapped air in polar cap ice cores 4 CRITIQUES OF GROWTH 45 to “pursue efforts” to limit it to 1.5°. This has been adopted by 196 countries, but immense efforts and very radical reductions of greenhouse gas emissions will be required to comply with the agreement. Even if net greenhouse gas emissions were reduced to zero, surface temperatures would remain constant at their increased levels for hundreds of years to come and climate change impacts such as ocean acidification and rising sea levels would continue for hundreds or even thousands of years once global temperatures are stabilised; moreover, a range of climate change impacts are deemed irreversible (IPCC 2014: 16). One controversial question in the debate about economic growth and environmental impacts has been whether growth can be decoupled from the damage it causes. Important to this debate is the theory of the Environmental Kuznets Curve which applies Simon Kuznets’ hypothesised inverted u-shaped relationship between economic development and income inequality to the relationship between economic development and environmental degradation. According to this theory, environmental degradation is low in the early phases of economic development, then rises with increasing development up to a certain point, beyond which it falls again with advancing development because more resources can be invested to render production and consumption more efficient and less polluting. Therefore, this theory suggests that it is possible to decouple economic growth (measured in GDP) from its environmental implications. The counter-argument to this theory is that it does not take into account the difference between relative and absolute decoupling. Relative decoupling refers to the environmental impacts generated over time per unit of economic output, for instance CO2 emissions per million of US$. In contrast, absolute decoupling would examine aggregate environmental impact, compared to total economic output over time. Here it has been argued that while relative decoupling may be possible as the environmental impact per unit of economic output decreases over time due to efficiency gains, absolute decoupling is much harder to achieve while growth continues. Indeed, there is no evidence for absolute decoupling as total environmental impacts, for instance total global CO2 emissions, are still rising with rising global GDP (Jackson 2011: 67–86). This is partly due to rebound effects which we discussed in Chap. 2: rising consumption because the increase in efficiency has made it cheaper to produce/consume (Jackson 2011: 67–86; see also Czech 2013: Chap. 8 criticising “green growth”). Furthermore, if decoupling is examined at the country level, one would need to take consumptionbased resource use/emissions into account rather than productionbased impacts. Substantial environmental impacts related to everything that is consumed in rich countries occur in developing countries from which goods are imported. A focus on production-based environmental impacts would hence be misleading as it ignores the [and] environmental impacts that relate to a country’s living standards and that occur outside of that country. Social Critiques of Growth Economic growth has not only been criticised from an ecological perspective, but also from an individual and social wellbeing point of view. Here, we can again distinguish a critique of GDP as a measure of wellbeing and a wider critique which highlights potential negative consequences of economic growth for human wellbeing. Several scholars have argued that GDP is an inadequate measure of prosperity or wellbeing because it only includes market transactions and ignores activities of the informal economy in households and the volunteering sector which make an important contribution to individual and social wellbeing (Stiglitz et al. 2011; van den Bergh 2009; Jackson 2011). It also excludes the contribution of certain government services that are provided for free (Douthwaite 1999: 14; Stiglitz et al. 2011: 23), and the roles of capital stocks and of leisure in generating welfare (Costanza et al. 2015: 137). Furthermore, all market transactions make a positive contribution to GDP, regardless of whether expenditures increase or decrease welfare. Similar to the way in which environmental costs of growth are either excluded from GDP or even increase it, expenditures that arise from road accidents, divorces, crime, etc., contribute positively to GDP (ibid.: 133). The focus on market transactions also means that an increasing marketisation (or “commodification”) of an economy will be reflected in a rise of GDP, which may or may not be related to actual “welfare” outcomes (Stiglitz et al. 2011: 49). It also implies that GDP is an insufficient cross-national comparator for the quality of life, as it does not take into account the different sizes of the informal economy across countries (ibid.: 15). Furthermore, GDP does not indicate how income and consumption are distributed in society (Stiglitz et al. 2011: 44). This implies that a rise of GDP can be consistent with a rise of inequality of income and wealth. 4 CRITIQUES OF GROWTH 47 However, if greater inequality has negative impacts on social wellbeing (Wilkinson and Pickett 2009), this would be masked by rising GDP figures (Douthwaite 1999: 17). An even more fundamental criticism of GDP as a measure of wellbeing is that it focuses on the accumulation of money or wealth and thus on the material aspects of wellbeing. Such a narrow conception of the goals of economic activity and wellbeing has been criticised early on in the history of economic thought, e.g. by Aristotle’s distinction between oikonomia and chrematistics. The latter refers to the accumulation of wealth and was regarded by him as an “unnatural” activity which did not contribute to the generation of use value and wellbeing (Cruz et al. 2009: 2021). The argument that wider conceptions of wellbeing and prosperity are required has also become relevant for contemporary critiques of economic growth (Jackson 2011; Paech 2013; Schneider et al. 2010) as we will discuss this in more detail in Chap. 5. Arguments About the Psychological and S ocial Costs of G rowth The broader social critique of economic growth highlights potential “social limits” to or even negative consequences of economic growth for individual and collective wellbeing. The term “social limits to growth” was coined by Fred Hirsch (1976). He argued that the benefits of growth are initially exclusive to small elites and that these benefits disappear as soon as they spread more widely through mass consumption. For instance, only few people can own a Rembrandt painting; holiday destinations are more enjoyable when they are not overrun by hordes of other tourists; there are only few leadership positions, etc. From this perspective, there are “social limits” to the extent to which the benefits of growth can be socially expanded and equally shared. Other scholars have expressed concern about individual and collective social costs of economic growth. First, there is the argument that the need to keep up with ever-rising living standards and new consumer habits, “keeping up with the Joneses”—a lot of which is seen to be driven by advertisement and social pressure rather than real needs, for instance fashionable clothing or gadgets—can generate stress and increase the occurrence of mental disorders (James 2007; Offer 2006; Kasser 2002). 48 M. BÜCHS AND M. KOCH Second, it has been argued that economic growth can imply wider social costs. For instance, with its emphasis on individual gain, market relations and competition, and the need that it generates for spatial mobility (e.g. for successful participation in education and labour markets), it is feared to undermine moral and social capital and put a strain on family and community relations, potentially even leading to increasing divorce and crime rates (Douthwaite 1999; Daly and Cobb 1989: 50–51; Hirsch 1976). Social costs of technological development and industrialisation also include industrial workplace and traffic accidents and time lost in traffic jams and for commuting (Czech 2013: Chap. 2; Stiglitz et al. 2011: 24). Technological innovation which arises from growth can also act as a factor for job losses and increasing job insecurity (Douthwaite 1999), especially if growth rates are not sufficiently high to compensate gains in productivity. It is often assumed that growth will benefit the many because of assumed “trickle-down” effects which promise to improve the lot of the poor simply because the “cake” of available wealth is growing. While progress has been made in reducing extreme global poverty and inequality (Sala-i-Martin 2006; Rougoor and van Marrewijk 2015), the number of people living in poverty across the globe remains high.1 At the same time, income inequality in a range of countries has been rising and the situation of many of the people living in extreme poverty is not improving which means the fruits of economic growth remain to be unequally distributed (Collier 2007; Piketty and Saez 2014). The post-development debate goes even further than that in arguing that not only may growth not have reached the global poor to the extent that had been predicted by neoclassical economists, but that it can also have negative impacts on indigenous communities in developing countries, especially those who rely on local natural resources for their livelihoods which often suffer exploitation, pollution or even destruction through the inclusion of local economies into global value chains (Rahnema and Bawtree 1997). While the distinction between critiques of growth that focus on its problematic ecological and social consequences is useful for analytic purposes, the two dimensions are of course closely linked. Ecological consequences of growth have the potential to severely impact or even undermine human wellbeing. Local livelihoods are already affected by current climate change impacts such as ocean acidification and its impact on marine organisms, draughts, floods and severe weather events, the 4 CRITIQUES OF GROWTH 49 frequency of which has been rising. Accordingly, it is estimated that crop and fish yields are already diminishing in several regions (Stern 2015; IPCC 2014) and that millions of people are already being displaced and forced to migrate due to climate change and other environmental impacts (Black et al. 2011). While the overall long-term impacts of climate change and the surpassing of other planetary boundaries are difficult to predict, they clearly have the potential to substantially undermine human wellbeing. Since greenhouse gas emissions are driven by economic growth, the development of alternative economic models that do not depend on growth is urgent since continued growth “threatens to alter the ability of the Earth to support life” (Daly and Farley 2011: 12).

#### Carbon border tax coming now and key to solving warming.

Kellard 1/28 Neil Kellard [Dean, Professor in Finance, Essex Business School, University of Essex] “Why the EU’s proposed carbon border levy is an important test for global action on climate change” January 28, 2021 <https://theconversation.com/why-the-eus-proposed-carbon-border-levy-is-an-important-test-for-global-action-on-climate-change-154041> SM

In the more than two decades since the Kyoto Protocol was adopted, national policies on climate change have had dangerously and disappointingly little effect on global emissions.

Within the current economic system, perhaps the most ambitious attempt to reduce emissions has been the EU’s emissions trading system (or ETS). In operation since 2005, the ETS covers more than 11,000 heavy-energy-using power stations, factories and airlines, representing around 40% of the EU’s greenhouse gas emissions. The scheme operates via a cap-and-trade principle where an EU-wide cap on emissions means that firms must buy allowances, essentially paying for their polluting activities.

Yet although the ETS has had some success in reducing emissions, finance professor Panayiotis Andreou and I recently showed that the scheme is under-penalising those who pollute the most – primarily because the price of allowances has typically been too low.

The current price of an allowance to emit greenhouse gases is around €33 per tonne, a price already much higher than the average over the life of the ETS. However, to meet EU climate change targets, this price will need to be more like €40 by 2030 and close to €250 in 2050. Given the substantial costs this will impose on EU firms, either to pay for allowances or to invest in low carbon technologies, companies based outside the EU will have a hefty competitive advantage unless they face similar regulatory controls in their own countries.

This is why the European Commission, the EU’s executive branch, plans to present its carbon border levy in June 2021 as part of its Green Deal planning. Frans Timmermans, the first vice-president of the European Commission, recently stressed that:

It’s a matter of survival of our industry. So, if others will not move in the same direction, we will have to protect the European Union against distortion of competition and against the risk of carbon leakage.

Although its details are still undecided, the carbon border levy is expected to charge imports into the EU at an amount related to the emissions trading system price. As commission official Benjamin Angel notes, this could mean setting a carbon amount per product and multiplying it by the ETS price. For example, given production of each tonne of steel typically generates around 1.9 tonnes of CO₂ emissions, if we assume an ETS price of €30 then a firm would pay €57 extra to import it.

Having such a levy in place would send a strong signal to EU firms that potentially expensive investments in environmentally beneficial technologies would not result in undercutting, either by non-EU rivals that enjoy looser regulations, or by firms relocating to outside the EU – the so called “carbon leakage” that Frans Timmermans mentions.

Combining the EU ETS with a border levy is a sensible and workable strategy, providing a long-term context for firms that encourages the reduction of emissions by pricing in the pollution they produce. The benefits of a border levy may also spill over to outside the EU in at least one of two ways. First, and most obviously, non-EU firms that wish to export into Europe will be encouraged to reduce emissions to limit their charge. Secondly, other governments and regulatory authorities will be watching closely to see if the approach is workable and this could see the spread of cap-and-trade agreements more globally.

#### But lack of WTO legitimacy is key – the threat of disputes deters action.

Ashurst 7/16 Ashurst [A progressive global law firm] Proposed EU Regulation on CBAM, July 16 2021, <https://www.ashurst.com/en/news-and-insights/legal-updates/proposed-eu-regulation-of-cbam-published/> SM

Next steps for the Commission's proposal

Following publication of the detailed proposal for the CBAM, it will need to go through the ordinary legislative procedure, which involves being reviewed and modified by the European Parliament and the Council. This process will provide Member States with the opportunity to introduce significant changes.

Future developments

While only a proposal, the draft CBAM regulation also contains a reporting and review mechanism. Here, the draft CBAM regulation obliges the Commission to report before the end of the transitional period on the application of the CBAM, with a view to extending the scope of CBAM to indirect emissions and goods other than those listed in Annex I.

How might the proposal be challenged?

The CBAM is controversial outside the EU. Commentators have already started to map out potential challenges to it. In principle, these challenges follow two distinct routes:

that the CBAM breaches international obligations; and/or

that the CBAM breaches EU domestic law.

The main international route would be a WTO challenge by another WTO member government. As the WTO dispute settlement process is a government-to-government process, business would need to either lobby a government to bring a WTO Dispute Settlement Understanding (DSU) case, or, in certain jurisdictions, use formal processes (e.g. section 301 of the U.S. Trade Act of 1974) to stimulate a government to bring a case that it would not otherwise bring.

The obvious candidates are countries such as Brazil, India, Australia, China and Russia, all of which will be affected by the CBAM.

The WTO DSU process is currently functioning poorly since the US has refused to appoint new Appellate Body (AB) members, so the AB cannot function. This may have influenced the EU's decision to publish the draft regulation at this time, and until new AB members are appointed the prospect of the CBAM being held, definitively, to be incompatible with WTO obligations appears slim.

#### Otherwise, countries dispute through the WTO

Brooks 7/21 “Trade experts positive on EU’s CBAM, despite risk of rich nation-poor nation rift”, July 21 2021 Cristina Brooks [Senior Journalist, Climate & Sustainability, IHS Markit] <https://ihsmarkit.com/research-analysis/--trade-experts-positive-on-eus-cbam-despite-risk-of-rich-nati.html> SM

In addition to EU due process, the CBAM will face international challenges. World Trade Organization (WTO) rules were not drafted to accommodate climate change policies, so countries slapped with new charges on exports may challenge the CBAM via a WTO dispute settlement case.

Stephen Woolcock, a lecturer in international political economy at the London School of Economics, told Net-Zero Business Daily there are several ways of challenging the CBAM. "If the EU were to introduce the measure, other countries would challenge this, and you then go through a dispute settlement mechanism. The WTO appellate body, if you like 'the international trade court,' would then rule on whether this is complying with the WTO rules," he said.

However, he said it seems likely countries will discuss it in other forums since the US under the Trump administration blocked appointees to the WTO's appellate body. "So, we don't have a functioning appellate body in the WTO at the moment," said Woolcock.

#### Economic interdependence can’t solve war, because history proves the restraining factor is all about the expectation of future trade – security crises and Trump both moot that

Fay 3/20

Matthew Fay, Director of Defense and Foreign Policy Studies—Niskanen Center, Fellow—GMU Center for Security Policy Studies, PhD—GMU Schar School of Policy and Government, bachelor’s degree in political science from Saint Xavier University and has two master’s degrees, one in international relations from American Military University and one in diplomatic history from Temple University, TRUMP, TRADE, AND GREAT POWER WAR, MARCH 20, 2017, <https://niskanencenter.org/blog/trump-trade-great-power-war/>

One of the signature features of President Donald Trump’s campaign was his hostility to free trade. Then-candidate Trump repeatedly denigrated various multilateral trade pacts as bad deals for the United States. Pulling out of the Trans-Pacific Partnership, appointing opponents of free trade—such as Steve Bannon and Peter Navarro—into key positions, and promises of tariffs that are likely to produce retaliatory measures, all demonstrated that Trump was planning on following through on his protectionist campaign rhetoric. While Trump’s attack on free trade has important implications for American and global economies, it will also have an impact on the likelihood of war between the great powers. As discussed here previously, President Trump sees the world in zero sum terms. Absent disproportionate economic gains for the United States, international agreements cannot be considered successful. However beneficial such arrangements prove to be for all involved, Trump’s mercantilist outlook sees them as a raw deal for Americans. It is not surprising therefore, that U.S. Treasury Secretary Steve Mnuchin nixed attempts to include language supporting free trade in a statement from a G-20 meeting in Baden-Baden, Germany. As CNN reported, while the statement included some positive words on trade, “conspicuous by its absence was the phrase ‘we will resist all forms of protectionism’ that was contained in the communiqué from the last meeting of the group in China, July 2016.” Mnuchin rejected the idea that the omission was meaningful, but the unwillingness to reaffirm American opposition to protectionism ignores that trade provides benefits beyond the global economy. Specifically, the expectation of future trade affects the likelihood of war and peace. The connection between trade and conflict has never been as simple as early liberal theorists suggested. The idea, wrongly attributed to the nineteenth century French economist Frederic Bastiat, that “when goods don’t cross borders, soldiers will” still offers a good summation of the longstanding position that trade has pacifying effects on international politics. The logic behind the argument is compelling: the greater the extent of commercial relations between states, the less likely there will be conflict because the economic cost of war (and the lost benefits of trade) will be too high. However, history has shown that states still sometimes go to war despite high levels of economic interdependence at the time of the conflict. In his book Economic Interdependence and War, political scientist Dale Copeland explained that it is not the current level of trade that is important to the likelihood of conflict. Rather, Copeland argues, it is the expectation of future trade that determines a state’s willingness to go to war. He writes, In a very real way, it does not matter in the least whether past and current levels of trade and investment have been low, as long as leaders have strongly positive expectations of for the future. It is their future orientation and expectations of a future stream of benefits that will likely make the leaders incline to peace. Likewise, it does not matter whether past and current levels of commerce have been high if leaders believe they are going to be cut off tomorrow or in the near future. It is their pessimism about the future that will probably drive these leaders to consider hard-line measures and even war to safeguard the long-term security of the state. Multilateral trade has been a feature of the liberal international order developed after World War II for a reason. Postwar policymakers feared a return to the closed economic blocs of the 1930s that helped drive the world to war. It is entirely possible that the norms in favor of free trade are robust enough to withstand the absence of routine language from a statement by a meeting of the world’s finance ministers. But groups like the G-20 help set expectations about the future. Given the connection between those expectations and conflict, failing to reaffirm America’s opposition to protectionism could put the world on a dangerous path.

#### Trade doesn’t solve war – interdependence theory is wrong

Krugman 8/17/14

Paul Krugman, Nobel Prize-winning economist at Princeton, NYT, August 17, 2014, “Why We Fight Wars”, http://www.nytimes.com/2014/08/18/opinion/paul-krugman-why-we-fight.html?ref=opinion&\_r=2

A century has passed since the start of World War I, which many people at the time declared was “the war to end all wars.” Unfortunately, wars just kept happening. And with the headlines from Ukraine getting scarier by the day, this seems like a good time to ask why.

Once upon a time wars were fought for fun and profit; when Rome overran Asia Minor or Spain conquered Peru, it was all about the gold and silver. And that kind of thing still happens. In influential research sponsored by the World Bank, the Oxford economist Paul Collier has shown that the best predictor of civil war, which is all too common in poor countries, is the availability of lootable resources like diamonds. Whatever other reasons rebels cite for their actions seem to be mainly after-the-fact rationalizations. War in the preindustrial world was and still is more like a contest among crime families over who gets to control the rackets than a fight over principles.

If you’re a modern, wealthy nation, however, war — even easy, victorious war — doesn’t pay. And this has been true for a long time. In his famous 1910 book “The Great Illusion,” the British journalist Norman Angell argued that “military power is socially and economically futile.” As he pointed out, in an interdependent world (which already existed in the age of steamships, railroads, and the telegraph), war would necessarily inflict severe economic harm even on the victor. Furthermore, it’s very hard to extract golden eggs from sophisticated economies without killing the goose in the process.

We might add that modern war is very, very expensive. For example, by any estimate the eventual costs (including things like veterans’ care) of the Iraq war will end up being well over $1 trillion, that is, many times Iraq’s entire G.D.P.

So the thesis of “The Great Illusion” was right: Modern nations can’t enrich themselves by waging war. Yet wars keep happening. Why?

One answer is that leaders may not understand the arithmetic. Angell, by the way, often gets a bum rap from people who think that he was predicting an end to war. Actually, the purpose of his book was to debunk atavistic notions of wealth through conquest, which were still widespread in his time. And delusions of easy winnings still happen. It’s only a guess, but it seems likely that Vladimir Putin thought that he could overthrow Ukraine’s government, or at least seize a large chunk of its territory, on the cheap — a bit of deniable aid to the rebels, and it would fall into his lap.

And for that matter, remember when the Bush administration predicted that overthrowing Saddam and installing a new government would cost only $50 billion or $60 billion?

The larger problem, however, is that governments all too often gain politically from war, even if the war in question makes no sense in terms of national interests.

Recently Justin Fox of the Harvard Business Review suggested that the roots of the Ukraine crisis may lie in the faltering performance of the Russian economy. As he noted, Mr. Putin’s hold on power partly reflects a long run of rapid economic growth. But Russian growth has been sputtering — and you could argue that the Putin regime needed a distraction.

Similar arguments have been made about other wars that otherwise seem senseless, like Argentina’s invasion of the Falkland Islands in 1982, which is often attributed to the then-ruling junta’s desire to distract the public from an economic debacle. (To be fair, some scholars are highly critical of this claim.)

And the fact is that nations almost always rally around their leaders in times of war, no matter how foolish the war or how awful the leaders. Argentina’s junta briefly became extremely popular during the Falklands war. For a time, the “war on terror” took President George W. Bush’s approval to dizzying heights, and Iraq probably won him the 2004 election. True to form, Mr. Putin’s approval ratings have soared since the Ukraine crisis began.

No doubt it’s an oversimplification to say that the confrontation in Ukraine is all about shoring up an authoritarian regime that is stumbling on other fronts. But there’s surely some truth to that story — and that raises some scary prospects for the future.

Most immediately, we have to worry about escalation in Ukraine. All-out war would be hugely against Russia’s interests — but Mr. Putin may feel that letting the rebellion collapse would be an unacceptable loss of face.

And if authoritarian regimes without deep legitimacy are tempted to rattle sabers when they can no longer deliver good performance, think about the incentives China’s rulers will face if and when that nation’s economic miracle comes to an end — something many economists believe will happen soon.

Starting a war is a very bad idea. But it keeps happening anyway.

#### Trade wars don’t go to hot wars

**Dayen 17**, New Republic contributor (David “Trump Is Signaling a Trade War, but It’s Not as Disastrous as You May Think”, https://www.thenation.com/article/trump-is-signaling-a-trade-war-but-its-not-as-disastrous-as-you-may-think/)

Can Trump enact tariffs on his own? Though it would appear to contradict the Origination Clause of the Constitution, Congress has delegated that authority in enough pieces of legislation that Trump could probably raise import duties unilaterally. But what would be the practical effect? Hard-core free traders paint a picture of cataclysm. Tariffs will launch trade wars, increase prices, and destroy the economy. This is all hard-wired into the pro-globalization worldview. Thomas Friedman once famously admitted that he wrote a column supporting a free-trade agreement with Central America without knowing a thing about it: “I just knew two words: free trade,” he told an audience. Presumably the opposite is true for Friedman: He sees one word, “tariff,” and immediately screams in horror. Oddly, many of those same proponents of free trade favor a policy that looks very much like a tariff. The Republican corporate-tax revamp includes something called a border-adjustment tax, which would impose a 20 percent tax on imports while eliminating a tax on exports. Like with tariffs, the goal appears to be to encourage domestic production. In fact, the tax would be much higher than the 5-10 percent tariff being floated. (It also might be illegal under the current global trade regime.) Supporters of border adjustment, particularly economists, argue that it will end up trade neutral, because the exchange rate will fluctuate in response to the tax. In other words, though the tax would make American-made goods more attractive, the value of the dollar would increase, leveling that out. Few of these economists seem to carry over the same analysis to the effects of a tariff. I don’t understand why. There’s no reason to doubt the fact that, if Trump imposed an across-the-board tariff, the dollar would strengthen, thus nullifying the desired effect. Indeed, before Trump has even taken office, the dollar has risen to a 14-year high, in anticipation of a more protectionist stance. Incidentally, for all the one-off announcements by Trump (however factually challenged) about hundreds of jobs he has allegedly rescued here or there, this one development—the rise in the dollar—has likely caused the loss of hundreds of thousands of manufacturing jobs, under standard economic theory. Looked at this way, higher tariffs wouldn’t cause a recession (as Paul Krugman has acknowledged), but would be somewhat pointless, with currency exchanges shifting to account for any changes. Trade wars might temporarily reduce efficiency, as domestic supply chains would have to be rebuilt, but they’re unlikely to radically alter the balance of trade on their own. There are other variables here. Importers and exporters who have lived in a world of floating exchange rates for decades may be fairly nimble in adjusting to them. On the downside, Krugman explains that raising tariffs could inhibit capital flows, meaning that investors will place less money into US markets. You can see how that might reduce economic growth. But Jeff Spross points out that America currently has a problem with too much foreign money flowing in; reducing the flow could arguably make the economy more stable. Trump could also seek to prevent unlawful currency manipulation (not necessarily from China, but from other Asian nations) that artificially disadvantages US manufacturing. The real unknown here is what Trump would do with all that tariff revenue. The border adjustment tax at 20 percent is assumed to bring in $1 trillion over the 10-year budget window. So a tariff of even one-quarter or one-half that size would draw significant funds. What’s the plan for it? Would it get plowed into job-creating investments? Tax cuts for the wealthy? That’s a significant variable as well. We do know that the same pundits who confidently predicted that globalization would be a win-win policy for America repeatedly got it wrong. Those on the losing side saw their jobs shipped out and factories closed down, and weren’t given the kind of assistance needed to offset the disruption. So it’s worth being a little skeptical of the warnings coming from the same corners now. I don’t have a ton of faith in the Trump team to necessarily make their trade agenda work (especially as corporate interests will seek to co-opt the redesigned policies in ways even friendlier to their bottom line). And I think there are smarter ways to balance our trade deficit than a tariff strategy which will just run up against currency exchange rates. But the hysteria accompanying these tariffs (which wasn’t at all present when President Obama imposed his own tariffs on Chinese tires and steel) seems far beyond what little we can assume about the actual results of such a strategy.

#### But WTO legitimacy trades off with the efficacy and legitimacy of regional trade agreements.

Kwak and Marceau 16 “Overlaps and Conflicts of Jurisdiction between the World Trade Organization and Regional Trade Agreements,” Kyung Kwak [Kyung Kwak is an associate of a law firm, Ashurst, in Brussel] and Gabrielle Marceau [Gabrielle Marceau, Ph.D., is counsellor in the Légal Affairs Division of the Secretariat to the World Trade Organization] Published online by Cambridge University Press: 09 March 2016 <https://www.cambridge.org/core/journals/canadian-yearbook-of-international-law-annuaire-canadien-de-droit-international/article/abs/overlaps-and-conflicts-of-jurisdiction-between-the-world-trade-organization-and-regional-trade-agreements/6C0C9CA77BED3390A38226F9E01EB44D> SM

The relationship between the dispute settlement mechanism of the World Trade Organization (WTO) and that of regional trade agreements (RTAs) demonstrates the difficulties surrounding the issues of overlaps/conflicts of Jurisdiction and of hierarchy of norms in international law.1 Jurisdiction is often defined in terms of either legislative or judicial Jurisdiction — that is, the authority to legislate or to adjudicate on a matter. Jurisdiction may be analyzed from horizontal points of view (the allocation of Jurisdiction among states or among international organizations) and from a vertical point of view (the allocation of jurisdiction between states and international organizations) . 2

This article addresses the issue of horizontal allocation of judicial jurisdiction between RTAs and the WTO, as expressed in the dispute settlement provisions of each treaty. The choice of a dispute settlement forum is often an expression of the importance that states give to the System of norms that may be enforced by the related dispute settlement mechanism. For instance, if the same states — which are parties to two treaties A and B that contain similar obligations — provide that priority or exclusivity is given to the dispute settlement mechanism of A over that of B, it may be that the states are expressing their choice to favour the enforcement of treaty A over treaty B.

In the case of RTAs, the situation is further complicated because the General Agreement on Tariffs and Trade (GATT)3 authorizes WTO members to form regional trade agreements. The WTO jurisprudence has made it clear that members have a "right" to form preferential trade agreements. This right is however conditional. In the context of an RTA, Article XXIV may justify a measure that is inconsistent with certain other GATT provisions. However, in a case involving the formation of a customs union, this RTA "defence" is available only when two conditions are fulfilled. First, the party claiming the benefit of this defence must demonstrate that the measure at issue is introduced upon the formation of a customs union that fully meets the requirements of sub-paragraphs 8 (a) and 5 (a) of Article XXIV. Second, this party must demonstrate that the formation of the customs union would be prevented if it were not allowed to introduce the measure at issue. Again, both of these conditions must be met to have the benefit of the defence under Article XXIV of GATT.4

Many RTAs include (substantive) rights and obligations that are parallel to those of the Marrakesh Agreement Establishing the World Trade Organization (WTO Agreement).5 Generally, these RTAs may provide for their own dispute settlement mechanism, which makes it possible for the states to resort to different but parallel dispute settlement mechanisms for parallel or even similar obligations. This situation is not unique as states are often bound by multiple treaties, and the dispute settlement Systems of these treaties operate in a parallel manner.6 At the same time, the WTO dispute settlement System claims to be compulsory and exclusive. Article 23 of the Understanding on Rules and Procedures Governing the Settlement of Disputes (DSU)7 mandates exclusive jurisdiction in favour of the DSU for WTO violations. By simply alleging that a measure affects or impairs its trade benefits, a WTO member is entitled to trigger the quasi-automatic, rapid, and powerful WTO dispute settlement mechanism, excluding thereby the competence of any other mechanism to examine WTO law violations. The challenging member does not need to prove any specific economic or legal interest nor provide any evidence of the trade impact of the challenged measure in order to initiale the DSU mechanism.8 The WTO will thus often "attract" jurisdiction over disputes with (potential) trade effects even if such disputes could also be handled in fora other than that of the WTO.

OVERLAPS OF JURISDICTION BETWEEN RTAs AND THE WTO

Overlaps of jurisdiction in dispute settlement can be defined as situations where the same dispute or related aspects of the same dispute could be brought to two distinct institutions or two different dispute settlement Systems. Under certain circumstances, this occurrence may lead to difficulties relating to "forum-shopping," whereby disputing entities would have a choice between two adjudicating bodies or between two different jurisdictions for the same facts. When the dispute settlement mechanisms of two agreements are triggered in parallel or in sequence, there are problems on two levels: first, the two tribunals may claim final jurisdiction (supremacy) over the matter and, second, they may reach different, or even opposite, results.9

Various types of overlaps of jurisdiction may occur. For the purpose of the present discussion, an overlap of jurisdiction occurs: ( i ) when two fora claim to have exclusive jurisdiction over the matter; (2) when one forum claims to have exclusive jurisdiction and the other one offers jurisdiction, on a permissive basis, for dealing with the same matter or a related one; or (3) when the dispute settlement mechanisms of two different fora are available (on a non-mandatory basis) to examine the same or similar matters. Conflicts are possible in any of these three situations. All of the RTAs examined in Table i at the end of this article have dispute settlement mechanisms with jurisdiction that may potentially overlap with that of the WTO Agreement.

#### Regional trade integration is key to the African economy.

Gammadigbe 21 IMF Working Paper Strategy, Policy, & Review “Is Regional Trade Integration a Growth and Convergence Engine in Africa?” Prepared by Vigninou Gammadigbe [Research Fellow at Banque Centrale des Etats de l'Afrique de l'Ouest Authorized for distribution by Johannes Wiegand January 2021 <https://www.imf.org/en/Publications/WP/Issues/2021/01/29/Is-Regional-Trade-Integration-a-Growth-and-Convergence-Engine-in-Africa-50040> SM

\*REC = Regional Economic Communities (for example, FTAs, unions, etc.)

It has been argued in the literature that regional integration promotes shared economic growth and income convergence among member countries through direct and indirect channels of increased intra-regional trade, economies of scale, dissemination of knowledge and technology, and structural transformation. This paper contributes to this literature in Africa and African RECs. Its main objective was to analyses the effects of RTI on growth and income convergence in Africa and its different RECs. The study examines whether regional integration has played an important role in economic growth and income convergence of member countries in African major RECs in order to draw lessons for the process of establishing the African Continental Free Trade Area (AfCFTA). To this end, the study estimated two models, one for economic growth and the other for income convergence in the African sample and in the African major RECs over the period 1989 to 2018 using the instrumental variable method and the panel fixed-effects model.

The baseline results as well as the results of the multiple robustness tests indicate that RTI promotes economic growth in the participating countries. However, econometric evidence shows that it fuels divergence rather than income convergence across the continent implying that the positive effect on economic growth is mostly captured by the relatively more developed economies on the continent. These results are robust to the use of alternative indicators of trade integration, to the time frame of the analysis and to the estimation method particularly for the sample of Africa and in large RECs including COMESA, SADC, ECOWAS, WAEMU and SADC. For these RECs and in the context of the African continental free trade project, these results show how necessary it is to design specific programs (social programs and training programs) to support the most vulnerable economies in order to protect their sectors that will suffer negative shocks when the African Continental Free Trade Area (AfCFTA) will be in force. The results also show that regional integration offers substantial gains, whose full absorption is conditional on the implementation of comprehensive structural reforms aimed at diversifying economies and increasing their productivity. The positive effect of regional integration on growth suggests that the process of African trade integration would be beneficial to the continent’s economic growth. Therefore, the study recommends the elimination of non-tariff barriers in order to increase its effectiveness. Furthermore, regarding the positive effect on income divergence, the study recommends that RTI, beyond its traditional role as an instrument for trade promotion, should also be used as an instrument for providing essential infrastructure, improving the quality of institutions, building human capacity and strengthening the physical capital stock.

#### That’s key to preventing terror.

Ray 1/11 “Does Africa Matter to the United States?” Charles A. Ray [a member of the Board of Trustees and Chair of the Africa Program at the Foreign Policy Research Institute, served as U.S. Ambassador to the Kingdom of Cambodia and the Republic of Zimbabwe] January 11, 2021 <https://www.fpri.org/article/2021/01/does-africa-matter-to-the-united-states/> SM

The population of African countries is also overwhelmingly young. Approximately 40% of Africans are under 15, and, in some countries, over 50% is under 25. By 2050, two of every five children born in the world will be in Africa, and the continent’s population is expected to triple. These developments have positive and negative potential impacts on the United States and the rest of the world. Young Africans have, for the most part, completely skipped the analog age and gone directly digital. Comfortable with technology, they form a huge potential consumer and labor market. If, on the other hand, the countries of Africa fail to develop economically and do not create gainful employment for this young population, then there is the risk that they will become a huge potential source of recruits to extremist and terrorist movements, which currently target disadvantaged and disenchanted youth.

Lack of economic opportunity, increased urbanization, and climate-fueled disasters will also contribute to movement of people seeking better lives, which will impact economies and security not only on the continent of Africa, but also the economic and security situations around the world. Nations, lacking adequate critical infrastructure, education, and job opportunities are ripe for internal unrest and radicalization. In particular, inadequate health delivery systems, when coupled with natural disasters, such as droughts or floods that limit food production, cause famine and mass movements of populations.

The Challenges for U.S. Policy

Prior to World War II, the U.S. policy towards Africa was not as active as it was toward Europe, Asia, or Latin America. During the Cold War, Africa policy was primarily viewed from a perspective of super-power competition. The end of the Cold War and the rise of international terrorism introduced this as a major component in U.S. Africa policy along with competition with a rising China and increased Chinese engagement in Africa.

Before his first official trip to Kenya, U.S. President Barack Obama said, “Africa had become an idea more than an actual place . . . with the benefit of distance, we engaged Africa in a selective embrace.” This is probably an apt description of U.S. policy towards African nations despite the bipartisan nature of that policy. The United States, with the many domestic and international issues it has to cope with, can ill afford to continue to ignore Africa. Going forward, U.S. policy must include a hard-headed look at where Africa fits in policy priorities.

The incoming Biden administration will face a number of important issues and challenges as it develops its Africa policy. The most pressing issues are the following:

Climate Change: Climate change is an existential problem that affects the entire globe, but Africa has probably suffered more from the effects of climate change than other continents—and the problem will only get worse with time. In an October 2020 article, World Meteorological Organization (WMO) Secretary-General Petteri Taalas said,

Climate change is having a growing impact on the African continent, hitting the most vulnerable hardest, and contributing to food insecurity, population displacement and stress on water resources. In recent months we have seen devastating floods, an invasion of desert locusts and now face the looming specter of drought because of a La Nina event. The human and economic toll has been aggravated by the COVID-19 pandemic.

Climate change impacts water quality and availability, and millions in Africa will likely face persistent increased water stress due to these impacts. A multi-year drought in parts of South Africa, for instance, threatened total water failure in several small towns and had livestock farmers facing financial ruin. Another pressing climate-change issue is the need for protection of the Congo Basin rainforest. This 178-million-hectare rainforest is the world’s second largest after the Amazon and is currently threatened by agricultural activities in Cameroon, Central African Republic, Democratic Republic of Congo, Republic of the Congo, Equatorial Guinea, and Gabon. Countries in the Congo Basin need to address the preservation issue, while also enabling sustainable agricultural activities to ensure food security for the region’s population. In addition to the impact on global climate caused by destruction of the rainforest, such destruction also brings human populations into closer contact with the region’s animals, creating the risk of future animal-to-human transmission of new and possibly more virulent viruses similar to COVID-19, which will have a global impact. In a January 2021 CNN report, Dr. Jean-Jacques Muyembe Tamfum, who as a researcher helped discover the Ebola virus in 1976, warned of possible new pathogens that could be as infectious as COVID-19 and as virulent as Ebola.

Rule of Law/Mitigation of Corruption: A key to African development, given the increasing urbanization, population increases, and youthfulness of the continent’s population, will be an increase in domestic and international investment to build the industries that can provide meaningful employment and improved standards of living. In order for this to be successful, African nations will need to address the issues of rule of law and corruption. Investors will not risk money if the business climate comes with a level of political risk that is too high. Government leaders throughout Africa need to establish legislation that provides an acceptable level of security for investments and take action to curb the endemic corruption that currently discourages investment. Corruption in Africa ranges from wholesale political corruption on the scale of General Sani Abachi’s looting of $3-5 billion of state money during his five years as Nigeria’s military ruler to the bribes paid by businessmen to police and customs officials. The “tradition” of having to pay bribes, or “sweeteners,” drives away domestic investment and scares away foreign investment, leaving many countries mired in poverty.

Violent Extremism and Terrorism: A number of African nations are currently plagued with rising extremist movements. While primarily a domestic issue, the mass movement of people fleeing violence and the disruption of economic activity have the potential to negatively impact the rest of the world. African nations need regional responses to curb extremist and terrorist organizations, many of which are supported by international terrorist organizations, such as ISIS and al Qaeda. In addition, the underlying conditions that helped to create these movements must be addressed. Terrorist groups in Africa range from relatively large and dangerous groups, such as Boko Haram, a group in Nigeria that has received support from al Qaeda and that aims to implement sharia law in the country; Al-Shabab, an al Qaeda affiliate aiming to overthrow the government in Somalia and to punish neighboring countries for their support of the Somali regime; and Uganda’s Lord’s Resistance Army, a fundamentalist Christian group. Terrorist groups in the fragile political climate of Libya also pose a threat to sub-Saharan Africa.

#### Causes terrorist CBW usage.

Fyanka 20 Bernard B. Fyanka (epartment of History and International Studies, Redeemer’s University) (2020): Chemical, biological, radiological and nuclear (CBRN) terrorism: Rethinking Nigeria’s counterterrorism strategy, African Security Review, DOI: 10.1080/10246029.2019.1698441 (SGK)

The most commonly used non-conventional weapons are chemical or biological in nature. The long history of chemical and biological weapons usage dates as far back as 600 BC when, during a siege, Solon of Athens poisoned the drinking water of the city of Kirrha.44 More recently – starting with the use of mustard gas during the First World War – nations have acquired chemical and biological weapons easily, deploying them against enemies and their own citizens alike. For terrorist groups like Boko Haram, chemical and biological weapons are uniquely suited to their agenda and as such present very attractive alternatives to nuclear; they are extremely difficult to detect, cost effective and easy to deploy. Aerosols of biological agents are invisible to the naked eye, silent, odourless, tasteless and relatively easily dispersed. Most importantly they are 600 to 2000 times cheaper than other WMDs. Recent esti- mates place the cost of biological weapons at about 0.05% of the cost of a conventional weapon which could produce similar numbers of mass casualties per square kilometre. 45 The proliferation of chemical and biological weapons has proved to be very fluid over the past century due to advancements in technology. Production is comparatively easy via the commonplace technology that is used in the manufacturing of antibiotics, vaccines, foods and beverages, while delivery systems such as spray devices deployed from airplane, boat or car are widely available. Another advantage of biological agents is the natural lead time pro- vided by the organism’s incubation period (three to seven days in most cases), allowing the ter- rorists to deploy the agent and then escape before an investigation by law enforcement and intelligence agencies can even begin. Furthermore, not only would the use of an endemic infec- tious agent likely cause initial confusion because of the difficulty of differentiating between a biological warfare attack and a natural epidemic, but with some agents the potential also exists 46 for secondary or tertiary transmission from person to person or via natural vectors. Unlike their nuclear and radiological counterparts, biological and chemical weapons have been used for terrorism by both state and non-state actors. The challenges faced in preventing the use of these weapons through international control mechanisms include the increasing availability of larger quantities of substances, ease of use and most especially advanced tech- nological deployment facilities that portend a high risk factor to larger populations. Table 1 catalogues the use of biochemical weapons in warfare and by terrorists and other groups or individuals over the past century, offering concrete historical precedent and empirical grounds for the potential future actions of Boko Haram. The data shows consistent recourse to the use of these weapons, in spite of the chemical and biological weapons conventions out- lawing them. It can be seen that from the 1970s onwards there has been an increase in the use of biochemical weapons by religious cults and terrorist groups in pursuit of their agendas. The rise of Boko Haram and its ISIS affiliation could lead to a future where the use of biochemical weapons is the norm rather than the exception.

#### COVID incentivizes engineered bioterror- extinction

Walsh, 20 -- Axios Future correspondent [Bryan Walsh, "The coronavirus pandemic reawakens bioweapon fears," Axios, 5-14-2020, https://www.axios.com/coronavirus-pandemic-pathogen-bioweapon-45417c86-52aa-41b1-8a99-44a6e597d3a8.html, accessed 9-7-2020]

The coronavirus pandemic reawakens bioweapon fears

The immense human and economic toll of the COVID-19 pandemic only underscores the threat posed by pathogens that could be deliberately engineered and released.

Why it matters: New technology like gene editing and DNA synthesis has made the creation of more virulent pathogens easier. Yet security and regulation efforts haven't kept pace with the science.

What's happening: Despite some claims by the White House, overwhelming scientific evidence indicates that the novel coronavirus was not accidentally released from a lab or deliberately engineered, but naturally spilled over from an animal source.

That doesn't mean the threat from bioweapons isn't dire. Along with AI, engineered pandemics are widely considered the biggest existential risk facing humanity.

That's in part because a pathogen could be engineered in a lab for maximum contagiousness and virulence, well beyond what would arise through natural selection.

Case in point: a 2018 pandemic simulation put on by the Johns Hopkins Center for Health Security featured a fictional engineered virus called Clade X that combined the contagiousness of the common cold with the virulence of the real-life Nipah virus, which has a mortality rate of 40-75%. The resulting simulated global outbreak killed 150 million people.

COVID-19 isn't anywhere near that fatal, but the pandemic has shown the vulnerability of the U.S. and the world to biological threats both natural and manmade.

"Potential adversaries are of course seeing the same things we’re seeing," says Richard Pilch of the Middlebury Institute of International Studies. "Anyone looking for a radical leveling approach — whether a state actor like North Korea or a motivated terrorist organization — may be influenced by COVID-19 to consider pursuing a biological weapons capability."

Background: Bioweapons were officially banned by the Biological Weapons Convention in 1975, though North Korea is suspected of maintaining an offensive bioweapons program.

A particular concern about biowarfare and bioterror, though, is that many of the tools and methods that could be used to create a weaponized virus are largely indistinguishable from those used in the course of legitimate scientific research. This makes biotechnology "dual-use" — and that much more difficult to safely regulate without cutting off research that could be vitally important.

While earlier bioweapons fears focused on the possibility that a state or terror group could try to weaponize a known dangerous agent like smallpox — which would require somehow obtaining restricted pathogens — new technology means that someone could obtain the genetic sequence of a germ online and synthesize it in the lab.

"If you've been trained in a relevant technical discipline, that means you can make almost any potentially harmful agent that you're aware of," says Kevin Esvelt, a biologist at the MIT Media Lab and a member of the CDC's Biological Agent Containment Working Group. That would include the novel coronavirus that causes COVID-19, which was recently synthesized from its genetic sequence in a study published in Nature.

How it works: Currently, synthetic DNA is ordered through commercial suppliers. But while most suppliers screen DNA orders for the sequences of dangerous pathogens, they're not required to — and not all do, which means safety efforts are "incomplete, inaccurate, and insecure," says Esvelt.

Screening efforts that look for the genetic sequences of known pathogens also wouldn't necessarily be able to detect when synthetic DNA was being used to make something entirely novel and dangerous.

In the near future, desktop DNA synthesizers may be able to generate synthetic DNA in the lab, cutting out the need for commercial suppliers — and potential security screenings.

The democratization of biotechnology could unleash a wave of creativity and innovation, just as the democratization of personal computing did. But it also increases the number of people who could potentially make a dangerous engineered virus, whether deliberately or by accident.

#### War with China is their only scenario for great power war in the lake evidence:

#### US-China war is structurally inevitable --- China delays it to buy time to modernize

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Harry J. Kazianis. Harry J. Kazianis is director of defense studies at the [Center for the National Interest](https://cftni.org/), founded by former President Richard M. Nixon, “A US-China trade war is coming, but here's how to stop it.” Fox News. April 6, 2018. http://www.foxnews.com/opinion/2018/04/06/us-china-trade-war-is-coming-but-heres-how-to-stop-it.html

But even if a deal is struck to prevent most of the new tariffs from taking effect, we have crossed an important milestone in the U.S.-China relationship. Both sides now realize the nature of their ongoing geopolitical struggle. It is not out of the question to wonder whether ties between these countries with the two largest economies in the world are entering a heated, almost Cold War atmosphere.

[As I noted](http://www.foxnews.com/opinion/2018/04/04/china-is-no-friend-to-us-trump-is-right-to-take-them-on.html) in an op-ed for Fox News this week, clearly China is no friend of America. Our two nations have very different trade as well as diplomatic, economic and geopolitical goals that will naturally create tensions for perhaps decades to come. And as President Trump pointed out Thursday, each nation is understandably seeking to come out on top in any deal the two work out.

What’s needed now are tough and serious negotiations between China and the U.S. to reach a reasonable and fair compromise that gives each nation some of what it wants. But this is now a matter for diplomacy – not tweets or off-the-cuff comments. It would be a strategic mistake for the U.S. and China to engage in a tit-for-tat war of words in the media, simply adding gasoline to the fire of their trade dispute.

This is especially true because there are some indications that Beijing may be ready to blink – for strategic reasons.

Thursday night I spoke with several top-tier Chinese academics, scholars, and economists – all close to the government, all with good insights into Beijing’s thinking on escalating trade tensions with Washington. They all echoed a very similar opinion: there is a possibility of a deal with America, [even despite Beijing’s comments that no negotiations are likely](https://www.reuters.com/article/us-usa-trade-china/trump-threatens-tariffs-on-100-billion-more-china-goods-beijing-ready-to-strike-back-idUSKCN1HD0NW), for very clear reasons.

The experts I spoke with talked to me on the condition that I not identify them by name, so they could speak candidly.

“China was not ready for the sheer magnitude of President Trump coming after us on the so-called trade imbalance,” a senior Chinese economist with close ties to the government told me. “However, there is a deal that could be struck, as both sides have a lot to lose, especially China, as we are not ready for economic warfare with such a big power as America.”

The economist continued: “What scares me, and many government officials, is the rhetoric is heating up very quickly, leaving both sides very little room to work out a deal. Both sides are making a big mistake, as trying to score quick points for their own domestic political audiences is a big error. Now is the time to get both sides in a room, lock the doors, and work towards a deal that is fair to everyone.”

A Chinese scholar, also with close ties to the Beijing government, agreed with that sentiment, but with a twist.

“Chinese officials will likely offer some strong concessions to make sure we avoid a trade battle with Washington,” the scholar told me. “At the moment, we aren’t fully ready to take America on, and must continue to grow our economic and military power. This confrontation is not in our interest, and must be, at least for the moment delayed, until we are in a more powerful position.”

This scholar explained that it might even be in China’s interest to “fold” on this issue, because Beijing has much bigger issues that it must confront in the coming years.

“China must think correctly on all of this trade discussion,” the scholar said. “Our goal is to ensure our rise is not halted. We have greater strategic goals in mind. Winning a trade skirmish with America could come at the highest of prices – and turning America into an enemy that we can’t hope to defeat, at least not yet. We must delay that day for as long as we can.”

A White House official, who spoke to me Friday on condition that I not name him, also expressed hope that a deal could be worked.

“President Trump has always said he was willing to negotiate with Beijing, that is nothing new,” the U.S. official said. “But we are done being suckers to China. We want fair, reciprocal trade. I think we can get there.” However, the official expressed some caution, stating quite clearly that “the ball is now in China’s court.”

What happens now is really anyone’s guess. I would argue that a deal is most likely possible, with both sides making some concessions, especially China on intellectual property and access for U.S. products to its massive domestic markets in the years ahead.

But, at the same time, we should be cautious. The Trump administration has invested precious political capital in making sure China not only understands our intent but understands that we will defend our interests – even if that requires America to take an economic hit.

The U.S. must make sure that any agreement protects American workers, our technological base and other vital national priorities. Such a negotiation could take some time and cause us some economic pain, but would protect our long-term economic interests.

There is, however, a much bigger challenge looming just over the horizon: China’s changing strategic outlook.

Beijing is adjusting its gaze across the globe, seeing America as a very real strategic threat – and posing an increasing threat to America. Just this week, Chinese defense officials offered words of support to Russia[, forging ties that are looking more and more like a straight-up alliance](http://www.foxnews.com/world/2018/04/05/russia-china-hail-burgeoning-ties.html).

Washington must be prepared for the long haul and be ready to confront Chinese power in the months and years to come.

A Chinese economist, based out of Hong Kong, who I have known for a long time now, put it bluntly: “Washington and Beijing are set to clash. It’s just a matter of when and how.”

#### US wins now, but by 2025 A2/AD makes it game over --- strikes stay conventional and neutralize military targets

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Dave Majumdar, Defense Editor of the National Interest, “New Report Details Why a War between China and America Would be Catastrophic.” The National Interest. August 1, 2016. <https://nationalinterest.org/blog/the-buzz/new-report-details-why-war-between-china-america-would-be-17210?page=0%2C1>

A war between the United States and China would cause severe losses on both sides, but—today at least—Beijing would bear the brunt of the casualties. However, as China’s anti-access/area denial (A2/AD) capabilities continue to improve—the balance of losses would shift more towards Beijing’s favor by 2025. Nonetheless, China would still suffer more losses than Washington even at that stage—according to a new report from [the RAND Corporation](http://www.rand.org/pubs/research_reports/RR1140.html#relatedProducts). Victory for either side might prove to be elusive as the conflict could degenerate into inconclusive bloodletting.

“As its military advantage declines, the United States will be less confident that a war with China will conform to its plans,” reads the new report by [David C. Gompert](http://www.rand.org/about/people/g/gompert_david_c.html), [Astrid Cevallos](http://www.rand.org/pubs/authors/c/cevallos_astrid.html)and [Cristina L. Garafola](http://www.rand.org/about/people/g/garafola_cristina_l.html). “China’s improved military capabilities, particularly for anti-access and area denial (A2AD), mean that the United States cannot count on gaining operational control, destroying China’s defenses, and achieving decisive victory if a war occurred.”

A war with China—now and in the future—would likely be fought at sea and in the air, but cyber and space capabilities would play a significant role, according to the report. But the RAND researchers expect that should a war breakout, it would remain a conventional fight. “Each side’s increasingly far-flung disposition of forces and growing ability to track and attack opposing forces could turn much of the Western Pacific into a ‘war zone,’ with grave economic consequences,” reads the report. “It is unlikely that nuclear weapons would be used: Even in an intensely violent conventional conflict, neither side would regard its losses as so serious, its prospects so dire, or the stakes so vital that it would run the risk of devastating nuclear retaliation by using nuclear weapons first.”

Moreover, while the RAND study postulates that the United States would strike heavily at the Chinese mainland, the researchers don’t believe that Beijing would strike at the U.S. homeland except via cyber attacks. “We also assume that China would not attack the U.S. homeland, except via cyberspace, given its minimal capability to do so with conventional weapons,” the report states. “In contrast, U.S. nonnuclear attacks against military targets in China could be extensive.”

A Sino-American war could develop in a number of ways—including short bloody war or a long and devastating war. Moreover, modern technologies incentivize either side to launch a preemptive attack first. “Sensors, weapon guidance, digital networking, and other information technologies used to target opposing forces have advanced to the point where both U.S. and Chinese military forces seriously threaten each other,” the report reads. “This creates the means as well as the incentive to strike enemy forces before they strike one’s own. In turn, this creates a bias toward sharp, reciprocal strikes from the outset of a war, yet with neither side able to gain control and both having ample capacity to keep fighting, even as military losses and economic costs mount.”

In the case of a brief war fought today, American losses would be significant, but Chinese losses might be catastrophic. “If either U.S. or Chinese political leaders authorize their military commanders to carry out plans for sharp strikes on enemy forces, a severely violent war would erupt,” the report reads. “As of 2015, U.S. losses of surface naval and air forces, including disabled aircraft carriers and regional air bases, could be significant, but Chinese losses, including to homeland-based A2AD systems, would be much greater. Within days, it would be apparent to both sides that the early gap in losses favoring the United States would widen if fighting continued.”

By 2025, however, China’s military capabilities are likely to have expanded to a point where it will not sustain as many losses. “By 2025, though, U.S. losses would increase because of enhanced Chinese A2AD. This, in turn, could limit Chinese losses, though these would still be greater than U.S. ones,” the report reads. “It could be unclear then whether continued fighting would result in victory for either side.”

A longer war would be far more devastating—and could leave both military forces in shambles. “As of 2015, the longer a severe war dragged on, the worse the results and prospects would be for China,” the report states. “By 2025, however, inconclusive results in early fighting could motivate both sides to fight on despite heavy losses incurred and still expected. Although prospects for U.S. military victory then would be worse than they are today, this would not necessarily imply Chinese victory.”

#### No escalation --- we’d use counterforce strikes

Lieber and Press 16

Keir A. Lieber and Daryl G. Press. Keir A. Lieber is Director of the Security Studies Program and Associate Professor in the Edmund A. Walsh School of Foreign Service at Georgetown University. Daryl G. Press is Associate Professor in the Department of Government at Dartmouth College. “The New Era of Nuclear Weapons, Deterrence, and Conflict.” Strategic Studies Quarterly. Vol. 10, No. 5. 2016.

https://www.jstor.org/stable/pdf/26271621.pdf?refreqid=excelsior%3A928c663c72c835e2ad1bf2512a0f4eb3

“The United States is not seeking to neutralize adversary deterrent forces.”

Some critics argue that the United States is not seeking strategic primacy. They reject any intent behind the emergence of US nuclear primacy and downplay the effort to neutralize adversary deterrent forces in US military strategy. Instead of the United States bolstering its counterforce capabilities, critics emphasize how it is minimizing the role of nuclear weapons in national security strategy—as only this is consistent with international arms control and nonproliferation efforts aimed at convincing other states to forego strategic weapons, reduce existing arsenals, or cancel modernization programs. The implication is that we have mistakenly imputed sinister motives to US defense programs and planning.

Disavowal of the US pursuit of strategic primacy comes most frequently from those who work inside or outside the government on arms control and nonproliferation policy. Yet, those who work on US regional war plans and counterproliferation policy typically see nothing controversial in our claim that the United States seeks the ability to neutralize adversary strategic weapons. In fact, this effort appears to be official US policy. As a simple Internet search shows, the US government does not hide the wide range of research and planning efforts underway that fall under the rubric of “defeat WMD” or “combatting WMD.” And the underlying logic behind those efforts is simple: deterrence may fail, especially during conventional wars, and therefore the United States needs the ability to defend US forces, allies, and the US homeland from enemy WMD using, depending on the circumstances, conventional strikes, missile defenses, special operations, offensive cyber attacks, and in extreme cases nuclear strikes. In short, “defeating WMD” and “seeking strategic primacy” are essentially synonymous: protecting oneself from others’ strategic weapons (which sounds reasonable) and neutralizing others’ strategic deterrent forces (which sounds more malicious) are simply two phrases describing the same behavior.

**That kills 700 max**

**Lieber 17**

Keir A. Lieber, Associate Professor in the Edmund A. Walsh School of Foreign Service and the Department of Government at Georgetown University, and Daryl G. Press, Associate Professor in the Department of Government at Dartmouth College, The New Era of Counterforce: Technological Change and the Future of Nuclear Deterrence, Volume 41, Number 4, Spring 2017

Third, the emergence of a new era of counterforce raises the question of whether it is wise, for the United States in particular, to continue improving nuclear and nonnuclear counterforce capabilities. On the one hand, improved **counterforce capabilities** could be invaluable in a range of plausible scenarios.11 Improved offensive capabilities could help the United States **deter** weak countries from **initiating conventional conflicts** or from **escalating** in the midst of war. Enhanced counterforce capabilities could also help **protect U.S. forces, allies, and the U.S. homeland from nuclear attack if a conventional war did escalate**. On the other hand, better counterforce could be a source of danger: not only might improved disarming strike capabilities—in any country's hands—increase the temptation to attack, but also potential victims of disarming strikes will seek to escape their vulnerability, thereby possibly triggering arms racing and incentives to strike preemptively.12 Both views may be correct. The net benefit of decisions to enhance counter-force capabilities will therefore depend on the particular case. For countries that perceive a highly malign threat environment, face aggressive nuclear [End Page 12] armed adversaries, or have ambitious foreign policy goals, the benefits of developing advanced counterforce capabilities may outweigh the costs. For those countries that face a benign environment and have more modest goals, however, the secondary costs of enhancing counterforce may be too great. In any case, these contentious issues have not received sufficient attention; analysts and policymakers have largely overlooked the ways that rapidly changing technologies are eroding the foundation of deterrence. The remainder of this article is organized as follows. We first discuss the key role that arsenal survivability plays in nuclear deterrence theory. Second, we describe the main strategies that planners employ to ensure arsenal survivability in practice. Next, we explore one of the major technological trends eroding survivability, the **great leap in weapons accuracy**, and illustrate how improved accuracy creates new possibilities for counterforce strikes. We then focus on the second major trend, **dramatic improvements in remote sensing**, and how the resulting increase in transparency threatens **concealed and mobile nuclear forces**. We conclude with a summary of our findings and their implications for international politics and U.S. national security. Nuclear Survivability in Theory At its core, nuclear deterrence theory rests on two simple propositions. First, countries will not attack their adversaries if they expect the costs to exceed the benefits. Second, nuclear weapons allow countries, even relatively weak ones, to inflict unprecedented levels of damage on those who attack them. Taken together, these propositions suggest that nuclear weapons are the ultimate instruments of deterrence: no conceivable benefit of attacking a nuclear-armed state could be worth the cost of getting hit with nuclear weapons in retaliation. As long as nuclear arsenals are survivable, that is, able to withstand an enemy's first strike and retaliate, nuclear weapons are a tremendous force for peace. The theory of the nuclear revolution builds on the logic of deterrence theory and extends its implications. Because nuclear weapons make countries fundamentally secure, countries can escape the most pernicious consequences of anarchy. According to the theory of the nuclear revolution, once countries deploy survivable arsenals they no longer need to fear conquest.13 As a result, they [End Page 13] can stop worrying about the relative balance of power;14 engaging in arms races;15 or competing for alliance partners and strategic territory.16 Proponents of the theory of the nuclear revolution have always recognized the discrepancy between their theory's predictions and the actual behavior of countries in the nuclear era. The Cold War competition between the United States and the Soviet Union, in particular, is filled with empirical anomalies: extensive arms racing, intense concerns about relative power gains and losses, and competition for allies and control of strategic territory—all occurring at a time when the main adversaries appeared to be invulnerable to disarming strikes.17 World War III was averted, as nuclear deterrence theory would predict, [End Page 14] but the transformation of international politics that advocates of the theory of the nuclear revolution anticipated never materialized. Today, nuclear powers still eye each other's economic power and military capabilities warily; strive for superiority over their adversaries in conventional and nuclear armaments; aim to control strategically relevant areas of land, air, sea, and space; seek to build and maintain alliances; and prepare for war. The discrepancy between the theory of the nuclear revolution and the behavior of states stems from the theory's misplaced confidence in the survivability of nuclear arsenals.18 Proponents of the theory believe that nuclear weapons deployed in even moderate numbers are inherently survivable.19 Moreover, according to the argument, survivability is a one-way street: once a country deploys a survivable arsenal, it will remain that way. Yet, what if survivability is reversible? If arsenal survivability depends on the uncertain course of technological change and the efforts of adversaries to develop new technologies, states will feel compelled to arms race to ensure that their deterrent forces remain survivable in the face of adversary advances. They will worry about relative gains, because a rich and powerful adversary will have more resources to invest in technology and military forces. They will value allies, which help contribute resources and valuable territory. Moreover, states may be enticed to develop their own counterforce capabilities in order to disarm their adversaries or limit the damage those adversaries can inflict in case of war. In short, if nuclear stalemate can be broken, one should expect countries to act as they always have when faced with military threats: by trying to exploit new technologies [End Page 15] and strategies for destroying adversary capabilities. If arsenals have been more vulnerable than theorists assume, or if survivability and stalemate are reversible, then the central puzzle of the nuclear era—continued geopolitical competition—is no longer a puzzle. We argue not only that stalemate is reversible in principal, but also that changes in technology occurring today are making all countries' arsenals less survivable than they were in the past. The fear of suffering devastating retaliation will still do much to deter counterforce attacks, but countries will increasingly worry that their adversaries are trying to escape stalemate, and they will feel pressure to do the same. Deterrence will weaken as arsenals become more vulnerable. In extreme circumstances—for example, if an adversary threatens escalation (or begins to escalate) during a conventional war—the temptation to launch a disarming strike may be powerful.20 In short, in stark contrast to the expectations of the theory of the nuclear revolution, security competition has not only endured, but also will intensify as enhanced counterforce capabilities proliferate. Nuclear Survivability in Practice The survivability of retaliatory arsenals has long been a crucial objective of real-world military planning, not just a fertile topic of theoretical analysis. Military planners have employed three basic approaches to protect their countries' nuclear forces from attack: hardening, concealment, and redundancy. In terms of hardening, planners deploy missiles in reinforced silos designed to resist blast, heat, ground shock, and the other effects of nuclear detonations; place aircraft in hardened shelters; create protective sites for patrolling mobile missile launchers; and bury command and control sites, as well as the secure means used to communicate launch orders. Nuclear planners also rely heavily on concealment. Concealment is the foundation of survivability for mobile delivery systems, such as ballistic missile submarines (SSBNs) or mobile missile launchers (known as "transporter erector launchers," or TELs), both of which hide in vast deployment areas. Aircraft are harder to hide because they require airfields for takeoff and landing, but they too can employ concealment by dispersing to alternate airfields or remaining [End Page 16] airborne during alerts. Even the most difficult facilities to hide, hardened missile silos or command bunkers, can be concealed using camouflage and decoys. Finally, redundancy is used to bolster every aspect of the nuclear mission, especially force survivability. Most nuclear-armed states use multiple types of delivery systems and warheads to complicate enemy strike plans and protect against warhead design flaws. They spread their forces and warheads across multiple bases. Moreover, the most powerful nuclear-weapon states employ redundant communication networks, command and control arrangements, and early warning systems. No single strategy of survivability is ideal, because each entails important trade-offs. Hardening is attractive, but it comes at the price of concealment: for example, it is difficult to hide the major construction entailed in building a nuclear silo. Also, hardened sites are not mobile; once discovered, they remain so.21 Similarly, concealment comes at the price of hardening. If mobile forces are discovered, they tend to be easy to destroy. Concealment has another significant drawback: it is a "fail deadly" strategy, meaning that if an adversary develops a way to locate one's forces, one's arsenal might go from highly survivable to completely vulnerable almost overnight. Even worse, one might not know that the nuclear balance has shifted in such a calamitous manner.22 Some countries have adopted operating doctrines that attempt to capitalize on the advantages of both hardening and concealment: China today, for example, appears to plan to disperse its mobile missiles in a nuclear crisis from its peacetime garrisons to remote protective sites.23 Such approaches capture the [End Page 17] benefits of both strategies, but they also pay the costs. For example, China's strategy **leaves its forces vulnerable if an attacker has identified its dispersal sites** or detects mobile missiles in transit.24 Major technological trends are **directly undermining** these strategies of survivability. Leaps in weapons accuracy threaten nuclear forces that rely on hardening, while an unfolding revolution in remote sensing threatens nuclear forces that depend on concealment. (Another major change since the end of the Cold War, **far smaller nuclear arsenals** among potential adversaries, weakens the third strategy of survivability: redundancy.)25 Developing survivable forces is not impossible, but **a new age of vulnerability has begun**. Counterforce in the Age of Accuracy For most of the nuclear age, neither bombers nor ballistic missiles could deliver weapons accurately enough to reliably destroy hardened targets. Too many variables affected the impact point of a bomb—such as the aircraft's speed and altitude; the air defense environment; and atmospheric conditions including wind, temperature, and humidity—for even highly skilled crews to deliver bombs precisely.26 Long-range ballistic missiles were even less accurate. Although their initial deployment conjured fears of "bolt-from-the-blue" disarming strikes, throughout the 1970s long-range missiles were not accurate enough to destroy fields of hardened silos.27 **Technological improvements chipped away** at the sources of inaccuracy, however. Leaps in navigation and guidance, including advanced inertial sensors [End Page 18] with stellar updates, improved the ability of missiles to precisely determine their position in flight and guide themselves, as needed, back on course. Other breakthroughs allowed mobile delivery systems, such as submarines and mobile land-based launchers, to accurately determine their own position prior to launch, greatly improving their accuracy.28 As a result of these innovations, new missiles emerged in the mid-1980s with far better accuracy than their predecessors, rendering hardened targets vulnerable as never before. For bombers, onboard computers now continuously measure the variables that previously confounded bombardiers. Data on aircraft speed and location are uploaded from the aircraft into the computers of "smart" bombs and cruise missiles, which in turn automatically plot a flight path from the release location to the target. The weapons adjust their trajectory as they fly to remain on course.29 **As a result, bombs and missiles can achieve levels of accuracy unimaginable at the start of the nuclear age.** The leap in munitions accuracy has been showcased repeatedly during conventional wars: videos of missiles and bombs guiding themselves directly to designated targets now appear mundane. Although the effects of the accuracy revolution on nuclear delivery systems are equally dramatic, they have received far less attention, despite huge implications for the survivability of hardened targets. IMPROVED MISSILE ACCURACY Figure 1 illustrates one consequence of the accuracy revolution, as applied to nuclear forces, by comparing the effectiveness of U.S. ballistic missiles in 1985 to those in the current U.S. arsenal.30 We use formulas, employed by nuclear analysts for decades, to estimate the effectiveness of missile strikes against a [End Page 19] Figure 1. The Growing Vulnerability of Hard Targets, 1985–2017 NOTE: The calculations underlying this figure assume targets hardened to withstand 3,000 pounds per square inch (psi). Data for 1985 are based on the most capable U.S. land-based intercontinental ballistic missile (ICBM) and submarine-launched ballistic missile (SLBM) at the time: the Minuteman III ICBM armed with a W78 warhead and the Trident I C-4 SLBM armed with a W76 warhead. The 2017 ICBM data are based on the same Minuteman III / W78, with an improved guidance system. The 2017 SLBM data show both contemporary configurations of the Trident II D-5 missile: one version armed with the W76 and the other with higher-yield W88 warheads. The data and sources for U.S. weapon systems are in the online appendix, , table A1. Click for larger view View full resolution Figure 1. The Growing Vulnerability of Hard Targets, 1985–2017 NOTE: The calculations underlying this figure assume targets hardened to withstand 3,000 pounds per square inch (psi). Data for 1985 are based on the most capable U.S. land-based intercontinental ballistic missile (ICBM) and submarine-launched ballistic missile (SLBM) at the time: the Minuteman III ICBM armed with a W78 warhead and the Trident I C-4 SLBM armed with a W76 warhead. The 2017 ICBM data are based on the same Minuteman III / W78, with an improved guidance system. The 2017 SLBM data show both contemporary configurations of the Trident II D-5 missile: one version armed with the W76 and the other with higher-yield W88 warheads. The data and sources for U.S. weapon systems are in the online appendix, http://dx.doi:10.7910/DVN/NKZJVT, table A1. typical hardened silo.31 The figure distinguishes three potential outcomes of a missile strike: hit, miss, and fail. "Hit" means that the warhead detonates within the lethal radius (LR) of the aimpoint, thus destroying the target. "Miss" means that the warhead detonates outside the LR, leaving the target undamaged. "Fail" means that some element of the attacking missile system malfunctioned, leaving the target undamaged. [End Page 20] Figure 1 shows that the accuracy improvements of the past three decades have led to substantial leaps in counterforce capabilities. In 1985 a U.S. intercontinental ballistic missile (ICBM) had only about a 54 percent chance of destroying a missile silo hardened to withstand 3,000 pounds per square inch (psi) overpressure. In 2017 that figure exceeds 74 percent. The improvement in submarine-launched weapons is starker: from 9 percent to 80 percent (using the larger-yield W88 warhead). Figure 1 also suggests, however, that despite vast improvements in missile accuracy, the weapons still are not effective enough to be employed individually against hardened targets. Even modern ballistic missiles are expected to miss or fail 20–30 percent of the time. The simple solution to that problem, striking each target multiple times, has never been a feasible option because of the problem of fratricide: the danger that incoming weapons might destroy or deflect each other.32 The accuracy revolution, however, also offers a solution to the **fratricide**

**problem**, opening the door to assigning **multiple warheads against a single target**, and thus paving the way to **disarming counterforce strikes**. THE FADING PROBLEM OF FRATRICIDE One type of fratricide occurs when the prompt effects of nuclear detonations—radiation, heat, and overpressure—destroy or deflect nearby warheads. To protect those warheads, targeters must separate the incoming weapons by at least 3–5 seconds.33 A second source of fratricide is harder to overcome. Destroying hard targets typically requires low-altitude detonations (so-called ground bursts), which vaporize material on the ground. When the debris begins to cool, 6–8 seconds after the detonation, it solidifies and forms a dust cloud that envelops the target. Even small dust particles can be lethal to incoming warheads speeding through the cloud to the target. Particles in the debris cloud take approximately 20 minutes to settle back to ground.34 For decades, these two sources of fratricide, acting together, posed a major [End Page 21] problem for nuclear planners.35 Multiple warheads could be aimed at a single target if they were separated by at least 3–5 seconds (to avoid interfering with each other); yet, all inbound warheads had to arrive within 6–8 seconds of the first (before the dust cloud formed). As a result, assigning more than two weapons to each target would produce only marginal gains: if the first one resulted in a miss, the target would likely be shielded when the third or fourth warhead arrived.36 Improvements in accuracy, however, have greatly mitigated the problem of fratricide. As figure 1 shows, the proportion of misses—the main culprit of fratricide—compared to hits is fading. To be clear, some weapons will still fail; that is, they will be prevented from destroying their targets because of malfunctioning missile boosters, faulty guidance systems, or defective warheads. Those kinds of failures, however, do not generally cause fratricide, because the warheads do not detonate near the target. Only those that miss—that is, those that travel to the target area and detonate outside the LR—will create a dust cloud that shields the target from other incoming weapons. In short, leaps in accuracy are essentially reducing the set of three outcomes (hit, fail, or miss) to just two: hit or fail. The "miss" category, the key cause of fratricide, has **virtually disappeared**.37 THE CUMULATIVE CONSEQUENCES FOR COUNTERFORCE The end of fratricide is just one development that has helped negate hardening and increased the vulnerability of nuclear arsenals. The computer revolution has led to other improvements that, taken together, **significantly increase counterforce capabilities**. First, improved accuracy has transformed the role of ballistic missile submarines, turning these instruments of retaliation against population centers into potent counterforce weapons. Recall (from figure 1 above) that a 1985 submarine-launched ballistic missile (SLBM) had only a 9 percent chance of destroying a hardened target. This meant that although ballistic missile submarines could destroy "soft" targets (e.g., cities), they could not destroy the hardened sites that would be a key focus of a disarming attack. Increased [End Page 22] SLBM accuracy has added hundreds of SLBM warheads to the counterforce arsenal; it has also unlocked other advantages that submarines possess over land-based missiles. For example, submarines have flexibility in firing location, allowing them to strike targets that are out of range of ICBMs or that are deployed in locations that ICBMs cannot hit.38 Submarines also permit strikes from close range, reducing an adversary's response time. And because submarines can fire from unpredictable locations, SLBM launches are more difficult to detect than ICBM attacks, further reducing adversary response time before impact. Second, upgraded fuses are making ballistic missiles even more capable than figure 1 reports. In a compelling new analysis, Theodore Postol explores the implications of new "compensating" fuses that exist on most U.S. SLBMs and that will soon be deployed on the entire force.39 Reentry vehicles equipped with this fusing system use an altimeter to measure the difference between the actual and expected trajectory of the reentry vehicle, and then compensate for inaccuracies by adjusting the warhead's height of burst.40 Specifically, if the altimeter reveals that the warhead is off track and will detonate "short" of the target, the fusing system lowers the height of burst, allowing the weapon to travel farther (hence, closer to the aimpoint) before detonation. Alternatively, if the reentry vehicle is going to detonate beyond the target, the height of burst is adjusted upward to allow the weapon to detonate before it travels too far.41 Without this technology, as figure 1 shows, the lower-yield W76 warheads are much less effective against hardened targets than their higher-yield cousins, the W88s. The improved fuse cuts the effectiveness gap roughly in half, making the hundreds of W76s in the U.S. arsenal potent counterforce weapons for the first time.42 **The consequences** of the new fuse [End Page 23] **are**, therefore, **profound**, essentially **tripling the size of the U.S. submarine-based arsenal against hard targets**.43 More broadly, the technology at the core of compensating fuses is available to any state capable of building modern multistage ballistic missiles.44 A third key improvement, rapid missile retargeting, increases the effectiveness of ballistic missiles by reducing the consequence of malfunctions. As figure 1 illustrates, when accuracy increases, missile reliability becomes the main hurdle to attacks on hardened targets. For decades analysts have recognized a solution to this problem: if missile failures can be detected, the targets assigned to the malfunctioning missiles can be rapidly reassigned to other missiles held in reserve.45 The capability to retarget missiles in a matter of minutes was installed at U.S. ICBM launch control centers in the 1990s and on U.S. submarines in the early 2000s, and both systems have since been upgraded.46 We do not know if the United States has adopted war plans that fully exploit rapid reprogramming to minimize the effects of missile failures.47 Nevertheless, such a targeting approach is within the technical capabilities of the United States and other major nuclear powers and may already be incorporated into war plans.48 [End Page 24] Table 1 illustrates the consequences of these improvements against two hypothetical target sets: 100 moderately hard mobile missile shelters and 200 hardened missile silos.49 Row 1 shows the approximate counterforce capabilities of a 1985-era U.S. Minuteman III ICBM strike; a 2-on-1 attack would have been expected to leave 8 mobile missile shelters intact. A strike against 200 hardened silos would fare worse, with 42 targets expected to survive. The remaining rows in table 1 highlight the implications of the changes that have occurred from 1985 to 2017. Row 2 illustrates the impact of improved Minuteman III guidance, which reportedly reduced circular error probable (CEP) from 183 to 120 meters. Row 3 employs the most capable missile and warhead combination in the current U.S. arsenal: the Trident II armed with a high-yield W88 warhead. As the results in both rows show, upgraded missiles perform better than their predecessor, but not well enough to conduct effective disarming strikes against large target sets. Rows 4–7 demonstrate how the various improvements in missile technology have combined to create transformative counterforce capabilities. In row 4, we use a more realistic figure for missile system reliability. Although 80 percent missile reliability is traditionally used as a baseline, **much evidence suggests that the actual reliability of modern missiles exceeds 90 percent**.50 Row 4 shows attack outcomes for a Trident II/W88 with 90 percent reliability. Row 5 shows the consequences if the United States can reprogram its missiles [End Page 25] Table 1. The Demise of Hard Target Survivability NOTE: Results are displayed for 100 mobile missile shelters hardened to withstand up to 1,000 pounds per square inch (psi) or 200 missile silos hardened to 3,000 psi. Yield is in kilotons and circular error probable (CEP) is in meters. The column "Attack Plan" indicates the number of warheads assigned to each target; "R" (for reprogramming) means that the attacker uses reserve missiles to replace boost phase malfunctions. The columns titled "p(K)" list the probability that each individual target is destroyed, and "Survives" is the expected number of targets surviving the attack. The designation of "0.99+" under p(K) indicates 99.9 percent or greater chance of destroying each individual target. Light shaded cells indicate successful disarming attacks; darker cells indicate very successful strikes. Note that a single surviving mobile missile shelter does not necessarily imply that a mobile missile survived, whereas a surviving silo suggests a surviving missile. Click for larger view View full resolution Table 1. The Demise of Hard Target Survivability NOTE: Results are displayed for 100 mobile missile shelters hardened to withstand up to 1,000 pounds per square inch (psi) or 200 missile silos hardened to 3,000 psi. Yield is in kilotons and circular error probable (CEP) is in meters. The column "Attack Plan" indicates the number of warheads assigned to each target; "R" (for reprogramming) means that the attacker uses reserve missiles to replace boost phase malfunctions. The columns titled "p(K)" list the probability that each individual target is destroyed, and "Survives" is the expected number of targets surviving the attack. The designation of "0.99+" under p(K) indicates 99.9 percent or greater chance of destroying each individual target. Light shaded cells indicate successful disarming attacks; darker cells indicate very successful strikes. Note that a single surviving mobile missile shelter does not necessarily imply that a mobile missile survived, whereas a surviving silo suggests a surviving missile. [End Page 26] to replace boost-phase failures. As row 5 reveals, a 2-on-1 attack with reprogramming would be expected to destroy every hardened shelter or silo. Row 6 omits reprogramming, but it demonstrates the impact of the decline in fratricide by adding a third warhead to each target, resulting again in the destruction of either target set. Row 7 illustrates the impact of compensating fuses. This row, unlike the others, employs the lower-yield warhead on the Trident II missiles (the W76). With the compensating fuse, a 2-on-1 attack using W76s would be expected to destroy all the mobile missile shelters and all but one of the hardened silos. (An attack that mixed W88s and W76s could destroy the entire hardened silo force.) The results in table 1 are simply the output of a model. In the real world, the effectiveness of any strike would depend on many factors not modeled here, including the skill of the attacking forces, the accuracy of target intelligence, the ability of the targeted country to detect an inbound strike and "launch on warning," and other factors that depend on the political and strategic context. As a result, these calculations tell us less about the precise vulnerability of a given arsenal at a given time—though one can reach arresting conclusions based on the evidence—and more about trends in how technology is undermining survivability.51 One crucial consequence of the accuracy revolution is not captured in the above results. Yet, its impact on the vulnerability of nuclear arsenals may be just as profound. The accuracy revolution has rendered **low-casualty counter-force attacks** plausible for the **first time**. THE DAWN OF LOW-CASUALTY COUNTERFORCE In nuclear deterrence theory, the primary factor preventing nuclear attack is the attacker's fear of retaliation. In reality, however, additional sources of inhibition exist, including the terrible civilian consequences of an attempted counterforce strike. If a leader contemplating a disarming strike knows that such an attack will inflict massive casualties on the enemy, that leader will also understand that the failure to disarm the enemy will provoke a massive punitive response, foreclosing the possibility of a limited nuclear exchange. Furthermore, if a disarming strike would cause enormous civilian casualties in the target country, but also possibly in allied and neutral neighboring countries, leaders who value human life or the fate of allies would contemplate such an [End Page 27] attack in only the direst circumstances. The link between civilian casualties and nuclear inhibition explains why many arms control advocates oppose the development of less destructive nuclear weapons; they worry that such weapons are more "usable."52 Counterforce was tantamount to mass casualties throughout the nuclear age, **but the accuracy revolution is severing that link**. In the past, the main impediment to low-casualty nuclear counterforce strikes has been **radioactive fallout**. Targeters would have had to rely on ground bursts to maximize destructive effects against hardened facilities such as silos and storage sites. Detonations close to the ground have a major drawback, however: debris is sucked up into the fireball, where it mixes with radioactive material, spreading radiation wherever it settles. Although the other effects of nuclear detonations (e.g., blast and fire) can have large-scale consequences for civilians, in many circumstances those effects can be minimized.53 If a strike produces fallout, however, the consequences are potentially vast and difficult to predict.54 In theory, it has always been possible to employ nuclear weapons without creating much fallout. If weapons are detonated at high altitude (above the "fallout threshold"), very little debris from the ground will be drawn up into the fireball, greatly reducing fallout.55 In practice, however, this targeting strategy has never been feasible against hardened sites. The problem is that any high-yield weapon that detonates low enough to destroy a hardened target will also be low enough to create fallout. Low-yield weapons could do the job and remain above the fallout threshold, but that has always been impractical because low-yield weapons would need to be delivered with great precision to destroy hardened sites, which was previously impossible.56 [End Page 28] Figure 2. The Potential for Low-Fallout Nuclear Counterforce NOTE: "Target hardness" (the horizontal axis) is measured in pounds per square inch (psi), with a typical range of psi for hardened mobile missile shelters and missile silos noted. "Yield" (the vertical axis) is measured in kilotons and plotted on a logarithmic scale. The curve depicts the maximum weapon yield that can destroy a given target from above the fallout threshold. Any weapon yield/target hardness combination above the line that is effective enough to destroy the target will necessarily result in fallout. Points below the line indicate that weapons can be detonated at an altitude that will destroy the target yet produce little or no fallout. See the online appendix for calculations. Click for larger view View full resolution Figure 2. The Potential for Low-Fallout Nuclear Counterforce NOTE: "Target hardness" (the horizontal axis) is measured in pounds per square inch (psi), with a typical range of psi for hardened mobile missile shelters and missile silos noted. "Yield" (the vertical axis) is measured in kilotons and plotted on a logarithmic scale. The curve depicts the maximum weapon yield that can destroy a given target from above the fallout threshold. Any weapon yield/target hardness combination above the line that is effective enough to destroy the target will necessarily result in fallout. Points below the line indicate that weapons can be detonated at an altitude that will destroy the target yet produce little or no fallout. See the online appendix for calculations. Figure 2 illustrates why high-yield strikes against hard targets inevitably create fallout, and it highlights the potential low-yield solution to the fallout problem. The vertical axis reflects weapon yield, and the horizontal axis depicts the hardness of potential targets—with the approximate values for mobile missile shelters and missile silos indicated. The solid black line shows the maximum yield of a weapon that can generate enough overpressure to destroy a target from above the fallout threshold. For example, figure 2 shows that for a 3,000 psi target, the highest-yield weapon that can destroy it while remaining above the fallout threshold is 0.35 kilotons. A larger-yield weapon will necessarily cause fallout if it destroys the target. A low-fallout strike against a 1,000 psi mobile missile shelter would require a weapon with 50 kilo [End Page 29] tons yield, or less. In short, low-fatality nuclear counterforce is possible, but it requires low-yield weapons, and hence very accurate delivery. The accuracy of nuclear delivery systems is now to the point that low-casualty disarming strikes are possible. For example, a 0.3 kiloton bomb would require a CEP of 10–15 meters to be highly effective against hard targets;57 that level of accuracy is likely within the reach of the new guided B61-12, which is slated to replace all nuclear gravity bombs in the U.S. arsenal.58 Similarly, a 5-kiloton missile warhead, which may approximate the yield of the fission primary on many existing ballistic missiles, could destroy a hardened target if its CEP was approximately 50 meters.59 That level of accuracy was implausible for most of the Cold War, yet it is within reach of many countries today.60 By detonating weapons above the fallout threshold, targeters can greatly reduce fallout relative to ground bursts. But how significant are these reductions? How many fewer deaths would be caused in comparison with ground burst strikes? To compare the fallout and potential fatalities from high-yield and low-yield counterforce operations, we used unclassified U.S. Defense Department software, called Hazard Prediction and Assessment Capability (HPAC).61 We modeled two different counterforce strikes, one using a "traditional" high-yield approach and one employing low-yield airbursts, against five hardened targets in North Korea (e.g., nuclear storage sites or hardened mobile missile shelters). Because there is no available unclassified information about the location of North Korea's nuclear storage sites, we modeled strikes against notional locations around the DPRK's periphery. [End Page 30] Figure 3. Low-Fallout Counterforce Option against North Korea NOTE: The figure illustrates the potential fallout consequences of two alternative counter-force strikes against five notional North Korean hardened nuclear sites. In both strike options, each target is destroyed with **greater than 95 percent probability**. The high-yield attack employs ten W88 warheads (455-kiloton yield), with two warheads against each target. Because high-yield weapons cannot destroy hardened sites from above the fallout threshold, the W88s are ground bursts. The low-yield attack uses twenty B61 bombs (0.3-kiloton yield), set to detonate at an altitude that maximizes effectiveness while minimizing fallout. The fallout patterns and casualty figures were generated using unclassified U.S. Defense Department software, called Hazard Prediction and Assessment Capability. Click for larger view View full resolution Figure 3. Low-Fallout Counterforce Option against North Korea NOTE: The figure illustrates the potential fallout consequences of two alternative counter-force strikes against five notional North Korean hardened nuclear sites. In both strike options, each target is destroyed with greater than 95 percent probability. 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As long as the targets were located outside North Korean cities, the number of Korean fatalities from a low-yield strike would be comparable to the human losses from conventional operations. In fact, the fallout contours that are visible in figure 3 for the low-yield scenario correspond to annual radiation levels deemed acceptable by the U.S. Occupational Safety and Health Administration. The precise results of the HPAC simulation should be treated with skepticism: wind speed and direction change constantly, altering fallout patterns. The amount of fallout generated in the low-yield scenario is so low, however, that the results of figure 3 are robust regardless of which way the wind blows: [End Page 31] few people located away from the actual targets would be killed. The point of figure 3 is not to predict the outcome of a counterforce strike on North Korea, but to reveal the relationship between accuracy and fallout. When accuracy was poor, the only approach to nuclear counterforce was high-yield strikes, which would create catastrophic results such as the one depicted above. The accuracy revolution has **changed the calculus**, however; **low-fatality nuclear strikes are now possible**.62 The accuracy revolution is ongoing. As accuracy continues to improve, the effectiveness of conventional attacks on hard targets will continue to increase. Today, low-yield nuclear weapons can destroy targets that once required very large yield detonations. In the future, many of those targets will be vulnerable to conventional attacks. In sum, from the start of the nuclear age to the present, force planners have relied on hardening as a key strategy for ensuring the survivability of their arsenals. That strategy made sense, and until recently ensured that disarming strikes would not only fail, but also kill millions of civilians in the process. Technology never stands still, however, and the technical foundations of deterrence, particularly for the strategy of hardening, have been greatly undermined by leaps in accuracy. Counterforce in the Age of Transparency While advances in accuracy are negating hardening as a strategy for protecting nuclear forces, leaps in remote sensing are undermining the other main approach: concealment. Finding concealed forces, particularly mobile ones, remains a major challenge. Trends in technology, however, are eroding the security that mobility once provided. In the ongoing competition between "hiders" and "seekers," waged by ballistic missile submarines, mobile land-based missiles, and the forces that seek to track them, the hider's job is growing more difficult than ever before. Five trends are ushering in an age of unprecedented transparency.63 First, [End Page 32] sensor platforms have become more diverse. The mainstays of Cold War technical intelligence—satellites, submarines, and piloted aircraft—continue to play a vital role, and they are being supplemented by new platforms. For example, remotely piloted aircraft and underwater drones now gather intelligence during peacetime and war. Autonomous sensors, hidden on the ground or tethered to the seabed, monitor adversary facilities, forces, and operations. Additionally, the past two decades have witnessed the development of a new "virtual" sensing platform: cyberspying.64 Second, sensors are collecting a widening array of signals for analysis using a growing list of techniques. Early Cold War strategic intelligence relied heavily on photoreconnaissance, underwater acoustics, and the collection of adversary communications—all of which remain important. Now, modern sensors gather data from across the entire electromagnetic spectrum; they employ seismic and acoustic sensors in tandem; and they emit radar at various frequencies depending on their purpose, for example, to maximize resolution or to penetrate foliage. Modern remote sensing exploits an increasing number of analytic techniques, including spectroscopy to identify the vapors leaking from faraway facilities, interferometry to discover underground structures, and signals processing techniques (such as those underpinning synthetic aperture radars) that allow radars to perform better than their antenna size would seem to permit.65 Third, remote sensing platforms increasingly provide persistent observation. At the beginning of the Cold War, strategic intelligence was hobbled by sensors that collected snapshots rather than streams of data. Spy planes sprinted past targets, and satellites passed overhead and then disappeared over the horizon. Over time those sensors were supplemented with platforms that remained in place and soaked up data, such as signals intelligence antennas, undersea hydrophones, and geostationary satellites. The trend toward persistence is continuing. Today, remotely piloted vehicles can loiter near enemy targets, and autonomous sensors can monitor critical road junctures for months or years. Persistent observation is essential if the goal is not merely to count enemy weapons, but also to track their movement. [End Page 33] The fourth factor in the ongoing remote sensing revolution is the steady improvement in sensor resolution. In every field that employs remote sensing technology, including medicine, geology, and astronomy, improved sensors and advanced data processing are permitting more accurate measures and fainter signals to be discerned from background noise. The leap in satellite image resolution is but one example: the first U.S. reconnaissance satellite (Corona) could detect objects as small as 25 feet across. Today, even commercial satellites (e.g., DigitalGlobe's WorldView-3 and WorldView-4) can collect images with 1-foot resolution, and U.S. spy satellites are reportedly capable of resolutions less than 4 inches.66 Advances in resolution are not merely transforming optical remote sensing systems; they are extending what can be seen by infrared sensors, advanced radars, interferometers and spectrographs, and many other sensors. The fifth key trend is the huge increase in data transmission speed. During the first decades of the Cold War, it took days or longer to transmit information from sensors to analysts. At least a full day passed before the photographs snapped by U-2 aircraft were developed and analyzed. Early satellites were slower: the satellite had to finish its roll of film, and then eject the canister, which would be caught midair and flown to a facility for development and analysis. All told, images collected at the beginning of a satellite mission might take weeks before they arrived at an analyst's desk. Today, by contrast, intelligence gathered by aircraft, satellites, and drones can be transmitted in nearly real time. The data can be transmitted to intelligence analysts, political leaders, and in some cases directly to military commanders conducting operations. None of these technological trends alone is transformative. Taken together, however, they are creating a degree of transparency that was unimaginable even two decades ago. These new remote sensing technologies are not proliferating around the world evenly; the United States, for example, seems to have exploited new sensing technologies more intensively than other countries. Many countries are developing expertise in advanced sensing, however. The sensing revolution is a global phenomenon, with implications for the survivability of all countries' nuclear arsenals. Remote sensing technologies have improved greatly, but the crucial question is whether these advances have meaningfully increased the vulnerability of the two most elusive types of nuclear delivery systems: SSBNs and mobile land-based missiles. If the ability to track submarines at sea or mobile missiles [End Page 34] on patrol remains out of reach, then the counterforce improvements we identify are less significant, at least for now. In fact, SSBNs have never been as invulnerable as analysts typically assume, and advances in remote sensing appear to be reducing the survivability of both submarines and mobile missiles. REMOTE SENSING AND TRACKING SUBMARINES During the Cold War, the competition between submariners and antisubmarine warfare operators was shrouded in secrecy, but that history is finally being revealed. We now know that the United States was able to locate, and even track, Soviet SSBNs during extended periods of the Cold War.67 The core of U.S. ASW efforts against the Soviet Union lay in a series of breakthroughs in passive sonar and signals processing, as well as doctrine and tactics to exploit those advances. Starting in the 1950s, the United States deployed an expanding network of underwater hydrophones designed to identify and locate adversary submarines. Data from the hydrophones were transmitted across undersea cables to onshore computing facilities, where powerful computers discerned the faint sounds of submarines from ocean noise. Potential targets were then passed along to aircraft and attack submarines (SSNs) for further location and tracking. U.S. capabilities to track Soviet submarines leapt forward in the late 1960s and 1970s, as the United States deployed new attack submarines, which were equipped with powerful sonars in their bows, towed sonar arrays, and improved on-ship computing power, giving U.S. SSNs an unprecedented combination of acoustic gathering and data processing capabilities.68 The competition between Soviet SSBNs and the pack of U.S. submarines, aircraft, and surface ships hunting them varied throughout the Cold War. There were periods in which U.S. forces were winning, trailing every Soviet SSBN on patrol, from port to sea and back. In later periods, after discovering their vulnerability, the Russians pulled their forces into protected "bastions" near Soviet territory to counter the U.S. ASW strategy. The United States did not give up, and worked until the end of the Cold War (and beyond) to regain undersea superiority. [End Page 35] The duration of U.S. Cold War ASW superiority cannot be accurately assessed today because of enduring classification constraints. But for periods of the superpower competition, U.S. naval leaders believed they had the ASW problem well in hand. As the former commander of the U.S. Pacific Fleet in the mid-1980s remarked, the United States was able to "identify by hull number the identity of Soviet subs…and know exactly where they were. In port or at sea. If they were at sea, N3 [director for operations] had an SSN [on them]."69 There are three key lessons to draw from the Cold War ASW competition. First, previous advances in remote sensing greatly increased the vulnerability of deployed submarines.70 Second, escaping vulnerability was no easy task. In the late 1960s, the Soviet Union learned that its submarines were vulnerable. But despite Moscow's significant economic and technological resources, it took the Soviet navy more than a decade to develop good countermeasures against the evolving U.S. ASW capabilities.71 Third, and most broadly, the Cold War ASW competition demonstrates that the deployment of ballistic missile submarines neither ended the Cold War nuclear competition nor negated hopes on either side of attaining military superiority. The United States led the undersea competition for a time because of its superior technology and tactics; the Soviet Union developed countermeasures because it discovered its vulnerabilities and innovated. This back-and-forth struggle between hiders and seekers looks more like a traditional struggle for naval superiority than the common depiction of invulnerable submarines. Today's technological advances in remote sensing, data processing, and communication are occurring at a rapid pace, and their ultimate impact on the submarine competition is too uncertain to predict with confidence (especially given the tight controls over information on contemporary ASW capabilities). Yet, there are good reasons to suspect that the dramatic leaps in remote sensing are increasing the transparency of the seas and undermining the ability of submarines to remain concealed.72 Some of the promising new anti-submarine [End Page 36] technologies include improved acoustic sensors (including low-frequency active sonars and new networks of seabed passive sonars); non-acoustic techniques (such as laser detection); sophisticated "big data" analysis (which exploits leaps in processor speed to sift vast quantities of sensor data); and a variety of unmanned and autonomous undersea vehicles (including those designed to find and shadow adversary submarines for weeks or months).73 The point is not that submarines are now easy to locate or that the challenges of ASW have been solved. Locating technologically sophisticated, well-operated submarines in vast ocean sanctuaries remains a substantial challenge. Rather, the key point is that even the nuclear delivery system sometimes touted as the most survivable has been vulnerable in the past and appears to be increasingly vulnerable today, as ASW efforts and capabilities rapidly improve. What about mobile land-based missiles? Are breakthroughs in sensing technology increasing their vulnerability as well? REMOTE SENSING AND HUNTING MOBILE MISSILES We illustrate the impact of two advanced surveillance systems, radar satellites and remotely piloted aircraft, on the survivability of mobile land-based nuclear missiles. The effectiveness of sensing systems depends on the characteristics of the target country—for example, its size, location, topography, and defenses. As such, their impact is difficult to quantify in the abstract. Instead, we explore the potential contributions of two advanced sensor systems in a hypothetical case: a U.S.-led operation to destroy a small arsenal of North Korean nuclear-tipped mobile missiles.74 We assume that North Korea's TELs are postured like most other countries' mobile missiles; they remain in hardened shelters during peacetime, with plans to disperse a portion of the force during a conflict.75 U.S. and allied strategic intelligence would have at least three critical roles in [End Page 37] support of a military operation against North Korean TELs. The first, a peacetime mission called "intelligence preparation of the battlefield" (IPB), involves locating North Korea's nuclear and missile facilities, identifying the patrol routes utilized by its missile forces, learning its organizational routines, and mapping its command and communication network. The other two roles are principally wartime missions. "Detection" refers to sensing possible targets; it typically involves sensors that can monitor large areas, but that have inadequate resolution for positive identification or targeting. "Identification" is the next step; once a possible target is detected, other platforms (often with higher-resolution sensors) are cued to identify and precisely locate the target.76 SATELLITES/SAR SENSORS A core element of U.S. surveillance capabilities lies in a constellation of satellites that use synthetic aperture radar to image targets on the ground. Satellites provide a unique capability to peer deep into adversary territory, and they are especially useful for missions that require frequent observations of critical facilities. Whereas manned aircraft and unmanned aerial vehicles (UAVs) are often restricted from adversary airspace, satellites routinely overfly adversary territory. Moreover, unlike satellites with optical or infrared sensors, radar satellites can image targets at night and through cloudy weather. Until recently, the type of radar employed on most satellites—synthetic aperture radar (SAR)—could not image moving targets, limiting the effectiveness of space-based sensors for hunting mobile missiles.77 But over the past two decades, engineers have developed data-processing techniques that enable SAR systems to detect moving targets and determine their speed and direction of travel.78 Although the precise capabilities of intelligence satellites are classified, [End Page 38] civilian radar satellites can scan approximately 150-kilometer-wide swaths along the ground as they pass overhead with sufficient resolution to detect truck-sized moving vehicles.79 New techniques are being developed that may soon double or triple the width of the swath that can be scanned on each pass.80 SAR-equipped satellites, now able to find mobile targets, have the potential to transform counter-TEL operations. If U.S. intelligence satellites can detect moving vehicles within a 150-kilometer-wide swath along the ground, a conservative assumption given that a civilian satellite launched nearly a decade ago can do so, then centering the radar on a mobile missile garrison would put all the roads within two hours' drive-time of that facility within the radar's swath width.81 A single satellite can generate up to twelve 150 kilometer x 150 kilometer swaths in a single pass over North Korea, enough to image all the country's roads more than once—and key sections multiple times—before passing over the horizon.82 Although SAR satellites have become powerful tools for hunting TELs, they have important limitations. Surveillance satellites provide only intermittent coverage of key areas, passing overhead and then descending over the horizon. Thus, even if a constellation of satellites could image the entire road network in North Korea every hour, North Korean TELs might be able to disperse without being observed, by seeking shelter whenever a satellite approaches. Furthermore, if many of North Korea's critical facilities are located in its mountainous regions, topography may block the satellite's line-of-sight, which would allow targets within the swath to be hidden from the radar. The potential effectiveness of radar satellites for hunting mobile missiles, therefore, depends [End Page 39] on two key factors: the time interval between satellite passes and the percentage of road network that is observable in a given pass.83 To assess the effectiveness of SAR satellites for hunting North Korean mobile missiles, we conducted an analysis with three key steps. First, we created a digital map of North Korea's roads. Second, we used geospatial analysis software to determine the visible portion of those roads as a function of a satellite's position. Third, we calculated the frequency with which satellites pass within an orbital band that provides high levels of visibility of the road network.84 Our analysis of satellite orbits and North Korean topography reveals that satellites passing through an orbital band that stretches as far as 1,500-kilometer lateral distance from the Korean Peninsula can view, on average, 90 percent of North Korean roads. A typical radar satellite (which operates in low earth orbit) will pass through such a band, what we call a "usable pass," roughly 2.5 times per day. The total number of usable passes per day thus depends on the number of SAR satellites in orbit that are available for hunting mobile missiles. The number of available satellites, in turn, depends on the willingness of the United States and its close allies to share sensitive satellite imagery, the technical preparations that have been undertaken to facilitate that sharing, and the precise technical capabilities of the satellites. Table 2 shows the implications of different assumptions about those uncertainties. If the United States and key allies create the political and technical arrangements to share satellite data during wartime, North Korean TEL commanders would have little time between passes—specifically, as few as 24 minutes.85 Twenty-four minutes between satellite passes could provide enough time for TELs or other vehicles to move quickly from shelter to shelter, but that strategy requires precise information on satellite orbits, and the short time interval between passes leaves little margin for error for vehicles racing for cover. Moreover, the challenge for TEL operators is more serious than the data suggest. The analysis here focuses on the twenty military and intelligence SAR [End Page 40] satellites, not the half dozen or more U.S. and allied civilian platforms that might be pressed into service in wartime.86 Nor does the analysis count the optical and infrared satellites that supplement SAR coverage. Finally, the number and capability of radar satellites available to the United States is growing.87 As that number increases, the window for mobile missiles to scoot away without being observed will narrow further. Table 2. Synthetic Aperture Radar (SAR) Satellites and Frequency of Usable Passes NOTE: The category "Number of SAR Satellites" counts major military and intelligence SAR satellites operated by the United States and key allies. The other columns are cumulative and show how satellite coverage grows when one adds the assets of various U.S. partners. "Usable Passes per Day" indicates the daily satellite overflights that pass through an orbital band that offers, on average, 90 percent coverage of North Korean roads. Click for larger view View full resolution Table 2. Synthetic Aperture Radar (SAR) Satellites and Frequency of Usable Passes NOTE: The category "Number of SAR Satellites" counts major military and intelligence SAR satellites operated by the United States and key allies. The other columns are cumulative and show how satellite coverage grows when one adds the assets of various U.S. partners. "Usable Passes per Day" indicates the daily satellite overflights that pass through an orbital band that offers, on average, 90 percent coverage of North Korean roads. SAR satellites do not solve the problem of locating mobile targets. For one thing, Russia and China are improving their ASAT capabilities, partly in response to U.S. capabilities.88 Furthermore, adversaries will seek to place missile garrisons and conduct deterrent patrols in locations that are difficult to observe.89 Those choices, however, force adversaries into ever-narrower zones, which then become the focus of other surveillance tools—for example, stealthy penetrating UAVs and unattended ground sensors. [End Page 41] In terms of the three key sensing missions (IPB, detection, and identification), SAR-equipped satellites offer a high level of capability for the IPB mission, because they can repeatedly image stationary or moving targets in peacetime. They also contribute a high level of capability to detection, by offering frequent wide-area coverage of North Korean roads. Finally, SAR satellites offer fairly good capability for the identification mission: they can produce high-resolution images of stationary TELs and enough resolution of moving vehicles to determine that a target is "truck-sized."90 UAVS/SAR SENSORS A second set of sensing capabilities lies in a fleet of aircraft, including manned and remotely piloted vehicles, that use powerful radars to scan adversary territory. These aircraft carry SARs, and many are equipped with Ground Moving Target Indicator (GMTI) radars, allowing them to create high-resolution images of stationary targets or track a large number of moving vehicles. Most surveillance aircraft must operate from "standoff" distances to reduce their vulnerability to air defenses. Some drones, however, are stealthy and can penetrate adversary airspace. Below we illustrate the capabilities of standoff SAR/GMTI platforms and penetrating UAVs in the context of a U.S. and allied operation against North Korean mobile missiles. The United States uses several types of aircraft for standoff radar-reconnaissance missions; we base our model on one of them: the remotely piloted RQ-4 Global Hawk. We explore the potential effectiveness of radar surveillance from four continuous orbits 80 kilometers outside North Korean territory.91 ArcGIS software allows us to identify orbital locations that maximize coverage of North Korean roads, as well as calculate the visible percentage of the road network from those locations.92 Figure 4 shows the results. Figure 4 reveals that even against a small country such as North Korea, standoff airborne radars cannot, by themselves, provide complete coverage of key roads and regions. Four orbits can observe 54 percent of North Korea's roads; the remainder is out of sensor range or shielded by mountainous terrain. These results also suggest, however, that standoff UAVs could play a crucial role in a sensing operation; that is, the ability to continuously monitor [End Page 42] roughly half of North Korea's road network during a conflict would compel North Korea to constrain its mobile missile operations to the north-central region of the peninsula. Figure 4. Coverage of North Korea with Standoff Unmanned Aerial Vehicles (UAVs) NOTE: The white circles depict potential orbital locations for four UAVs; the locations were selected to maximize surveillance of North Korea's road network. The orbits are located 80 kilometers from North Korea's territory at an altitude of 60,000 feet, which reflect plausible operations for RQ-4 Global Hawks. White road segments are observable from at least one of the locations. For additional discussion of the underlying analysis, see the online appendix at . The image was created using ArcGIS and road data from OpenStreetMap and DIVA-GIS. Click for larger view View full resolution Figure 4. Coverage of North Korea with Standoff Unmanned Aerial Vehicles (UAVs) NOTE: The white circles depict potential orbital locations for four UAVs; the locations were selected to maximize surveillance of North Korea's road network. The orbits are located 80 kilometers from North Korea's territory at an altitude of 60,000 feet, which reflect plausible operations for RQ-4 Global Hawks. White road segments are observable from at least one of the locations. For additional discussion of the underlying analysis, see the online appendix at http://dx.doi:10.7910/DVN/NKZJVT. The image was created using ArcGIS and road data from OpenStreetMap and DIVA-GIS. In addition to standoff UAVs, the United States has developed drones for so-called penetrating operations.93 These UAVs reduce their visibility to enemy radar [End Page 43] by utilizing stealth technologies and a combination of passive sensors and "low-probability of intercept" (LPI) radars to observe targets on the ground.94 Even sophisticated, stealthy UAVs are vulnerable to air defenses. To some extent their vulnerability depends on technical questions, for example, the state of competition between radar engineers and designers of stealth technology. The vulnerability of penetrating drones, however, depends greatly on their mission. Of the two critical wartime missions, "detection" is likely more dangerous than "identification." The detection mission—continuously monitoring a large area to detect possible targets—would require a drone to remain within the line-of-sight of a large portion of adversary territory. The mission would, therefore, require the drone to fly at high altitude (to maximize line-of-sight) and possibly use active sensors (to maximize the drone's sensor range). The identification mission, on the other hand, would allow penetrating drones to protect themselves better: to operate at lower altitude so that terrain would shield them from enemy sensors, and fly (when cued by detection systems) to investigate a possible TEL. Only then would the penetrating UAV employ LPI or passive sensors to examine the potential target. We used ArcGIS to explore the potential capability of penetrating drones in the identification mission by determining the percentage of the North Korean road network that would be visible using four UAV orbits. Because the penetrating UAVs would need to rapidly identify the vehicles detected by other sensors, we restricted the UAVs to 5 minutes of flight time to maneuver into position to observe the suspected TEL.95 Furthermore, because LPI radars and passive sensors have shorter range than the powerful radars on standoff platforms, we limit the sensor range to 50 kilometers.96 Our analysis reveals that four penetrating drones, operating as we describe above, can identify targets along 84 percent of North Korea's roads.97 As figure 5 [End Page 44] shows, penetrating and standoff systems would be particularly effective in combination, increasing the road network coverage to 97 percent. Assuming that penetrating UAVs can be cued by other reconnaissance systems, such as satellites, unattended ground sensors, or (near the coast) standoff drones, North Korean TEL operators would have great difficulty moving safely along the country's road network without being detected. If U.S. and South Korean intelligence had identified mobile missile garrisons and operating areas before the conflict, the regions surrounding those zones might be fully covered by only one or two drone orbits.98 Figure 5. Coverage of N. Korea with Standoff and Penetrating Unmanned Aerial Vehicles NOTE: The white circles depict potential orbital locations for four UAVs operating 80 kilometers outside North Korea's territory. The black circles depict the area over North Korea that four penetrating UAVs can overfly within five minutes of flight time starting from the center of each circle. Road segments are coded as visible (white) if they are observable from either a standoff or penetrating UAV. For discussion of the underlying analysis, see the online appendix at . The image was created using ArcGIS and road data from OpenStreetMap and DIVA-GIS. Click for larger view View full resolution Figure 5. Coverage of N. Korea with Standoff and Penetrating Unmanned Aerial Vehicles NOTE: The white circles depict potential orbital locations for four UAVs operating 80 kilometers outside North Korea's territory. The black circles depict the area over North Korea that four penetrating UAVs can overfly within five minutes of flight time starting from the center of each circle. Road segments are coded as visible (white) if they are observable from either a standoff or penetrating UAV. For discussion of the underlying analysis, see the online appendix at http://dx.doi:10.7910/DVN/NKZJVT. The image was created using ArcGIS and road data from OpenStreetMap and DIVA-GIS. [End Page 45] Each of the sensing systems explored here has important limitations. For example, radar satellites provide wide-area coverage, but do so intermittently and at only moderate resolution. Standoff drones provide persistent coverage, but only near the coast. Penetrating drones can provide persistent coverage inland (at the cost of increased risk to the aircraft) or intermittent inland coverage at lower risk. In many cases, however, the capabilities of one system can offset the limits of another. Moreover, this analysis merely scratches the surface in terms of new sensing platforms (e.g., unattended ground and seabed systems), signals (e.g., high-resolution spectroscopy), and approaches (e.g., cyber intrusions), many of which would be employed together for the same mission. Old assumptions about the survivability of mobile forces need to be revised in light of new sensing technologies and capabilities. Concealment is not impossible, of course. An adversary's mobile delivery systems can remain secure if its air defenses can keep UAVs at bay, its navy can keep enemy ASW forces from its coastal waters, and anti-satellite technology can blind satellites. But in this new era of transparency, whether concealed forces are survivable or not depends on the state of competition between opposing intelligence and military organizations. Survivability through concealment can no longer be assumed. What About Countermeasures? Countries will surely address the growing vulnerability of their nuclear arsenals by trying to develop countermeasures to thwart advanced sensor and strike systems. They will seek to deploy radar jammers, anti-satellite weapons, and decoys. They will try to adapt mobile missile doctrines to reduce vulnerability, for example, by timing movements to elude satellites and minimizing communications to thwart signals intelligence efforts. The new era of counter-force will not be static; it will be characterized by vigorous efforts to develop countermeasures, as well as equally vigorous efforts to overcome them. Yet, there are good reasons to expect that the net result of these efforts will leave nuclear delivery systems more vulnerable than they have been in the recent past. First, hunters are poised to do well in the back-and-forth battle of countermeasures. Counterforce is the domain of the powerful; those that are seeking to track enemy nuclear forces typically have greater resources than their rivals.99 Additionally, the countries that are leaders in sensing technology [End Page 46] have an advantage in the race to build (and thwart) countermeasures. As Brendan Green and Austin Long observe about the Cold War ASW competition, U.S. superiority in passive acoustics helped the United States quiet its own SSBNs, which in turn allowed it to practice and hone its tracking capabilities.100 Expertise in sensors and countermeasures go hand in hand. Perhaps most importantly, many countermeasures reduce one vulnerability at the cost of exacerbating others. For example, limiting communications between mobile missiles or submarines and their command authorities reduces vulnerability to signals intercepts, but it increases vulnerability to attacks designed to sever (or simulate) their command and control.101 Avoiding coastal roads neutralizes offshore sensors, but it channels forces into a smaller zone, easing the search problem. Even the simplest countermeasures, such as increasing security near sensitive facilities to prevent the emplacement of unattended ground sensors or improving air defenses around key sites to thwart UAVs, may cue hunters to the presence of high-value sites. Second, the potential targets of disarming strikes cannot merely respond to a single counterforce technology; they must respond to a daunting list of them. The revolutions in accuracy and sensing have had multiple, synergistic effects in bolstering counterforce. The task for hiders is not simply to thwart a single platform, such as SAR satellites, but rather to develop countermeasures to the entire array of (known) capabilities deployed by the hunters. For example, North Korea may find ways to interfere with U.S. radar satellites, but that still leaves its missiles vulnerable to detection by optical satellites; UAVs; unattended ground sensors; and a variety of tagging, tracking, and locating capabilities. Third, some vulnerabilities are difficult to fix. In the late 1960s, the Soviet Union learned that its SSBNs were being tracked by the United States, but it took more than a decade to counter this U.S. capability. Consider the challenge faced by China today in building a survivable ballistic missile submarine force; China deployed its first submarines in the 1960s, but more than half a century later Chinese submarines are still so noisy that experts predict it will be decades before Beijing can field survivable submarines.102 [End Page 47] The battle between countermeasures and corresponding attempts to defeat them is under way, and its outcome will likely depend on the strategic context. Rich countries with advanced research and development infrastructure are developing technology and doctrine to protect their nuclear forces in the face of improvements in weapons accuracy and remote sensing. Weaker countries with modest resources, however, will be hard pressed to develop effective countermeasures to the full spectrum of emerging means of counterforce. Conclusion For most of the nuclear age, there were many impediments to effective counterforce. Weapons were too inaccurate to reliably destroy hardened targets; fratricide prevented many-on-one targeting; the number of targets to strike was huge; target intelligence was poor; conventional weapons were of limited use; and any attempt at disarming an adversary would be expected to kill vast numbers of people. Today, in stark contrast, highly accurate weapons aim at shrinking enemy target sets. The fratricide problem has been swept away. Conventional weapons can destroy most types of counterforce targets, and low-fatality nuclear strikes can be employed against others. Target intelligence, especially against mobile targets, remains the biggest obstacle to effective counterforce, but the technological changes under way in that domain are revolutionary. Of the two key strategies that countries have employed since the start of the nuclear age to keep their arsenals safe, hardening has been negated, and concealment is under great duress. The new era of counterforce helps solve one of the enduring theoretical puzzles of the nuclear age. For decades, scholars of the theory of the nuclear revolution wondered why leaders seemed to be ignoring the profound implications of nuclear weapons for international politics. In theory, nuclear weapons make states that possess them so secure that they need not engage in traditional forms of competition with adversaries, such as arms racing, alliance building, relative gains competition, and rivalry over strategic territory. In practice, all those behaviors have endured. Scholars blame the persistent discrepancy between theory and practice on misperception, illogic, or other decisionmaking pathologies. The new era of counterforce suggests, however, that leaders have been correct to perceive that stalemate can be broken, and that the nuclear balance can vary dramatically across cases. If today's secure arsenal can become tomorrow's first-strike target, then there is little reason to expect [End Page 48] the geopolitical competition between countries to end with the deployment of seemingly secure nuclear weapons. **The policy implications of the new era of counterforce are** also **important**. First, if nuclear forces are becoming increasingly vulnerable to counterforce, then states need to improve their retaliatory arsenals just to maintain the same level of deterrence. Given that nuclear delivery systems are expensive and must last for decades, the challenge for force planners is extraordinary: deploy weapon systems that will remain survivable for multiple generations, even as technology improves at an ever-increasing pace. Second, the growing threat to nuclear arsenals (from nuclear strikes, conventional attacks, missile defenses, ASW, and cyber operations) raises major questions about the wisdom of cutting the size of nuclear arsenals. In the past, many arms control advocates believed that arms cuts reduced the incentives for disarming strikes; whether right or wrong in the past, that assumption is **increasingly dubious** as a recipe for **deterrence stability** today. Finally, leaps in accuracy and remote sensing should **reopen** debates in the United States about **the wisdom of** pursuing effective **counterforce** systems. Fielding those capabilities—nuclear, conventional, and other—may prove invaluable: enhancing deterrence during conventional wars and, if deterrence fails, allowing the United States to defend itself and its allies. Enhancing counterforce capabilities, however, may trigger arms races and other dynamics that exacerbate political and military conditions. In the past, technological conditions bolstered those who favored restraint: disarming strikes seemed impossible, so enhancing counterforce would likely trigger arms racing without much strategic benefit. Today, technological trends appear to **validate the advocates of counterforce**: remote sensing, conventional strike capabilities, ASW, and cyberattack techniques will continue to improve and increasingly threaten strategic forces **whether or not** the United States seeks to maximize its counter-force capabilities. In this new era of counterforce, technological **arms racing seems inevitable**, so exercising restraint may **limit options** **without yielding much benefit**. Nuclear deterrence can be robust, but **nothing about it is automatic** or everlasting. Nuclear stalemate might endure among some pairs of states, and technology could someday reestablish the ease of deploying survivable arsenals. Today, however, **survivability is eroding**, and **it will continue to do so** in the foreseeable future. Weapons will grow even more accurate. Sensors will improve. The new era of counterforce will likely yield benefits to those countries that best adapt to the new landscape, and costs to those that fall behind. The first step in understanding these dynamics is to recognize the new strategic reality confronting nuclear powers today.

#### Limited nuclear war doesn’t cause extinction – BUT – stigmatizes future use.

Deudney 18 [Daniel H. Deudney, Associate Professor of Political Science at Johns Hopkins University, March 15, 2018, “The Great Debate,” The Oxford Handbook of International Security, www.oxfordhandbooks.com, doi:10.1093/oxfordhb/9780198777854.013.22]

Although nuclear war is the oldest of these technogenic threats to civilization and human survival, and although important steps to restraint, particularly at the end of the Cold War, have been achieved, the nuclear world is increasingly changing in major ways, and in almost entirely dangerous directions. The third “bombs away” phase of the great debate on the nuclear-political question is more consequentially divided than in the first two phases. Even more ominously, most of the momentum lies with the forces that are pulling states toward nuclear-use, and with the radical actors bent on inflicting catastrophic damage on the leading states in the international system, particularly the United States. In contrast, the arms control project, although intellectually vibrant, is largely in retreat on the world political stage. The arms control settlement of the Cold War is unraveling, and the world public is more divided and distracted than ever. With the recent election of President Donald Trump, the United States, which has played such a dominant role in nuclear politics since its scientists invented these fiendish engines, now has an impulsive and uninformed leader, boding ill for nuclear restraint and effective crisis management. Given current trends, it is prudent to assume that sooner or later, and probably sooner, nuclear weapons will again be the used in war. But this bad news may contain a “silver lining” of good news. Unlike a general nuclear war that might have occurred during the Cold War, such a nuclear event now would probably not mark the end of civilization (or of humanity), due to the great reductions in nuclear forces achieved at the end of the Cold War. Furthermore, politics on “the day after” could have immense potential for positive change. The survivors would not be likely to envy the dead, but would surely have a greatly renewed resolution for “never again.” Such an event, completely unpredictable in its particulars, would unambiguously put the nuclear-political question back at the top of the world political agenda. It would unmistakably remind leading states of their vulnerability It might also trigger more robust efforts to achieve the global regulation of nuclear capability. Like the bombings of Hiroshima and Nagasaki that did so much to catalyze the elevated concern for nuclear security in the early Cold War, and like the experience “at the brink” in the Cuban Missile Crisis of 1962, the now bubbling nuclear caldron holds the possibility of inaugurating a major period of institutional innovation and adjustment toward a fully “bombs away” future.

#### Scenario 1 is MIRV ICBMS:

#### Continued modernization causes China to MIRV ICBMs

Killalea 17

Debra Killalea, Writer for AU News, “China: New missile, DF-41, expected to be deployed next year.” AU News. December 1, 2017. <https://www.news.com.au/world/asia/china-new-missile-df41-expected-to-be-deployed-next-year/news-story/5f0989eb732ab8f4c6b6a00db3eecae5>

CHINA has unveiled its most powerful weapon yet and its new intercontinental ballistic missile is a force to be reckoned with.

The DF-41 ICBM can carry up to 10 manoeuverable warheads ranging from 100 to 200 kilotonnes to megaton size and has a range of between 12,000kms and 15,000kms.

In comparison, North Korea’s Hwasong-15, which was launched yesterday, has an estimated range of 13,000km.

China’s[People Daily](http://en.people.cn/n3/2017/1128/c90000-9297997.html?mkt_tok=eyJpIjoiTnpkaFpUSTBOR00wWTJNNSIsInQiOiJuWmYrSTNYR0RzRlNnU2k2a3dQZTk5WUxYUlowSGQyZnBcL0xpbFV1ck9ISDNIVzFzN1dGb1BZQ3FDbUJ1NGpqcExMTHZcL0ZsWWhrczU0d0c1YXh6TUF4T0l4R1FOTTVCR1JUYWNaQUtSbW83TXl4cmJLandrMHhrcDkrZ1kyUkFtIn0%3D)newspaper revealed the DF-41 could enter service as early as the first half of next year.

Military expert Yang Chengjun told a TV program broadcasted on China Central Television (CCTV) earlier this week the DF-41 is China’s latest strategic missile and was quick, mobile and precise.

“The missile can hit every corner of the earth, allowing China to counter a nuclear strike on the country,” Mr Yang said.

According to the newspaper, the test launches have had a 100 per cent success rate.

Dr Malcolm Davis, a senior analyst in defence strategy and capability at the Australian Strategic Policy Institute, said this was China’s most advanced ICBM.

“It’s a road-mobile, solid fuelled ICBM with the range to cover all targets in the continental United States,” Dr Davis said.

“Its MIRVed — MIRV standing for multiple independently targeted re-entry vehicles.

“This means the missile can carry multiple nuclear warheads — up to 10 warheads each with yields of around 150 kilotons (150,000 tons TNT equivalent) — or a single warhead with a yield up to 3 megatons (millions of tons of TNT).”

Dr Davis said 24 of these missiles could deliver between 240 warheads against the US.

“The North Korean Hwasong-15 would by contrast carry a single warhead,” he said.

“It would also carry penetration aids (‘penaids’) designed to confuse US missiles defences.”

Dr Davis said China is also developing ‘MARVs’ — manoeuvring re-entry vehicles — that would give them the ability to further defeat US missile defence, and potentially, attack mobile targets.

“They are also developing hypersonic glide vehicles which would carry individual warheads and glide at up to Mach 20 at very high altitude on a highly evasive trajectory, with the hypersonic glide vehicle (called a ‘DZ-ZF’) being launched atop the DF-41 in place of the regular payload of warheads,” he said.

Beijing’s overall objective is to ensure Chinese ICBMs like the DF-41 can defeat US missile defence systems, Dr Davis said.

ULTIMATE WEAPON

Nuclear disarmament campaigner John Hallam said the DF-41 was simply the most powerful nuclear missile in the world and was the “ultimate doomsday weapon”.

“It’s a whopper, comparable to the biggest Russian missiles, which it resembles, including the recently tested Sarma,” Mr Hallam said.

He said there have been rumours and claimed sightings of this missile for some time and that it has been tested before.

“The backbone of China’s strategic force has always been the somewhat ancient DF-5 missile, each with a single 5 megaton warhead (by far) the biggest warhead in actual military use,” Mr Hallam said.

“For a long time there were just 20 of these things, but a few years back the Chinese started to upgrade, update, and add to the DF5’s, so there might be 30 now, and they started to deploy something called the DF-41 — the same designation as this one.”

The missile also could have a deadly impact if used in conflict.

“Just one of these missiles, with 10 warheads each of 100kt plus range, could essentially destroy either the major cities or the significant military capacity of the United States, especially if command and control nodes are prioritised,” Mr Hallam said.

“The DF-41 with multiple big warheads and probably a middling accuracy is ideally suited for incinerating cities, and its being mounted on a TEL (Transporter-Erector-Launcher), is consistent with that — it moves around so it can’t easily be targeted like a silo.

#### US missile defense ensures deployment – competition draws in India and escalates

Kristensen, director of the Nuclear Information Project at the Federation of American Scientists, ‘15

(Hans M., “Pentagon Report: China Deploys MIRV Missile,” May 11, https://fas.org/blogs/security/2015/05/china-mirv/)

**Why Chinese MIRV?**

The big question is why the Chinese leadership has decided to deploy MIRV on the silo-based, liquid-fuel DF-5A.

Chinese officials have for many years warned, **and US officials have predicted**, that advanced US non-nuclear capabilities such as missile defense systems could cause China to deploy MIRV **on some of its missiles.** The Pentagon report **repeats this analysis** by stating that China’s “new generation of mobile missiles, with warheads consisting of MIRVs and penetration aids, are intended to ensure the viability of China’s strategic deterrent in the face of continued advances in U.S. and, to a lesser extent, Russian strategic ISR, precision strike, and **missile defense capabilities**.”

Conclusions

**Chinese MIRV on the DF-5 ICBM is a** bad day for nuclear constraint.

Seen in the context of China’s other ongoing nuclear modernization programs – deployment of several types of mobile ICBMs and a new class of sea-launched ballistic missile submarines – the deployment of a MIRVed version of the DF-5 ICBM reported by the Pentagon’s annual report **strains the credibility of China’s official assurance** that it only wants a minimum nuclear deterrent and is not part of a nuclear arms race.

MIRV on Chinese ICBMs changes the calculus that other nuclear-armed states will make about China’s nuclear intensions and capacity. Essentially, **MIRV allows a much more rapid increase of a nuclear arsenal than single-warhead missile.** If China also develops MIRV for a mobile ICBM, then it would further deepen that problem.

To its credit, the Chinese nuclear arsenal is still much smaller than that of Russia and the United States. So this is not about a massive Chinese nuclear buildup. Yet the development underscores that a technological nuclear competition among the nuclear-armed states is in full swing – one that China also contributes to.

Although it is still unclear what has officially motivated China to deploy a MIRVed version of the DF-5 ICBM now, previous Chinese statements and US intelligence assessments **indicate that it may be a** reaction to the US development and deployment of missile defense systems **that can threaten China’s ability to retaliate with nuclear weapons.**

If so, **how ironic that the US missile defense system** – intended to reduce the threat to the United States – instead **would seem to have increased the threat by triggering development of MIRV** on Chinese ballistic missiles that could destroy more US cities in a potential war.

The deployment of a MIRVed DF-5 also raises serious questions about China’s strategic relationship with India. The Pentagon report states that in addition to US missile defense capabilities, “India’s nuclear force is an additional driver behind China’s nuclear force modernization.” **There is little doubt that Chinese MIRV has the potential to** nudge India into the MIRV club as well.

Indian weapons designers have already hinted that India may be working on its own MIRV system and the US Defense Intelligence Agency recently stated that “India will continue developing an ICBM, the Agni-VI, which will reportedly carry multiple warheads.”

**If** Chinese MIRV triggers Indian MIRV **it would** deepen nuclear competition **between the two Asian nuclear powers and reduce security for both**. This calls for both countries to show constraint but it also requires the other MIRVed nuclear-armed states (Britain, France, Russia and the United States) to limit their MIRV and offensive nuclear warfighting strategies.

#### No extinction from disease:

#### 1] Resilience and countermeasures prevent spread – distinct from burnout

Adalja 16

Amesh Adalja is an infectious-disease physician at the University of Pittsburgh, The Atlantic, June 17, 2016, “Why Hasn't Disease Wiped out the Human Race?”, https://www.theatlantic.com/health/archive/2016/06/infectious-diseases-extinction/487514/

But when people ask me if I’m worried about infectious diseases, they’re often not asking about the threat to human lives; they’re asking about the threat to human life. With each outbreak of a headline-grabbing emerging infectious disease comes a fear of extinction itself. The fear envisions a large proportion of humans succumbing to infection, leaving no survivors or so few that the species can’t be sustained.

I’m not afraid of this apocalyptic scenario, but I do understand the impulse. Worry about the end is a quintessentially human trait. Thankfully, so is our resilience.

For most of mankind’s history, infectious diseases were the existential threat to humanity—and for good reason. They were quite successful at killing people: The 6th century’s Plague of Justinian knocked out an estimated 17 percent of the world’s population; the 14th century Black Death decimated a third of Europe; the 1918 influenza pandemic killed 5 percent of the world; malaria is estimated to have killed half of all humans who have ever lived.

Any yet, of course, humanity continued to flourish. Our species’ recent explosion in lifespan is almost exclusively the result of the control of infectious diseases through sanitation, vaccination, and antimicrobial therapies. Only in the modern era, in which many infectious diseases have been tamed in the industrial world, do people have the luxury of death from cancer, heart disease, or stroke in the 8th decade of life. Childhoods are free from watching siblings and friends die from outbreaks of typhoid, scarlet fever, smallpox, measles, and the like.

**2] Intervening actors check**

**Zakaria 9—**Editor of Newsweek, BA from Yale, PhD in pol sci, Harvard. He serves on the board of Yale University, The Council on Foreign Relations, The Trilateral Commission, and Shakespeare and Company. Named "one of the 21 most important people of the 21st Century" (Fareed, “The Capitalist Manifesto: Greed Is Good,” 13 June 2009, http://www.newsweek.com/id/201935)

Note—Laurie Garrett=science and health writer, winner of the Pulitzer, Polk, and Peabody Prize

It certainly looks like another example of crying wolf. **After bracing ourselves for a global pandemic, we've suffered** something more like **the usual seasonal influenza**. Three weeks ago the World Health Organization declared a health emergency, warning countries to "prepare for a pandemic" and said that the only question was the extent of worldwide damage. **Senior officials prophesied that millions could be infected** by the disease. **But as of last week, the WHO had confirmed only 4,800 cases** of swine flu, with 61 people having died of it. Obviously, these low numbers are a pleasant surprise, but it does make one wonder, what did we get wrong? **Why did** the **predictions of a pandemic turn out to be so exaggerated**? Some people blame an overheated media, but it would have been difficult to ignore major international health organizations and governments when they were warning of catastrophe. I think **there is a** broader **mistake in the way we look at the world.** Once we see a problem, we can describe it in great detail, extrapolating all its possible consequences. But **we** can **rarely anticipate the human response to that crisis. Take** **swine flu. The virus** **had crucial characteristics** **that led researchers to worry that it could spread far and fast**. They described—and the media reported—what would happen if it went unchecked. **But it did not go unchecked**. **In fact, swine flu was met by an extremely vigorous response at its epicenter**, **Mexico. The Mexican government reacted quickly** and massively, quarantining the infected population, testing others, providing medication to those who needed it. **The noted expert on this subject,** Laurie **Garrett, says, "**We should all stand up and scream, **'Gracias, Mexico**!' because the Mexican people and the Mexican government have sacrificed on a level that I'm not sure as Americans we would be prepared to do in the exact same circumstances. They shut down their schools. They shut down businesses, restaurants, churches, sporting events. **They** basically paralyzed their own economy. They've suffered billions of dollars in financial losses still being tallied up, and thereby **really brought transmission to a halt." Every time one of these viruses is detected**, writers and **officials bring up the Spanish influenza** epidemic **of 1918** in which millions of people died. Indeed, during the last pandemic scare, in 2005, President George W. Bush claimed that he had been reading a history of the Spanish flu to help him understand how to respond. **But the world we live in today looks nothing like 1918. Public health-care systems are far better** and more widespread than anything that existed during the First World War. **Even Mexico, a developing country, has a first-rate public-health system**—far better than anything Britain or France had in the early 20th century.

#### 3] Their Naish ev does not get to extinction – it asserts new diseases would be highly transmissible but not disprove tradeoff with lethality – asserting its existential without a warrant isn’t an argument

#### Scenario 1 is warming:

#### 1] Disease outbreaks will be defeated with quarantines

**Szalai 7/26** [(Jennifer Szalai - author for the NYT) “The Extradordinary History (and likely busy future) of quarantine” The New York Times. 7-26-2021]

**Quarantine can be lifesaving**; it can also be dangerous, an exercise of extraordinary power in the name of disease control, a presumption of guilt instead of innocence.

In “Until Proven Safe,” a new book about quarantine’s past and future, Geoff Manaugh and Nicola Twilley do an impressively judicious job of explaining exactly why fears of quarantine are understandable and historically justified, while also showing how in coming years “we will almost certainly find ourselves more dependent on quarantine, not less.” Quarantine has to do with risk and uncertainty, and its logic is simple: “There might be something dangerous inside you — something contagious — on the verge of breaking free.”

**While medical advances have made some diseases more diagnosable** and less deadly, newfound knowledge can also accentuate the depths of our ignorance. The more we know, the more we know how much we don’t know — not to mention that **modern life, with escalating numbers of people and goods churning** their way **around the world**, has **increased the opportunities for contagion.**

Quarantine is distinct from isolation, even if the terms are often used interchangeably. Someone is isolated when they are known to be sick; **someone is quarantined when they might be but we cannot be sure**. Manaugh, an architecture and technology blogger, and Twilley, the co-host of a podcast about the science and history of food, bring an impressively wide range of interests to bear on a subject that involves not only infectious disease but also — in their ambitious yet seamless narration — politics, agriculture, surveillance and even outer space.

#### 2] Quarantines solve climate change – COVID was responsible for the largest drop in emissions ever

**Alexander 20** [(Kurtis, a general assignment reporter for The San Francisco Chronicle, frequently writing about water, wildfire, climate and the American West. His recent work has focused on the impacts of drought, the widening rural-urban divide and state and federal environmental policy. Before joining the Chronicle, Alexander worked as a freelance writer and as a staff reporter for several media organizations, including The Fresno Bee and Bay Area News Group, writing about government, politics and the environment.) "Coronavirus has altered the global warming trajectory. But for how long?" San Francisco Chronicle, 5/20/20, https://www.sfchronicle.com/health/article/Greenhouse-gas-emissions-on-track-for-record-drop-15279312.php] TDI

The disruption caused by the coronavirus has been so profound that it’s altered the trajectory of global warming.

Not since World War II — and perhaps never before — have the emissions of heat-trapping gases dropped as much around the planet as they have during the COVID-19 outbreak.

The latest and most detailed study yet on the pandemic’s impact on climate pollution, published Tuesday and authored by the research group Global Carbon Project chaired by Stanford University’s Rob Jackson, finds that the Earth will see up to a 7% decrease in carbon dioxide this year. The dip is five times the decline in emissions in 2009, when the recession choked the world’s economy, and double what it was in 1992, after the fall of the Soviet Union.

The paper’s findings mirror other reports that have similarly found sharp drops in greenhouse gases recently. The emerging research also is in agreement that the lull will likely be short-lived and, at best, buy time before the most devastating effects of climate change take hold. The lockdown that has halted factories, energy plants and automobiles during the pandemic is already lifting, and without deliberate action, carbon-intense activities are bound to resume.

“That’s the danger here,” said Jackson, a professor of earth system science and senior fellow at Stanford Woods Institute for the Environment. “We’ve decreased emissions for the wrong reasons. Will they jump back up starting this fall, or could the virus allow us to rethink transportation and other parts of the economy?”

The answer to the question, say Jackson and others, may not be so straightforward. Greenhouse gases could rebound in some areas, and there could be lasting decreases in others.

Measuring heat-trapping gas emissions, for which carbon dioxide is a proxy, is not easy to do, especially in real time. The researchers at the Global Carbon Project analyzed daily economic activity in 69 countries from January through April and modeled the carbon pollution that likely resulted, then compared it to last year. The countries included have historically produced almost all of the world’s carbon dioxide.

The researchers found that China, the largest polluter, reduced emissions by nearly 24% on some days in mid-February. The United States, the second-largest polluter, cut emissions by nearly 32% for almost two weeks in mid-April. The European Union, including Great Britain, trimmed emissions by about 27% during the first week of April.

The dates of peak reductions varied in different parts of the globe because each locked down at a different time. The biggest cumulative drop in carbon dioxide was on April 7 and measured about 17%, according to the study.

While a variety of activity explains the declines, fewer people driving was the largest contributor worldwide. Less industrial pollution was also a big contributor.

Based on the observed drops in emissions, the researchers estimate that going forward, carbon dioxide will fall between 4% and 7% for the year worldwide, depending on how quickly countries end their lockdowns.

Jackson said the amount of the decline can be viewed as both considerable, given that it’s the largest ever seen, and humbling because it’s the minimum needed annually to put the planet on track to meet the Paris climate agreement — enough of a drop to prevent the global temperature from rising 2 degrees Celsius above preindustrial levels.

“We would need to do this every year,” he said.

The International Energy Agency recently projected an 8% dip in greenhouse gases for the year while the International Monetary Fund came up with an estimate closer to 6%. Both organizations said carbon pollution would likely rise again in 2021.

After the decline in emissions in 2009 of about 1.4%, the following year saw an increase of 5.1%.

The Global Carbon Project says there’s reason to think that at least some parts of the globe will try to prevent heat-trapping gases from bouncing back. Stimulus programs aimed at developing clean energy and new carbon-friendly ways of living adopted during the pandemic, such as working from home, could help limit emissions.

“Cities from Seattle to Milan are keeping roads closed to cars and letting them stay open to bikes and pedestrians even after the shelter-in-place,” Jackson said. “And maybe COVID-19 and stimulus funding will jump-start electric cars.”

#### 3] Shutdowns solve climate change – substantially reduce emissions, air and water pollution, directs attention to climate

**Chow 20** [(Denise, a reporter for NBC News Science focused on general science and climate change) "Coronavirus shutdowns have unintended climate benefits: cleaner air, clearer water," NBC News, 3/18/20, https://www.nbcnews.com/science/environment/coronavirus-shutdowns-have-unintended-climate-benefits-n1161921] DRD

Concentrations of nitrogen dioxide in the atmosphere over Italy also fell precipitously, as they did in China. An analysis by The Washington Post found that the most dramatic drop was observed over northern Italy.

Nitrogen dioxide can irritate the lungs, and inhaling the pollutant can increase the risk of asthma and inflammation of the lungs. Although the noxious gas isn't thought to be a major contributor to climate change, studying its concentration in the atmosphere can help scientists understand other heat-trapping greenhouse gases that do drive global warming.

Jacqueline Klopp, co-director of the Center for Sustainable Urban Development at Columbia University in New York City, said she expects to see greenhouse gas emissions plummet across the board because of the quarantine measures.

"People were in their homes and really stopped a lot of the activities that lead to greenhouse gas emissions and other pollution," she said.

Early observations have shown that extreme social-distancing measures are likely also having an effect on air pollution at the city level in the U.S.

Jordan Wildish, a project director at Earth Economics, an environmental non-profit organization based in Tacoma, Washington, developed an online dashboard to track air quality in San Francisco, New York City and the Seattle area, comparing the measurements with figures from the same time last year.

In San Francisco, which is under shelter-in-place orders to control the spread of the coronavirus, the average concentration of fine particulate matter — tiny particles in the air that are dangerous because they can be breathed deeply into the lungs — over the past five days was almost 40 percent lower than the previous year.

In New York City, there was a 28 percent drop over the same period of time, and the Seattle-Tacoma-Bellevue saw a 32 percent decrease.

But experts warned that observed reductions are temporary and that as cities, countries and economies bounce back, so, too, will emissions — unless major infrastructure or societal changes are adopted.

Klopp said the pandemic could make companies and governments realize that other threats to humanity, including climate change, could be just as devastating and that it's imperative to develop protective measures.