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## AIRSPACE IN AN AGE OF DRONES

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*The growing interest in domestic drones is drawing new attention to unresolved questions regarding the scope of landowners’ rights in the airspace above their land. Domestic drones are small, unmanned aircraft capable of delivering packages or capturing photos. Existing aerial trespass and takings laws, which were formulated prior to the advent of modern drone technologies, are ill-equipped to handle conflicts between domestic drone operators and landowners. To establish claims under these laws, landowners generally must prove that an aircraft flew within the nebulous “immediate reaches” of the airspace above their parcels and substantially interfered with their use and enjoyment of their land. The indefinite nature of landowner airspace rights under these rules is already generating confusion and controversy, hindering growth in the fledgling domestic drone industry. This Article applies basic principles of microeconomics and property theory to analyze the complex new property law issues presented by drone technologies. This Article ultimately advocates for legislation giving landowners strict rights to exclude aircraft from a clearly defined column of low-altitude airspace directly above their parcels. Such legislation would clarify landowners’ entitlements in low-altitude airspace and thereby promote more efficient governance of this increasingly valuable resource as drones become ever more common in domestic skies.*

#### INTRODUCTION

For the first time since the Wright brothers ushered in the era of human flight at Kitty Hawk more than a century ago, the most groundbreaking aviation technologies of the day do not involve human flight at all. Instead, they involve aircraft purposely designed to fly without people on board—sophisticated unmanned aerial vehicles commonly known as “drones.”<sup>1</sup> For a

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<sup>1</sup> Several different terms are commonly used to refer to drones, including the terms “unmanned aerial vehicles” and “unmanned aircraft systems.” There is evidence that uses of these alternative terms may be at least partially aimed at shielding smaller domestic drones from the stigma sometimes associated with the massive drones that military units increasingly use to execute overseas surveillance and airstrikes. *See, e.g.,* Richard Whittle, *Don’t Say “Drones,” Beg Drone Makers*, BREAKING DEFENSE (Aug. 14, 2013, 5:39 PM), <http://breakingdefense.com/2013/08/dont-say-drones-beg-drone-makers/>, archived at <http://perma.cc/E94J-RZT5> (describing drone manufacturers’ efforts to discourage use of the word “drone” to describe their products). For purposes of consistency, this article uses “drone” to describe all modern, remote-controlled, unmanned aircraft systems, regardless of size, purpose, or design.

fraction of the cost of an airplane or helicopter, drones can fly through treacherous areas without endangering human lives, soar past traffic jams to make urgent deliveries, and provide valuable birds-eye views of happenings below.

Although drones have been around for decades,<sup>2</sup> recent advancements in drone technologies are fueling an unprecedented level of interest in these futuristic devices. A wide and growing array of ever-more-sophisticated drones is now readily available for purchase at hobby stores and on the Internet. Many of these drones sell for just a few hundred dollars and can effortlessly be controlled from ordinary smartphones.<sup>3</sup> Seemingly overnight, a domestic drones market that once catered primarily to weekend hobbyists is attracting journalists, real estate agents, wedding photographers, law enforcement agencies, and even delivery companies.

Unfortunately, the United States seems ill-prepared for the complex legal questions and regulatory challenges that this massive flock of new domestic drones will bring. Within the United States, there are already reports of civilian drones crashing into buildings,<sup>4</sup> having hazardously close encounters with helicopters,<sup>5</sup> peeping into residential windows,<sup>6</sup> and being intentionally shot down.<sup>7</sup> Anticipating the potential benefits and difficulties associated with the emergent domestic drone market, Congress enacted legislation in 2012 instructing the Federal Aviation Administration (“FAA”) to adopt regulations

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<sup>2</sup> See Ben Zimmer, *The Flight of “Drone” from Bees to Planes*, WALL ST. J., July 27, 2013 at C4 (describing the Navy’s use of drones prior to World War II).

<sup>3</sup> See Hillary B. Farber, *Eyes in the Sky: Constitutional and Regulatory Approaches to Domestic Drone Deployment*, 64 SYRACUSE L. REV. 1, 12-14 (2014) (indicating that nearly fifty companies developed roughly 150 different drones in 2012 alone and that there are now “hundreds of types of drones, ranging in size from a small insect to a commercial aircraft” and describing one popular drone—the Parrot AR 2.0 Quadrocopter—as a device that “hovers and flies in all directions, and can be controlled by any smartphone or tablet”).

<sup>4</sup> See, e.g., Leslie Kaufman & Ravi Somaiya, *Drones Offer Journalists a Wider View*, N.Y. TIMES, Nov. 25, 2013, at B1 (reporting that drones recently “crashed into skyscrapers in Midtown Manhattan and fell to a sidewalk, and spun out of control and into the crowd at a bull-running event in Virginia”).

<sup>5</sup> See, e.g., Alan Feuer, *2 Arrested After Drone Flies Close to a Police Helicopter*, N.Y. TIMES, July 9, 2014, at A22 (describing a close encounter between a New York City police helicopter and a drone that ultimately led to two arrests).

<sup>6</sup> See, e.g., Colleen Wright, *Regulatory Vacuum Exposed After “Peeping Drone” Incident*, SEATTLE TIMES (July 7, 2014, 12:44 PM), [http://seattletimes.com/html/localnews/2024002284\\_dronesxml.html](http://seattletimes.com/html/localnews/2024002284_dronesxml.html), archived at <http://perma.cc/HF79-BHG8> (describing a report of a drone hovering outside the bedroom window of a woman in a high rise building in Seattle, Washington).

<sup>7</sup> See, e.g., Lauren Russell, *PETA Eyes Drones to Watch Hunters, Farmers*, CNN (Apr. 12, 2013, 12:43 PM), <http://www.cnn.com/2013/04/11/us/animal-rights-drones/>, archived at <http://perma.cc/A798-RTXB> (describing how an animal rights group’s drones have been shot down on two separate occasions while filming pigeon shoots at a shooting resort in Berks County, Pennsylvania).

by September 2015 to facilitate the smooth integration of “civil unmanned aircraft systems” into U.S. airspace.<sup>8</sup> However, it appears increasingly doubtful that the FAA will meet that deadline.<sup>9</sup> And in the meantime, the agency is attempting to enforce a controversial moratorium on most commercial drone use.<sup>10</sup>

To date, most of the scholarly<sup>11</sup> and legislative<sup>12</sup> activity relating to domestic drones has centered on the devices’ potential impact on privacy rights and criminal evidence gathering. Regrettably, legal academicians and policymakers have devoted far less attention to an unsettled property law question that underlies these and many other domestic drone issues: Up to what height do surface owners hold strict rights to exclude flying objects from physically invading the airspace above their land? Legal uncertainty and confusion are likely to continue swirling around the domestic drone industry until courts or legislators clear up this basic property question.

This Article applies principles of microeconomics and property theory to analyze complex property law issues arising from the growing use of domestic drones. Drawing from the previous work of professors Harold Demsetz, Henry E. Smith, Thomas Merrill, and others, on factors that justify the emergence of

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<sup>8</sup> FAA Modernization and Reform Act of 2012, Pub. L. No. 112-95, § 332(a)(3), 126 Stat. 73 (2012).

<sup>9</sup> See Bart Jansen, *Watchdogs: FAA Won’t Meet 2015 Deadline for Drone Safety*, USA TODAY (Feb. 5, 2014, 12:30 PM), <http://www.usatoday.com/story/news/nation/2014/02/05/faa-drones-inspector-general-gao/5226427/>, archived at <http://perma.cc/GNL7-LDCP>.

<sup>10</sup> See Nabiha Syed & Michael Berry, *Journo-Drones: A Flight over the Legal Landscape*, 30 J. MEDIA INFO. & COMM. L. 1, 24 (2014) (describing the FAA’s ongoing reliance on a 2007 policy statement to effectively prohibit the commercial use of drones without special airworthiness certificates and the rigorous and costly process associated with obtaining such certificates).

<sup>11</sup> Multiple law review articles and comments highlighting drone-related privacy and criminal law questions have been published in recent years. See, e.g., Farber, *supra* note 3; Patrice Hendriksen, Note, *Unmanned and Unchecked: Confronting the Unmanned Aircraft System Privacy Threat Through Interagency Coordination*, 82 GEO. WASH. L. REV. 207 (2013); Ben Jenkins, Note, *Watching the Watchmen: Drone Privacy and the Need for Oversight*, 102 KY. L.J. 161 (2013-14).

<sup>12</sup> Federal legislators have recently introduced multiple bills focused primarily on the privacy issues raised by drones. See, e.g., Safeguarding Privacy and Fostering Aerospace Innovation Act of 2013, S. 1057, 113th Cong. (2013); Drone Aircraft Privacy and Transparency Act of 2013, H.R. 1262, 113th Cong. (2013). State legislatures have likewise focused primarily on the criminal law and privacy issues associated with drones in recent years. For instance, several have enacted statutes that restrict law enforcement agencies’ use of drones to gather criminal evidence and that limit admissibility of drone-gathered evidence in criminal proceedings. For a summary of recent state legislative enactments relating to domestic drones, see *2014 State Unmanned Aircraft Systems (UAS) Legislation*, NATIONAL CONFERENCE OF STATE LEGISLATURES, <http://www.ncsl.org/research/civil-and-criminal-justice/2014-state-unmanned-aircraft-systems-uas-legislation.aspx>, archived at <http://perma.cc/L55M-KAPL> (last updated Sept. 16, 2014).

private property rights in a given resource, this Article advocates for new laws expressly entitling landowners to exclude drones from the airspace above the surface of their land to a height of 500 feet in most locations. Such laws would at last provide a definite ceiling to the three-dimensional column of space initially allocated to surface owners under the common law's *ad coelum*<sup>13</sup> doctrine. By establishing clearer entitlements in low-altitude airspace and creating a solid legal backdrop from which to layer supplemental rules, these laws would be a valuable step toward the more orderly and efficient integration of drone technologies in the United States.

Part I of this Article provides background information about the rapidly expanding domestic drone industry and some specific legal issues that drones are beginning to raise throughout the country. Part II analyzes drone use from a property theory perspective, contrasting the uneven set of rules governing the low-altitude airspace where most domestic drones fly with purer property regimes governing the high-altitude space above it and the surface land below it. Part III extends the theories highlighted in Part II to argue in favor of new laws giving landowners strict exclusion rights in a definite column of airspace above their land. Part IV describes how such clarifications of airspace rights could promote more uniform and coordinated drone regulation among federal, state, and local governments.

#### I. THE GROWING CONTROVERSY SURROUNDING DOMESTIC DRONES

Over the past century, new technologies have spurred the evolution and expansion of property laws to accommodate such transformative innovations as radio broadcasting,<sup>14</sup> subsurface oil and gas extraction,<sup>15</sup> and the Internet.<sup>16</sup> Today, technology is once again stretching property law as unmanned aircraft systems commonly known as “drones” increasingly take to the skies.<sup>17</sup>

Unmanned flying vehicles are nothing new. In fact, the U.S. military has been building unmanned “drone” aircraft under that name for target practice exercises and other useful functions since at least the 1930s.<sup>18</sup> Hobbyists have

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<sup>13</sup> See *infra* note 54 and accompanying text.

<sup>14</sup> For basic information on modern laws governing the allocation of transmission rights within the radio spectrum, see generally *FCC Encyclopedia: Radio Spectrum Allocation*, FCC, <http://www.fcc.gov/encyclopedia/radio-spectrum-allocation>, archived at <http://perma.cc/EN7X-HKFQ> (last visited Oct. 23, 2014).

<sup>15</sup> For a general account of the development of oil and gas law in the United States, see generally David W. Miller, *The Historical Development of the Oil and Gas Laws of the United States*, 51 CAL. L. REV. 506 (1963).

<sup>16</sup> As a starting point for exploring the complex history of laws governing property interests related to the Internet, see generally Michael L. Rustad & Diane D'Angelo, *The Path of Internet Law: An Annotated Guide to Legal Landmarks*, 10 DUKE L. & TECH. REV. 1 (2011).

<sup>17</sup> See Farber, *supra* note 3, at 11-18.

<sup>18</sup> See generally Zimmer, *supra* note 2. Zimmer suggests that the first person to use the

likewise been building remote-controlled aerial vehicles and flying them recreationally for more than half a century.<sup>19</sup>

However, over the past couple of decades, the nature of unmanned air flight has dramatically changed. Just as technological advances have transformed military drones into powerful attack and surveillance tools,<sup>20</sup> innovation has likewise spurred a new and rapidly expanding market for smaller unmanned aircraft systems designed for civilian use much closer to the ground.<sup>21</sup> Today's most popular civilian drones cost less than \$1,000 and feature multiple downward-facing rotors which enable them to ascend, hover, maneuver, and land like miniature helicopters at their operators' commands.<sup>22</sup>

#### A. *The Burgeoning Domestic Drone Industry*

As drone technologies improve, the list of promising domestic uses for the devices continues to grow. Drones can serve as invaluable tools for utilities,<sup>23</sup> pipeline companies,<sup>24</sup> and border patrol agencies,<sup>25</sup> enabling quick visual

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word "drone" to refer to an unmanned aerial vehicle was a U.S. naval commander in the 1930s who employed the word "in homage" to the British Navy's own remote-controlled "DH 82B Queen Bee" device.

<sup>19</sup> For a brief history of radio-controlled model aircraft, see *Radio Control*, ACAD. MODEL AERONAUTICS, <http://www.modelaircraft.org/museum/radiocontrol.aspx>, archived at <http://perma.cc/NRP4-F2UH> (last visited Oct. 23, 2014) (describing the first radio-controlled model airplane contest as being held in 1937).

<sup>20</sup> To learn more about the CIA's use of drones for targeted killings in 2002 and the potential long-term implications of military drones, see generally John Sifton, *Drones: A Troubling History*, NATION, Feb. 27, 2012, at 11.

<sup>21</sup> See Farber, *supra* note 3, at 11.

<sup>22</sup> For descriptions and photos of some popular civilian drones, see generally Alex Bracetti, *The 10 Best Drones You Can Buy Right Now*, COMPLEX (Mar. 26, 2013), <http://www.complex.com/tech/2013/03/10-cool-drones-you-can-buy-right-now/parrot-ardrone-20> (identifying the \$300 Parrot AR.Drone 2.0 as "[t]he most popular drone on the consumer market").

<sup>23</sup> See Chad Garland, *Sempra Energy Gets FAA Approval to Test Drones for San Diego Utility*, L.A. TIMES (July 11, 2014, 4:51 PM), <http://www.latimes.com/business/la-fi-drones-utilities-20140712-story.html>, archived at <http://perma.cc/JV5Q-YKWG> (describing a San Diego utility company's testing use of drones to inspect transmission lines and related facilities).

<sup>24</sup> See Ryan Holeywell, *BP's Drone a Milestone for Commercial Flights*, HOUS. CHRON. (June 10, 2014, 10:28 PM), <http://www.houstonchronicle.com/business/article/BP-s-drone-a-milestone-for-commercial-flights-5543470.php#0>, archived at <http://perma.cc/BAU3-B6MH> (describing the FAA's approval of an oil company's use of drones to survey oil pipelines above land near Alaska's Prudhoe Bay); Krithika Krishnamurthy, *In Alaska's Oil Fields, Drones Count Down to Takeoff*, REUTERS (June 7, 2013, 9:03 AM), <http://www.reuters.com/article/2013/06/07/drones-oil-idUSL3N0E828H20130607>, archived at <http://perma.cc/MQM7-9FSQ> (describing the growing interest in using drones to inspect oil pipelines in remote areas of Alaska).

<sup>25</sup> See Syed & Berry, *supra* note 10, at 24 (observing that "U.S. Customs and Border

surveys of vast areas at a relatively low cost. Firefighters,<sup>26</sup> disaster response teams,<sup>27</sup> and groups researching volcanoes<sup>28</sup> and severe weather events<sup>29</sup> have also increasingly made use of drones in recent years because of their ability to penetrate otherwise hard-to-reach places and collect data or even execute simple tasks without putting lives in danger.

Drone technologies have likewise been assisting agricultural operations overseas for more than a decade<sup>30</sup> and could ultimately have a dramatic impact on that industry domestically.<sup>31</sup> Drones could enable farmers to spray crops with greater precision while using comparatively less fuel per acre.<sup>32</sup> They may

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Protection holds a certificate of authorization and maintains a large cache of drones that serves as a 'lending library' for other public entities"); Keith Wagstaff, *Eyes in the Sky: Are Pricey Border Patrol Drones Worth The Money?*, NBC NEWS (July 13, 2014, 12:16 PM), <http://www.nbcnews.com/storyline/immigration-border-crisis/eyes-sky-are-pricey-border-patrol-drones-worth-money-n153696> (detailing the advantages Predator drones offer border control agencies over traditional border monitoring mechanisms).

<sup>26</sup> See, e.g., Brian Smith, *Are Drones the Future of Firefighting?*, WASH. TIMES (July 5, 2014), <http://www.washingtontimes.com/news/2014/jul/5/are-drones-the-future-of-firefighting/?page=all>, archived at <http://perma.cc/C7X9-QLNE> (describing the increasing use of drones in wildfire fighting missions).

<sup>27</sup> For example, Japanese officials have even employed drones to safely investigate radioactive areas in the wake of the Fukushima nuclear disaster. See Alexis C. Madrigal, *Inside the Drone Missions to Fukushima*, ATLANTIC (Apr. 28, 2011, 10:02 AM), <http://www.theatlantic.com/technology/archive/2011/04/inside-the-drone-missions-to-fukushima/237981/>, archived at <http://perma.cc/HHU7-7RBW>.

<sup>28</sup> See, e.g., W.J. Hennigan, *NASA Sends Fleet of Small Drones to Inspect Noxious Volcano Plumes*, L.A. TIMES (Apr. 2, 2013), <http://articles.latimes.com/2013/apr/02/business/la-fi-mo-nasa-volcano-drones-20130402>, archived at <http://perma.cc/RKS7-5UDN> (describing NASA's use of drones to research an active volcano in Costa Rica).

<sup>29</sup> See, e.g., Jolie Lee, *Drones May Help Predict Tornadoes in the Future*, USA TODAY (Apr. 29, 2014, 5:06 PM), <http://www.usatoday.com/story/news/nation-now/2014/04/29/tornado-drone-oklahoma-noaa/8462481/>, archived at <http://perma.cc/2UGS-A84K> (describing researchers' development and use of drones to gather temperature information and other data from storms in Tornado Alley).

<sup>30</sup> See Saurabh Anand, *Hovering on the Horizon: Civilian Unmanned Aircraft*, 26 AIR & SPACE LAW. 9, 9-10 (2013) (stating that "Japanese farmers have been utilizing [drones] since the 1990s").

<sup>31</sup> See DARRYL JENKINS & BIJAN VASIGH, ASS'N FOR UNMANNED VEHICLE SYS. INT'L, THE ECONOMIC IMPACT OF UNMANNED AIRCRAFT SYSTEMS INTEGRATION IN THE UNITED STATES 2-20 (2013) (forecasting economic and employment benefits for the agriculture industry totaling about \$75.6 billion in economic impact should the FAA successfully complete drone integration by 2015, dwarfing the economic impacts predicted for other commercial and civil markets).

<sup>32</sup> See Gosia Wozniacka, *Drones Could Revolutionize Agriculture, Farmers Say*, HUFFINGTON POST (Jan. 25, 2014, 4:01 PM), [http://www.huffingtonpost.com/2013/12/14/drones-agriculture\\_n\\_4446498.html](http://www.huffingtonpost.com/2013/12/14/drones-agriculture_n_4446498.html), archived at <http://perma.cc/2R79-SYYZ> (describing joint research between professors at the

also help to increase per-acre yields for some crops by assisting in locating and targeting pest problems or dry spots in fields.<sup>33</sup>

Even journalists, film production companies, and real estate agents stand to benefit from drone technologies. Rather than relying on loud, gas-guzzling helicopters to cover traffic accidents or crime scenes, news outlets could eventually use agile drones to gather footage closer to the action<sup>34</sup> at far less expense. Television and movie studios are increasingly seeking authorization to use drones so that they may more affordably shoot aerial footage,<sup>35</sup> with six film companies having successfully obtained FAA authorization.<sup>36</sup> And a growing number of real estate brokers are using drones to create flattering videos of homes and surrounding areas in preparation to list properties for sale.<sup>37</sup>

In addition to spurring economic growth, drone technologies could offer some environmental advantages as well.<sup>38</sup> For example, drones have the potential to increase the environmental safety and sustainability of modern agriculture by improving the accuracy and energy efficiency of farm irrigation, fertilization, and pest control.<sup>39</sup> And drones that replace commercial delivery

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University of California, Davis, and Yamaha Motor Corp. USA on drone-facilitated crop spraying).

<sup>33</sup> See Wendie Kellington, *Unmanned Air Systems and Regulating Navigable Airspace*, SV003 ALI-ABA 613, 629-31 (2013), available at <http://www.wkellington.com/pdf/2013/Unmanned-Aerial-Systems-and-Regulating-Navigable-Airspace.pdf>, archived at <http://perma.cc/L8HB-H395>.

<sup>34</sup> See Jack Nicas, *FAA Clears Six Film Companies to Use Drones*, WALL ST. J. (Sept. 25, 2014, 7:23 PM), <http://online.wsj.com/articles/faa-set-to-approve-filmmaking-drones-1411667976> (reporting that the popularity of drones in the film industry is partly attributed to their ability to “fly in a sweet spot for filming that is too low for helicopters and too high for cranes”).

<sup>35</sup> See Doug Gross, *Hollywood to Feds: Let Us Use Drones*, CNN (June 4, 2014, 5:09 PM), <http://www.cnn.com/2014/06/04/tech/innovation/movies-drones-faa/>, archived at <http://perma.cc/S39J-EPG9>.

<sup>36</sup> Nicas, *supra* note 34.

<sup>37</sup> See, e.g., Joel Aschbrenner, *FAA Says Real Estate Agents' Drone Use Illegal*, USA TODAY (July 7, 2014, 6:12 PM), <http://www.usatoday.com/story/news/nation/2014/07/07/real-estate-drones-illegal/12299591/>, archived at <http://perma.cc/5NZD-HSVN> (highlighting the increasing use of drones to obtain photographs and aerial footage of for-sale property).

<sup>38</sup> For general descriptions of some companies that are already seeking to use drones to facilitate more sustainable business activities, see generally Garrett Hering, *Sky's the Limit: Drone Makers Target Sustainability*, GREENBIZ (July 14, 2014), <http://www.greenbiz.com/blog/2014/07/11/8-drone-developers-target-sustainability>, archived at <http://perma.cc/J2QK-KKN6>.

<sup>39</sup> See Christopher Doering, *Growing Use of Drones Poised to Transform Agriculture*, USA TODAY (Mar. 23, 2014, 7:18 AM), <http://www.usatoday.com/story/money/business/2014/03/23/drones-agriculture-growth/6665561/>, archived at <http://perma.cc/3T8Q-C4ED> (describing drones' potential to

trucks in dense urban areas could eventually reduce per-delivery carbon dioxide emissions and energy consumption in those settings.<sup>40</sup>

Because of this long list of potential commercial uses for modern drones, the domestic drone industry is expected to expand dramatically over the coming years. By one estimate, as much as \$89 billion could be invested worldwide on drones over the next decade.<sup>41</sup> And the FAA has forecasted that, by the year 2020, as many as 30,000 drones will be coursing through skies above the United States at any given time.<sup>42</sup>

### B. *Escalating Conflicts and Confusion*

Unfortunately, the United States will be unable to take full advantage of modern domestic drone technologies until federal, state, and local governments develop a more robust legal and regulatory structure to govern these high-tech devices. For example, conflicts are beginning to erupt almost daily between civilian drone users and private landowners. In Pittsburgh, a drone recently flew over the playing field during a professional baseball game.<sup>43</sup> In Seattle, a woman getting dressed in a high-rise building spotted a camera-equipped drone hovering just outside her window.<sup>44</sup> In Nashville, a civilian drone soared conspicuously close to the city's Fourth of July fireworks display.<sup>45</sup> In Los

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facilitate efficient pest control, fertilization and irrigation and thereby reduce the quantity of chemicals seeping into the surrounding environment).

<sup>40</sup> See Jim Lyza, *Could Drones Give Your Package a Sustainable Lift?*, GREENBIZ (May 2, 2014), <http://www.greenbiz.com/blog/2014/05/02/could-drones-give-your-package-sustainable-lift>, archived at <http://perma.cc/BZS8-4WJM> (arguing that, "for small, single order packages, drones could offer a very energy-efficient mode of delivery").

<sup>41</sup> See Press Release, Teal Group Corp., *Teal Group Predicts Worldwide UAV Market Will Total \$89 Billion in Its 2013 UAV Market Profile and Forecast* (June 17, 2013) (available at <http://tealgroup.com/index.php/about-teal-group-corporation/press-releases/94-2013-uav-press-release>, archived at <http://perma.cc/N9JK-Y7UZ>) (estimating that "UAV spending will more than double over the next decade from current worldwide UAV expenditures of \$5.2 billion annually to \$11.6 billion, totaling just over \$89 billion in the next ten years").

<sup>42</sup> Ben Wolfgang, *FAA Chief Says Drones Will Force Change at Agency*, WASH. TIMES (Aug. 7, 2012), <http://www.washingtontimes.com/news/2012/aug/7/faa-chief-says-drones-will-force-change-at-agency/>, archived at <http://perma.cc/83PG-R5TP>.

<sup>43</sup> See Editorial, *Drones are Coming: PNC Park's Aerial Visitor is a Warning for the Future*, PITTSBURGH POST-GAZETTE (July 6, 2014, 12:00 AM), <http://www.post-gazette.com/opinion/2014/07/06/Drones-are-coming/stories/201407030106>, archived at <http://perma.cc/Y8RT-XUZ8> (arguing that the drone flight over the stadium during a June 26, 2014, game was evidence that "[n]ew laws addressing drones are needed").

<sup>44</sup> See Wright, *supra* note 6 (suggesting that the operator of the drone involved in the incident was "in a drone no man's land, a frontier not yet fully understood" from a legal perspective).

<sup>45</sup> See Heidi Hall, *Nashville Entrepreneur Flies Drone to Film Fireworks*, TENNESSEAN (July 6, 2014, 2:04 AM),

Angeles, hockey fans near the entrance of a professional sports arena threw large objects at a drone and eventually knocked it out of the sky.<sup>46</sup> In each of these cases, it was debatable whether the drone operators involved could be held criminally or civilly liable simply for flying their drones above private land.<sup>47</sup>

Law enforcement agencies are also increasingly grappling with difficult questions regarding their own potential uses of drone technologies. Because of their modest size and ability to provide low-cost aerial vantage points of activities on land, drones could be of great value to police departments.<sup>48</sup> But should a police officer need a warrant before flying a small, camera-mounted drone above a private residence in search of illegal activities? And, if a police drone flies directly above private land with neither a warrant nor the landowner's permission and obtains incriminating photos or video footage, should that evidence be admissible in court? A few state legislatures have recently enacted laws addressing these sorts of issues,<sup>49</sup> but such questions still remain unsettled in most jurisdictions.

There is even active controversy regarding the proper scope of the FAA's regulatory authority over drone flights. The FAA clearly possesses power to bring enforcement actions against citizens whose drones soar through high-altitude airspace areas or near airports and create serious risks of collisions with human-occupied aircraft. But should the FAA have regulatory jurisdiction over the flight of a drone if it occurs several miles away from any airport and the device never climbs more than a few dozen feet off of the ground? In a

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<http://www.tennessean.com/story/news/local/2014/07/05/nashville-fireworks-drone-video/12245831/>, archived at <http://perma.cc/5ELL-UHER> (indicating that the operator of the drone asserts "he was on firm legal footing for the activity").

<sup>46</sup> See Joseph Serna & Brian Bennett, *Mystery Surrounds Drone That Flew Above L.A. Kings Victory Party*, L.A. TIMES, June 16, 2014, <http://www.latimes.com/local/lanow/la-me-ln-kings-game-drone-no-owner-20140616-story.html>, archived at <http://perma.cc/U889-JSUZ> ("Despite its legality, the [downed] drone highlights a new wrinkle in airspace regulation – what to do with the growing prevalence of unmanned personal aircraft and their ever-growing capabilities?").

<sup>47</sup> See Aaron Sankin, *The Dizzying State of America's Drone Laws*, DAILY DOT (Apr. 24, 2014), <http://www.dailydot.com/politics/us-state-drone-laws-mess/>, archived at <http://perma.cc/3ZMX-5QJU> (decrying the confusing nature of the current legal regime surrounding drones).

<sup>48</sup> See Farber, *supra* note 3, at 8 (observing that, "[w]hether the purpose is to search for missing persons, detect forest fires, or investigate criminal activity, a police department with limited resources can purchase a less expensive UAV that is much more efficient than a helicopter, which requires personnel to operate, fuel, and maintain").

<sup>49</sup> For a general discussion of recent state statutory enactments relating to government agencies' use of drones, see generally Syed & Berry, *supra* note 10, at 27 (explaining that, as of June 2014, at least nine states had enacted laws that "placed restrictions on the government's use of drones" and that most of these new statutes "revolve around protecting citizens' privacy, particularly from intrusion by law enforcement").

recent dispute between the FAA and a commercial drone operator, an administrative law judge for the National Transportation Safety Board expressed skepticism that the FAA presently had regulatory power over such flights. The judge colorfully pointed out that, under the FAA's expansive view of its own authority, even "a flight in the air of . . . a paper aircraft, or a toy balsa wood glider, could subject the 'operator' to" an FAA enforcement action.<sup>50</sup>

Frustrated by a lack of clear laws relating to drones, many potential commercial drone users are presently waiting on the sidelines for laws to develop, and some are even threatening to relocate their drone-related activities to other countries.<sup>51</sup> The magnitude of these delayed investments and lost opportunities will only grow until policymakers craft a more workable set of legal rules for drones.

### C. *An Ambiguity in Property Law*

One factor that is complicating the effort to formulate effective laws for drones is lingering uncertainty regarding landowners' rights in the low-altitude space through which most civilian drones fly. To what extent, if any, is an owner of surface land entitled to exclude drones from flying in the airspace directly over her parcel? Although property laws are fairly straightforward as they relate to surface land itself and to the high-altitude airspace through which airplanes routinely glide, there is considerably less legal clarity with respect to airspace situated closer to the ground. An overview of how low-altitude airspace laws have evolved over time helps to explain why uncertainty still clouds them today.

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<sup>50</sup> Rafael Pirker, Docket No. CP-217 at 3 (N.T.S.B. Mar. 6, 2014) (decisional order). Frustrated by the FAA's positions, some Oregon state legislators proposed a bill in 2013 that would have claimed all airspace below the navigable airspace line as controlled by the state. See Jason Koebler, *Oregon Drone Bill Would Claim the "Airspace" Above Your Shoestrings*, U.S. NEWS & WORLD REP. (Jan. 31, 2013, 5:40 PM), <http://www.usnews.com/news/articles/2013/01/31/oregon-drone-bill-would-claim-the-airspace-above-your-shoestrings>, archived at <http://perma.cc/SU6Y-RG53> (quoting one commentator as stating that "if the Oregon bill passes, an already complicated issue could become even more difficult if the state tries to regulate the 'airspace' around a homeowner's lawn or shrubs"). Just prior to the publication of this article, the National Transportation Safety Board reversed the administrative law judge's earlier decision, ruling that the FAA did possess authority over very-low-altitude drone flights. See Rafael Pirker, NTSB Order No. EA-5730 (Nov. 18, 2014) (opinion and order).

<sup>51</sup> See, e.g., Gregory S. McNeal, *Six Things You Should Know About Amazon's Drones*, FORBES (July 11, 2014, 6:57 AM), <http://www.forbes.com/sites/gregorymcneal/2014/07/11/six-things-you-need-to-know-about-amazons-drones/2/>, archived at <http://perma.cc/SL5A-T3WQ> (claiming that Amazon has hinted that it will move its drone-related research and development activities to other countries unless U.S. regulators clear the path for them to continue such activities in the United States).

1. *Causby v. United States*: Partial Clarification of Airspace Rights

Prior to the twentieth century, the common law generally allocated airspace rights pursuant to Cino da Pistoia's famous declaration,<sup>52</sup> "*Cujus est solum, ejus est usque ad coelum*," or "[t]o whomsoever the soil belongs, he owns also to the sky . . . ."<sup>53</sup> This phrase, which came to be known as the "*ad coelum* doctrine," assigned airspace rights based on ownership of the surface land situated immediately below the space.<sup>54</sup> Because the doctrine placed no upper boundary on the column of airspace held by landowners, that column theoretically extended indefinitely to the outer reaches of the heavens.

However, it became evident soon after the advent of modern aviation that a legal rule giving landowners airspace rights reaching up into the upper atmosphere would not be in the nation's best interest. Such an approach would have required airlines to acquire aviation easements<sup>55</sup> from thousands of different landowners to embark on a single cross-country flight. Accordingly, Congress enacted the Air Commerce Act of 1926<sup>56</sup> and later amended portions of it in the Civil Aeronautics Act of 1938.<sup>57</sup> This federal legislation expressly authorized interstate flights within "navigable airspace"—space situated at or above minimum safe altitudes of flight.<sup>58</sup> Federal regulators then defined "navigable airspace" to include most airspace over 500 feet above ground level.<sup>59</sup>

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<sup>52</sup> Stuart S. Ball, *The Vertical Extent of Ownership in Land*, 76 U. PA. L. REV. 631, 631 (1928) (attributing the phrase to Cino da Pistoia).

<sup>53</sup> BLACK'S LAW DICTIONARY 378 (6th ed. 1990). In full, the maxim reads, "[c]ujus est solum, ejus est usque ad coelum et ad inferos." *Id.*

<sup>54</sup> The *ad coelum* doctrine appeared in the famous commentaries of Coke and Blackstone and was thereby solidly incorporated into American law prior to the twentieth century. See EDWARD COKE, 1 INSTITUTES OF THE LAWS OF ENGLAND; OR, A COMMENTARY UPON LITTLETON § 4(a) (Charles Butler ed., 18th ed., corrected, 1823) (1670); 2 WILLIAM BLACKSTONE, COMMENTARIES \*18; ROBERT R. WRIGHT, THE LAW OF AIRSPACE 35 (1968) ("*Blackstone's Commentaries* . . . reiterated Coke's viewpoint on ownership of airspace. These *Commentaries* burst upon the scene practically on the eve of American independence, and were accepted as 'quasi authority' in America.>").

<sup>55</sup> Aviation easements "allow aircraft to fly through a given space." *Cnty. of Westchester v. Town of Greenwich, Conn.*, 793 F. Supp. 1195, 1204 (S.D.N.Y. 1992), *rev'd sub nom. Cnty. of Westchester, N.Y. v. Comm'r of Transp.*, 9 F.3d 242 (2d Cir. 1993).

<sup>56</sup> See generally Air Commerce Act of 1926, Pub. L. No. 69-254, 44 Stat. 568.

<sup>57</sup> See generally Civil Aeronautics Act of 1938, ch. 601, 52 Stat. 973 (codified as amended in scattered sections of 49 U.S.C., including 49 U.S.C. § 401 (1940)).

<sup>58</sup> Civil Aeronautics Act of 1938 §§ 1(24), 3; Air Commerce Act of 1926 § 10. See Walter S. King, *The Fifth Amendment Takings Implications of Aircraft Air Force Overflights and the Air Installation Compatible Use Zone Program*, 43 A.F. L. REV. 197, 199 (1997) (observing that Congress had defined navigable airspace "in terms of minimum safe altitudes of flight").

<sup>59</sup> See *supra* note 58. In the Federal Aviation Act of 1958, Congress expanded its statutory definition of "navigable airspace" to also include all "airspace needed to insure

These new laws and regulations seemingly contradicted the *ad coelum* doctrine because they precluded landowners from keeping most aircraft out of the high-altitude airspace above their land. A vigorous debate thus emerged regarding the appropriate extent of landowners' property interests in airspace.<sup>60</sup> What rights, if any, did landowners have to keep aircraft out of the space directly above their parcels?

In 1946, the U.S. Supreme Court finally provided some additional guidance regarding the scope of landowners' airspace rights in the famous case of *United States v. Causby*.<sup>61</sup> The plaintiffs in *Causby* owned a modest North Carolina chicken farm located adjacent to what was initially a small municipal airport.<sup>62</sup> When the U.S. government leased the airport in 1942 for use as a World War II military facility, large fighter planes soon began regularly taking off and landing there. Some of these loud planes passed as low as eighty-three feet above the Causbys' land and just sixty-seven feet over the roof of their home.<sup>63</sup> The noise and bright lights associated with this new influx of low overflights were so intense that they were causing large numbers of chickens to fly into the walls of the Causbys' chicken coop and die.<sup>64</sup> Unable to continue operating their chicken farm, the Causbys sued the government, claiming that the military's frequent flights over their land had amounted to a compensable taking under the Fifth Amendment.<sup>65</sup> Conscious of a split among lower courts on airspace rights issues involving aircraft, the Supreme Court agreed to hear the case.<sup>66</sup>

Writing for the majority in *Causby*, Justice William Douglas first made clear that the *ad coelum* doctrine—or at least a literal interpretation of it—had “no place in the modern world.”<sup>67</sup> The doctrine, which purported to give surface owners property rights stretching indefinitely up to the sky, was not to be taken literally.<sup>68</sup> Congress had placed navigable airspace into the “public domain” to

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safety in take-off and landing of aircraft.” Federal Aviation Act of 1958, Pub. L. No. 85-726, § 101(24), 72 Stat. 739. *See also* 14 C.F.R. § 77.23 (2009) (describing air in which an object would be “an obstruction to air navigation” as including airplane take-off and landing areas).

<sup>60</sup> For a more full account of the growing skepticism concerning the *ad coelum* rule during the 1930s and 1940s and the early development of airspace rights laws in that period, see generally STUART BANNER, WHO OWNS THE SKY? THE STRUGGLE TO CONTROL AIRSPACE FROM THE WRIGHT BROTHERS ON (2008).

<sup>61</sup> 328 U.S. 256, 264 (1946).

<sup>62</sup> *Id.* at 256. Professor Stuart Banner has constructed a far more detailed description of the facts and circumstances surrounding the famous *Causby* case. *See generally* BANNER, *supra* note 60, at 226-60.

<sup>63</sup> *Causby*, 328 U.S. at 258.

<sup>64</sup> *Id.* at 259.

<sup>65</sup> *See id.* at 258.

<sup>66</sup> *See* BANNER, *supra* note 60, at 239.

<sup>67</sup> *Causby*, 328 U.S. at 260-61.

<sup>68</sup> *See id.* (considering the consequences of literal adherence to the *ad coelum* doctrine

serve as a “public highway” for aviation, and landowners generally lacked rights to exclude aircraft from that space.<sup>69</sup>

However, Justice Douglas then proceeded to emphasize that a landowner did own “at least as much of the space above the ground as he can occupy or use in connection with the land.”<sup>70</sup> Intrusions of that space, he wrote, were “in the same category as invasions of the surface,”<sup>71</sup> meaning that landowners could still plausibly bring valid claims for aerial trespass through lower-altitude airspace in some situations. And in cases like *Causby*, in which government-controlled overflights were “so low and so frequent as to be a direct and immediate interference with the enjoyment and use of the land,”<sup>72</sup> such flights could still trigger compensable takings.

The implications of *Causby* were significant to say the least. The *Causby* court’s holding that landowners’ property rights do not extend indefinitely up “to the sky” meant that landowners generally could not exclude aircraft from the high-altitude “navigable” airspace above their land—an important victory for the budding aviation industry.<sup>73</sup> At the same time, the case also established that landowners did hold exclusion rights in at least some of the low-altitude “non-navigable” airspace directly above their parcels.<sup>74</sup>

## 2. Unanswered Questions in *Causby*’s Wake

Regrettably, the majority in *Causby* declined to specify just how much of the space below the general 500-foot<sup>75</sup> navigable airspace line belonged to surface owners,<sup>76</sup> opting instead to proffer a few vague statements on the

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and finding that “[c]ommon sense revolts at the idea” of strict application).

<sup>69</sup> *See id.*

<sup>70</sup> *Id.*

<sup>71</sup> *Id.* at 265.

<sup>72</sup> *Id.* at 266.

<sup>73</sup> *Id.* (holding that the “inconveniences which [airplanes] cause[] are normally not compensable under the Fifth Amendment” as “[a]irspace, apart from the immediate reaches above the land, is part of the public domain”).

<sup>74</sup> *Id.* (finding that frequent government intrusions in the “immediate reaches above the [claimants’] land” which amount to “direct and immediate interference with the enjoyment and use of the land” are actionable as “takings”).

<sup>75</sup> It is worth noting that the 500-foot dividing line between navigable and non-navigable airspace can vary depending on location. For instance, over “congested areas,” the line is drawn at “an altitude of 1,000 feet above the highest obstacle within a horizontal radius of 2,000 feet of the aircraft.” 14 C.F.R. § 91.119(b) (2010). Over bodies of water or in “sparsely populated areas,” aircraft can fly less than 500 feet above the ground so long as they are not “operated closer than 500 feet to any person, vessel, vehicle, or structure.” *Id.* § 91.119(c). Additionally, within six miles of some airports, the navigable airspace line may commence at heights of less than 500 feet above ground level to provide space for takeoffs and landings. *See id.* § 77.17.

<sup>76</sup> *Causby*, 328 U.S. at 266 (“We need not determine at this time what those precise limits are.”).

subject. In the Court's words, landowners held title only to airspace situated within the "immediate reaches" above their land.<sup>77</sup> At a minimum, those immediate reaches included airspace areas that the landowner could "occupy or use in connection with the land."<sup>78</sup> They also encompassed airspace through which unwelcome aerial invasions would "subtract from the owner's full enjoyment of the property."<sup>79</sup>

The *Causby* Court's fuzzy standards left plenty of unanswered questions. Just how high above land did the "immediate reaches" extend? And what sorts of airspace uses were sufficient to satisfy the Court's "occupy or use" standard? The Court openly refused to address these questions or to offer any further guidance regarding the upward limits of landowners' airspace rights, declaring instead: "We need not determine at this time what those precise limits are."<sup>80</sup>

The Court's nebulous statements were largely sufficient to address the essential property law questions raised by the dawn of modern aviation. Federal laws generally required manned aircraft to fly at high altitudes—well above the "immediate reaches," whatever was precisely meant by that phrase—so clearer assignments of property rights in low-altitude airspace were arguably unnecessary at that juncture. Indeed, in the years following *Causby*, conflicts between landowners and air travelers grew fairly uncommon.<sup>81</sup>

#### D. *Drone Technologies Now Reviving the Debate*

Unfortunately, *Causby*'s indefinite rules<sup>82</sup> for demarcating interests in low-

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<sup>77</sup> *Id.*

<sup>78</sup> *Id.* at 264.

<sup>79</sup> *Id.* at 265.

<sup>80</sup> *Id.* at 266. Other commentators have noticed this overt decision of the *Causby* Court not to more clearly define landowners' airspace rights. See, e.g., ALISSA M. DOLAN & RICHARD M. THOMPSON II, CONG. RESEARCH SERV., R42940, INTEGRATION OF DRONES INTO DOMESTIC AIRSPACE: SELECTED LEGAL ISSUES 5-6 (2013) (explaining that the *Causby* court "declined to draw a clear line" between privately owned airspace and public airspace).

<sup>81</sup> See, e.g., BANNER, *supra* note 60, at 259-60 (finding that, after *Causby*, "reported cases raising the issue" of aerial trespass "became less common" and "the aerial trespass debate largely fizzled out"). The only significant issue involving aviation and airspace that arose later and required judicial clarification related to the airspace near airports required for takeoffs and landings. Soon after "Congress redefined 'navigable airspace'" in 1958 to include airspace below 500 feet that was "'needed to insure safety in take-off and landing of aircraft,'" the Supreme Court clarified that overflights through those low-altitude areas could still trigger compensable takings even though they were technically confined within airspace that had been federally designated as "navigable" for aviation purposes. See *Griggs v. Allegheny*, 369 U.S. 84, 86-90 (1962); BANNER, *supra* note 60, at 259 (describing the *Griggs* case as holding that "[f]lights that remained within the federally defined navigable airspace were still takings if they crossed low enough over a landowner's property").

<sup>82</sup> Other commentators have drawn attention to the continued uncertainty associated with low-altitude airspace rights. See, e.g., Colin Cahoon, Comment, *Low Altitude Airspace: A*

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altitude airspace are already proving problematic in this new era of domestic drones. More than half a century after *Causby*, controversy surrounding landowners' airspace rights is brewing once again. Drone technologies have given citizens and businesses affordable access to low-altitude airspace like never before, and laws designed with large airplanes and helicopters in mind are struggling to effectively govern the conflicts that are arising as a result of these innovations. Airspace rights questions that the *Causby* Court knowingly left open several decades ago underlie much of this reemerging policy debate.

### 1. Drones and Aerial Trespass

The growing inadequacy of existing airspace rights laws is especially discernable in the context of aerial trespass questions involving drones. Because current laws provide no definite ceiling on the three-dimensional columns of airspace controlled by landowners, there is pervasive uncertainty as to where drones may and may not fly. For example, is someone who intentionally flies a small drone 100 feet above a neighbor's private land without the neighbor's consent liable for trespass? What if the drone flies only ten feet above the neighbor's parcel? What if it flies just one foot above the neighbor's parcel but causes no measurable damage during the flight? Courts generally need not engage in these sorts of location-based questions in surface land trespass claims because two-dimensional surface boundary lines are usually perfectly clear.<sup>83</sup>

The analysis is far less straightforward in the murky realm of aerial trespass because the upper boundaries of landowners' airspace rights are largely undefined. In aerial trespass cases, courts must engage in subjective and unpredictable inquiries into whether the alleged aerial intrusion penetrated the amorphous "immediate reaches" of the plaintiff's airspace and whether such intrusion substantially interfered with the plaintiff's "use" of her land.<sup>84</sup> And in the case of alleged trespasses involving drones, a court could even elect to apply an altogether different rule based on a finding that a drone was more like a projectile than an aircraft.<sup>85</sup>

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*Property Rights No-Man's Land*, 56 J. AIR L. & COM. 157, 198 (1990) ("With no definitive standard yet enunciated, and courts mixed in their approach to the question, landowners must still wonder just exactly what their property rights are to the airspace above their land.").

<sup>83</sup> See RESTATEMENT (SECOND) OF TORTS § 158 (1965) ("One is subject to liability to another for trespass, irrespective of whether he thereby causes harm to any legally protected interest of the other, if he intentionally (a) enters land in the possession of the other, or causes a thing or a third person to do so, or (b) remains on the land, or (c) fails to remove from the land a thing which he is under a duty to remove.").

<sup>84</sup> See RESTATEMENT (SECOND) OF TORTS § 159(2) (1965) ("Flight by aircraft in the air space above the land of another is a trespass if, but only if, (a) it enters into the immediate reaches of the air space next to the land, and (b) it interferes substantially with the other's use and enjoyment of his land.").

<sup>85</sup> See *id.* § 158, cmt. i ("[I]n the absence of the possessor's consent or other privilege to

Because of the blurry nature of aerial trespass laws, numerous journalists and commentators have noted that there is no telling how a court might rule in any given drone trespass dispute.<sup>86</sup> The low-altitude airspace where most domestic drones fly has been aptly described as a “property rights ‘no-man’s land,’” where landowners and drone operators can only guess regarding their respective rights.<sup>87</sup> This confusion is so great that some landowners have expressed a belief that they are legally entitled to shoot down unwelcome drones hovering above their parcels.<sup>88</sup>

## 2. Government Drones and Takings Law

Uncertainty regarding the scope of landowners’ airspace rights could eventually complicate the analysis of future takings claims involving drones as well. Suppose, for instance, that a U.S. Postal Service office were to begin regularly sending drone flights through the airspace above a neighboring parcel of land as part of a new drone delivery program. Suppose further that the drone

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do so, it is an actionable trespass to throw rubbish on another’s land . . . or to fire projectiles . . . through the air above it, even though no harm is done to the land or to the possessor’s enjoyment of it.”).

<sup>86</sup> See, e.g., DOLAN & THOMPSON, *supra* note 80, at 21 (positing that “determining whether a drone in flight is trespassing upon one’s property may be unusually challenging”); Syed & Berry, *supra* note 10, at 30 (stating that “flying drones above a person’s property, even for just a moment, might constitute a trespass,” but that it is ultimately “not clear how courts will treat drone flight over private property” in a trespass dispute); Alexis C. Madrigal, *If I Fly a UAV over My Neighbor’s House, Is It Trespassing?*, ATLANTIC (Oct. 10, 2012, 2:00 PM), <http://www.theatlantic.com/technology/archive/2012/10/if-i-fly-a-uav-over-my-neighbors-house-is-it-trespassing/263431/>, archived at <http://perma.cc/2X3X-GHJB>.

<sup>87</sup> Cahoon, *supra* note 82, at 198.

<sup>88</sup> In some instances, landowners are legally entitled to commit acts that might otherwise constitute conversion if necessary to protect their land from a threatened harm. See RESTATEMENT (SECOND) OF TORTS § 260 (1965) (providing that “one is privileged to commit an act which would otherwise be a . . . conversion if the act is, or is reasonably believed to be, necessary to protect the actor’s land or chattels or his possession of them, and the harm inflicted is not unreasonable as compared with the harm threatened”). A handful of people seem to believe that this principle could absolve them from liability for shooting down drones in certain situations. See, e.g., Stephen Rex Brown, *It’s Drone Season! Colorado Town to Vote on License to Shoot Down Unmanned Aircraft*, N.Y. DAILY NEWS (Dec. 10, 2013, 9:07 AM), <http://www.nydailynews.com/news/national/colorado-town-vote-license-shoot-drones-article-1.1543030#Ouf1RZQdS5LKXg6j.97> (quoting the drafter of a proposed ordinance in Deer Trail, Colorado, which would have expressly authorized citizens to shoot down drones, as proclaiming, “[w]hat has me fired up is it’s trespassing”); David Schneider, *Would You Shoot Your Neighbor’s Drone?*, IEEE SPECTRUM (Dec. 31, 2013, 2:58 PM), <http://spectrum.ieee.org/aerospace/aviation/would-you-shoot-your-neighbors-drone>, archived at <http://perma.cc/P7LP-PFT7> (describing an ongoing popular dialogue about the possibility of shooting down drones and the story of an animal rights group whose drones were shot out of the sky more than once).

flights were relatively quiet but that they occurred several times a day at an average altitude of just fifty feet directly over the neighbor's backyard. Would these regular drone overflights give rise to a compensable Fifth Amendment takings claim?

The existing case law on airspace takings generally provides that a taking occurs "when government action results in aircraft flying over a landowner's property low enough and with sufficient frequency to have a direct and immediate effect on the use and enjoyment of the property."<sup>89</sup> This sort of ad hoc test, which requires courts to make multiple subjective judgments to adjudicate a claim, could make it difficult for government entities interested in flying drones over private property to know where they stand under the law. How low is "low enough" to trigger a taking? And how frequent must the flights be to occur with "sufficient frequency" to require payment of just compensation? In an age when government entities are increasingly looking to employ drone technologies, the confusion and frustration over the current ad hoc approach to these issues will only grow.

### 3. Drone-Assisted Searches and the Fourth Amendment

The ambiguous state of landowners' airspace rights is even muddling new drone-related questions in the criminal law realm. Suppose that a police officer, having no probable cause or warrant, were to fly a camera-equipped drone a few feet above a private citizen's fenced backyard and take photos of a pair of marijuana plants in her garden. Would the officer have thereby subjected the private citizen to an unreasonable search in violation of the Fourth Amendment of the Constitution?<sup>90</sup> Or would the photos of her marijuana plants be admissible in court?<sup>91</sup>

The Supreme Court has already established that naked-eye aerial surveillance from an aircraft flying within navigable airspace does not violate the Fourth Amendment. In *California v. Ciraolo*,<sup>92</sup> the Court held that police surveillance conducted from an airplane flying 1000 feet above the ground did not violate a landowner's "reasonable expectations of privacy" or Fourth Amendment rights.<sup>93</sup> The Court supported its holding on a finding that airspace

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<sup>89</sup> Brenner v. New Richmond Reg'l Airport Comm'n, 816 N.W.2d 291, 310 (Wis. 2012).

<sup>90</sup> See U.S. CONST. amend. IV (protecting "[t]he right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures").

<sup>91</sup> See *id.* Under prevailing case law, the Fourth Amendment generally requires that law enforcement agencies have probable cause or a warrant to conduct "reasonable" searches. See generally *Illinois v. Gates*, 462 U.S. 213 (1983) (expounding the Fourth Amendment's probable cause requirement). Evidence gathered through unreasonable searches is generally not admissible in court actions against an individual who was unreasonably searched. See *Mapp v. Ohio*, 367 U.S. 643, 655-56 (1961); *Weeks v. United States*, 232 U.S. 383, 391-94 (1914).

<sup>92</sup> 476 U.S. 207 (1986).

<sup>93</sup> See *id.* (holding that observation of a citizen's backyard marijuana crop by law

at such altitudes is FAA-designated, open-access airspace for air travel and thus qualifies as a “public vantage point” where a police officer or any law-abiding member of the public “has a right to be.”<sup>94</sup>

However, the Supreme Court has also suggested that aerial surveillance from aircraft that are legally flying well below the 500-foot navigable airspace line can also pass constitutional muster in some circumstances. In the 1989 case of *Florida v. Riley*,<sup>95</sup> the Court plurality held that warrantless surveillance from a helicopter hovering only 400 feet above the ground was permissible under the Fourth Amendment.<sup>96</sup> Because helicopters are not required to stay above the 500-foot navigable airspace floor applicable to fixed-wing aircraft, the plurality in *Riley* observed that “[a]ny member of the public could legally have been flying” a helicopter at a height of 400 feet above the defendant’s land.<sup>97</sup> Based on that fact, the plurality determined that the police officer’s observations were conducted from a public vantage point and thus were not a search under the Fourth Amendment.<sup>98</sup>

The *Riley* approach of focusing on whether a police officer’s aerial vantage point was within publicly accessible airspace could prove problematic in drone surveillance cases. Indeed, Justice Brennan’s prophetic dissenting opinion in *Riley* used a hypothetical description of a modern drone to emphasize the potential unworkability of the plurality’s approach:

Imagine a helicopter capable of hovering just above an enclosed courtyard or patio without generating any noise, wind, or dust at all—and, for good measure, without posing any threat of injury. Suppose the police employed this miraculous tool to discover not only what crops people were growing in their greenhouses, but also what books they were reading and who their dinner guests were. Suppose, finally, that the FAA regulations remained unchanged, so that the police were undeniably “where they had a right to be.” Would today’s plurality continue to assert that “[t]he right of the people to be secure in their persons, houses, papers,

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enforcement from an airplane flying at 1000 feet above the ground did not violate the Fourth Amendment because it was not a search and that a photograph taken from the plane was admissible in a trial against the landowner). For a more detailed discussion of *Ciraolo* and related cases, see generally Farber, *supra* note 3, at 18-23.

<sup>94</sup> *Ciraolo*, 476 U.S. at 213.

<sup>95</sup> 488 U.S. 445 (1989) (plurality opinion).

<sup>96</sup> *See id.* at 447-52.

<sup>97</sup> *Id.* at 451; *see also* 14 C.F.R. § 91.119(d) (2010) (providing that “[h]elicopters may be operated at less than the minimums prescribed” for fixed-wing aircraft, provided “each person operating [the] helicopter [complies] with any routes or altitudes specifically prescribed for helicopters by the [FAA]”). Other cases have likewise confirmed that helicopters can legally fly below the navigable airspace line under certain conditions. *See, e.g.,* *People v. Sabo*, 230 Cal. Rptr. 170, 175 (Cal. Dist. Ct. App. 1986) (“The helicopter hovering above the surface of land in such a fashion as not to constitute a hazard to persons or property is . . . lawfully operated.”).

<sup>98</sup> *See id.*

and effects, against unreasonable searches and seizures” was not infringed by such surveillance? Yet that is the logical consequence of the plurality’s rule . . . .<sup>99</sup>

Twenty-five years after *Riley*, law enforcement agencies can now easily purchase the very hypothetical “miraculous tool” that Justice Brennan forebodingly described.<sup>100</sup> Tragically, most courts still have little more than the FAA’s safety-based regulations to assist them in determining whether officers or the public have a “right to be” in any particular area of low-altitude airspace. Until laws more clearly define the extent of landowners’ rights to exclude drones from their super-adjacent airspace, courts could have a difficult time analyzing these Fourth Amendment issues involving drones as well.

## II. LOW-ALTITUDE AIRSPACE RIGHTS: A PROPERTY THEORY PERSPECTIVE

As just described, the rising interest in domestic drones is drawing unprecedented attention to the question of how high above the ground surface owners’ airspace rights really extend. For decades, courts and legislatures have more or less dodged this question. Admittedly, identifying the optimal answer is no easy task given the great complexity associated with this ubiquitous and important resource.

Sandwiched between two very different types of resources, low-altitude airspace serves a diverse set of unique and valuable functions that has long made it a particularly difficult area to manage under the law. Directly underneath it sits surface land—a resource divided into numerous separately owned parcels by precise boundary lines that are strictly enforced under a private property regime.<sup>101</sup> Immediately above low-altitude airspace rests navigable airspace—a regulated commons that is open to all, owned by no one, and controlled under detailed federal regulations.<sup>102</sup> Which of these two contrasting property approaches best suits the low-altitude layer of airspace between them, through which domestic drones tend to fly? A theory-based comparison of the legal rules governing surface land and high-altitude airspace is a useful starting point for considering possible strategies for governing the precious space that lies between these two resources.

### A. *The Private Property System for Surface Land*

Interests in surface land—the solid ground above which most domestic drones hover—are governed under a classically rigid private property system. Unlike the murky set of legal rules governing low-altitude airspace, the laws

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<sup>99</sup> *Riley*, 488 U.S. at 462-63 (Brennan, J., dissenting).

<sup>100</sup> See Somini Sengupta, *Lawmakers Set Limits on Police in Using Drones*, N.Y. TIMES, Feb. 16, 2013, at A1 (describing an increase in interest among law enforcement agencies in using drone technologies and the seeming popular backlash to that trend).

<sup>101</sup> See *infra* text accompanying notes 103-106.

<sup>102</sup> See *infra* text accompanying notes 126-128.

delineating property rights in surface land could hardly be clearer. In accordance with rigorous principles and standards, surveyors meticulously measure and describe two-dimensional parcel boundaries.<sup>103</sup> Parties then use the legal descriptions borne out of that process to convey strictly defined property interests in those parcels.<sup>104</sup> The basic bundle of rights accompanying fee simple title includes the right to exclude others from intruding onto the parcel's surface for almost any reason.<sup>105</sup> Under common law, intentional invasions across surface boundary lines and onto neighboring land can give rise to actionable trespass claims, even when no measurable injury results from the invasion.<sup>106</sup>

Economists and property scholars have offered numerous theories over the years for why property interests in surface land are so scrupulously defined and resolutely enforced. These theory-based explanations shed light on the difficult property law questions implicated in the domestic drone debate.

### 1. Clearly Defined Parcel Boundaries

Surface land has long served as a paradigmatic example of a resource whose value is best maximized under a strong private property system.<sup>107</sup> Professor Harold Demsetz famously observed that property rights tend to emerge to help “internalize externalities when the gains of internalization become larger than

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<sup>103</sup> The American Land Title Association's uniform measurement standards for land/title surveys, which are widely accepted among commercial title insurance companies and real estate lenders for land surveying purposes in the United States, provide a sense of the precise and stringent nature of the land surveying process. *See* AM. LAND TITLE ASS'N, MINIMUM STANDARD DETAIL REQUIREMENTS FOR ALTA/ACSM LAND TITLE SURVEYS § 3.E (2011), available at <http://www.alta.org/forms/>, archived at <http://perma.cc/3DHD-AR2C> (providing for a “maximum allowable Relative Positional Precision” of “2 [centimeters] plus 50 parts per million” for ALTA/ACSM Land Title Surveys).

<sup>104</sup> *See* STUART M. SAFT, COMMERCIAL REAL ESTATE TRANSACTIONS § 12:9 (3d ed. 2014) (describing the parcel legal description as “the most important single aspect of the title report” associated with a commercial real estate transaction “and the one most likely to cause a problem” if it is erroneous).

<sup>105</sup> 63C Am. Jur. 2d *Property* § 1 (2014) (“The right to exclude others, as well as their property, is one of the most essential sticks in the bundle of rights that are commonly characterized as property.”).

<sup>106</sup> *See* RESTATEMENT (SECOND) OF TORTS § 158 (1965).

<sup>107</sup> It is worth noting that, for good reason, millions of acres of valuable land in the United States exist as “public lands” today and that those lands are not separately and privately owned. However, the precise boundaries of even these lands are still carefully defined and memorialized within property law's recording system. For general information on the location and characteristics of most of the federal public lands within the United States, see generally *Public Land Statistics*, U.S. DEP'T INTERIOR BUREAU OF LAND MGMT., [http://www.blm.gov/public\\_land\\_statistics/index.htm](http://www.blm.gov/public_land_statistics/index.htm), archived at <http://perma.cc/5ANY-BWSH> (last visited Oct. 27, 2014).

the cost of internalization.”<sup>108</sup> In essence, Demsetz’s observations suggest that laws recognizing private property rights in a given resource are generally justifiable when the aggregate social welfare benefits attainable through such laws exceed the costs associated with implementing and enforcing them. For much of the nation’s surface land, these proverbial cost-benefit scales have long tipped in favor of strong private property protection.

Because surface land is such a valuable resource, legal rules that cause parties to internalize most of the costs and benefits associated with using it can often produce sizable social welfare gains. Landowners are more apt to invest in land—to plant crops or erect buildings on it—if reliable legal rules are in place to protect such investments against intruding free riders. Parties are also less likely to waste or destroy surface land resources when operating under a private property regime that causes landowners to suffer most of the economic consequences of such destructive actions. These strong internalization effects born out of private property systems can motivate citizens to buy, sell, develop, and utilize surface land in more socially optimal ways, generating significant “gains of internalization.”<sup>109</sup>

The “costs of internalization”—costs associated with establishing and enforcing private property rights in land so as to facilitate the internalization effects just described—are also relatively low. Fences, walls, surveying equipment, recording systems, and other tools and policies make it relatively inexpensive to draw and protect private property rights in surface land.<sup>110</sup> These low costs in comparison to the large gains achievable through the internalization of land-related externalities help to explain why the law has long supported and protected strong private property rights in land.

## 2. A Strict Liability Exclusion Regime

Existing laws governing surface land not only allow parties to divide up and delineate interests in it with great accuracy; they also aggressively protect landowners’ rights to keep others out. As mentioned above, intentional trespassers on surface land can be liable at common law even when their

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<sup>108</sup> Harold Demsetz, *Toward a Theory of Property Rights*, 57 AM. ECON. REV. 347, 350 (1967). An externality arises “[w]hen the activity of one entity . . . directly affects the welfare of another in a way that is not transmitted by market prices.” HARVEY S. ROSEN, PUBLIC FINANCE 86 (5th ed. 1999).

<sup>109</sup> This general view of property is often traced back to the observations of Professor Ronald Coase in his seminal article, R. H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960). For a more detailed discussion of the evolution of property theory as it relates to the internalization of externalities, see generally Thomas W. Merrill & Henry E. Smith, *Making Coasean Property More Coasean*, 54 J.L. & ECON. S77, S78-S80 (2011).

<sup>110</sup> Other scholars have commented upon the valuable enforcement assistance that walls and fences can provide for property interests in land. See, e.g., Robert C. Ellickson, *Property in Land*, 102 YALE L.J. 1315, 1329 (1993) (“For millennia, absentee owners have employed simple technologies such as hedges, moats, and impregnable fencing to keep out persons and animals that do not respect boundaries.”).

intrusions result in no provable damages. Some courts have even upheld large punitive damage awards for surface trespasses in cases involving no measurable injuries to the plaintiffs or their property.<sup>111</sup>

One could imagine a surface trespass law that took a very different approach, seeking to resolve disputes by determining which of two competing uses of land is most valuable in each given situation and favoring the party engaged in that use. Under an *ex ante* version of such an approach, courts would rely on dozens of highly detailed rules aimed at covering every possible factual situation to help ensure that intrusions onto others' land created liability only in situations when the trespasser had less to gain from the intrusion than the landowner stood to lose from it. Under an *ex post* version, a single vague rule would give wide-reaching discretion to courts and count on judges and juries to determine on a case-by-case basis which of two competing land uses was most socially valuable. Under the perfect conditions, this more fact-intensive, use-based approach to governing land conflicts—what Professor Henry E. Smith termed a “governance” regime—could theoretically ensure that land was always put to its highest valued use.<sup>112</sup>

However, as Smith suggests, laws applying such governance rules to surface land would not work very well in most contexts because of the significant “information costs” they would impose on parties and courts.<sup>113</sup> Land is exceptionally multifunctional. A single parcel of land can potentially serve numerous different parties in a wide variety of ways, each with varying degrees of value to society. Under a governance regime for surface land, large numbers of people would thus be burdened with having to sift through piles of information to predict the extent to which their particular intended uses of any given parcel would be legally protected. Courts would similarly have to exhaust copious amounts of resources comparing the relative merits of competing land uses to resolve even the most basic property disputes.<sup>114</sup>

In contrast, strict liability surface trespass laws allow courts to settle many land conflicts simply by determining whether the defendant crossed over the property line.<sup>115</sup> Smith characterizes these laws as a “classic” example of an

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<sup>111</sup> For a renowned case involving a punitive damages award in a surface trespass case in which the defendant caused no material damage to the plaintiff's land, see generally *Jacque v. Steenberg Homes, Inc.*, 563 N.W.2d 154 (Wis. 1997).

<sup>112</sup> See Henry E. Smith, *Exclusion Versus Governance: Two Strategies for Delineating Property Rights*, 31 J. LEGAL STUD. S453, S455 (2002) [hereinafter Smith, *Exclusion Versus Governance*] (describing governance rules as rules that “pick out uses and users in more detail” than exclusion rules).

<sup>113</sup> Henry E. Smith, *Exclusion and Property Rules in the Law of Nuisance*, 90 VA. L. REV. 965, 984 (2004) [hereinafter Smith, *Exclusion and Property Rules*].

<sup>114</sup> See *id.* (asserting that, when adjudicating under exclusion regimes, “[j]udges and juries need not individuate and evaluate the reasonableness or value of uses of the land”).

<sup>115</sup> See Smith, *Exclusion Versus Governance*, *supra* note 112, at S470 (suggesting that exclusion regimes tend to be more useful when “it is relatively cheap and effective to draw a boundary around the asset and enforce a right to prevent border crossings”).

“exclusion regime.”<sup>116</sup> He defines an exclusion regime as one in which “very rough signals or informational variables—such as presence inside or outside the boundary line around a parcel of land—are employed to protect an indefinite class of uses with minimal precision.”<sup>117</sup> In the case of surface land, these exclusion-based rules bundle together several of the myriad potential uses of land and protect them in one fell swoop by simply protecting physical “access” to the land itself.<sup>118</sup> Such rules send uncomplicated “keep out” signals to would-be trespassers, often eliminating the need for further inquiry into the permissibility of various uses of land.<sup>119</sup> Because of land’s particular capacity to serve numerous potentially conflicting uses to numerous individuals, the information-cost advantages of simple rights to exclude may partly explain why strict liability trespass rules have long had a place in property law.

Professor Thomas Merrill suggests that transaction cost considerations also favor strong exclusion-based property laws in surface land.<sup>120</sup> Viewed in a Coasean sense, a landowner’s right to exclude others from her property is a legally protected entitlement to preclude others from intruding.<sup>121</sup> Because surface trespass disputes usually involve a small number of parties—often just one landowner and one intruder—the transaction costs associated with voluntary bargaining over this entitlement tend to be relatively low.<sup>122</sup> Merrill argues that the fairly low transaction costs inherent in such negotiations increase the desirability of rules that clearly define entitlements and that punish those who intentionally disregard them.<sup>123</sup> In low-transaction-cost situations, such laws can better incentivize parties to resolve conflicts through efficiency-enhancing voluntary bargains that channel entitlements to their highest-valued users.<sup>124</sup> In Merrill’s words:

[W]hen the costs of transacting are low, the legal system will gravitate

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<sup>116</sup> Smith, *Exclusion and Property Rules*, *supra* note 113, at 995.

<sup>117</sup> *Id.* at 978-79.

<sup>118</sup> Smith, *Exclusion Versus Governance*, *supra* note 112, at S469.

<sup>119</sup> See Smith, *Exclusion and Property Rules*, *supra* note 113, at 995-96 (observing that “gross physical invasions” of surface land “tend to be easy for third parties to avoid”).

<sup>120</sup> See Thomas W. Merrill, *Trespass, Nuisance, and the Costs of Determining Property Rights*, 14 J. LEGAL STUD. 13, 14 (1985).

<sup>121</sup> See Coase, *supra* note 109, at 44.

<sup>122</sup> See Stewart E. Sterk, *Property Rules, Liability Rules, and Uncertainty About Property Rights*, 106 MICH. L. REV. 1285, 1294 (2008) (“When the number of potential contestants for a right is high, contract solutions are impractical because any single claimant’s incentive to negotiate with other claimants is low . . . . By contrast, when a resource has only two potential users, allocation by agreement is more feasible . . .”).

<sup>123</sup> See Merrill, *supra* note 120.

<sup>124</sup> The famous Coase Theorem essentially posits that, in the absence of transaction costs, voluntary bargaining tends to enable scarce entitlements to flow to their highest-valued users regardless of to whom those entitlements were initially assigned under the law. See generally Coase, *supra* note 109.

toward rules that determine entitlements at a low cost—such as the strict liability rule of trespass. The combination of low transaction costs and low entitlement-determination costs will maximize the extent to which conflicts between competing uses of land can be resolved by market transactions.<sup>125</sup>

This potential to promote efficient bargaining for land entitlements is yet another factor that may help explain the common law’s rigid, exclusion-based approach to protecting property interests in the surface land context.

As compelling as the preceding explanations may seem for property law’s clear rules protecting surface land interests, such explanations may not necessarily apply to the low-altitude airspace typically occupied by domestic drones. Airspace has physical attributes totally unlike those of surface land and serves a strikingly different set of uses. From a property theory perspective, is low-altitude airspace similar enough to the ground immediately below it to deserve protection under the same sort of exclusion-based private property regime? Or, would it be better to treat low-altitude airspace more like the upper reaches of the sky, where jets and airplanes fly? To fully analyze these questions, it is necessary to examine the policy reasons behind the existing property regime governing high-altitude airspace as well.

#### B. *The Regulated Commons System for High-Altitude Airspace*

In most of the United States, airspace situated greater than 500 feet above the ground is classified as “navigable airspace”—a publicly shared area that the FAA manages under volumes of detailed regulations.<sup>126</sup> Congress and the FAA have expressly set aside this space as a “public highway” for air travel, and the Supreme Court unquestionably affirmed the validity of that designation in *Causby* decades ago.<sup>127</sup> Accordingly, landowners typically cannot exclude ordinary aircraft from flying directly above their land at altitudes of 500 feet or more.<sup>128</sup>

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<sup>125</sup> Merrill, *supra* note 120.

<sup>126</sup> See 49 U.S.C. § 40103(a)(2) (2006) (stating that “[a] citizen of the United States has a public right of transit through the navigable airspace”); 14 C.F.R. § 77.23 (2009). As previously noted, the FAA-designated navigable airspace line is higher in some dense urban areas to accommodate large high-rise buildings and is lower near many airports to facilitate takeoffs and landings. See *supra* note 75.

<sup>127</sup> See *supra* notes 56-69 and accompanying text.

<sup>128</sup> It should be noted that courts in some jurisdictions have recognized rights in superadjacent airspace above 500 feet to the extent necessary to protect landowners from substantial interference. See Cahoon, *supra* note 82, at 192 (describing a “modified ‘fixed height’ theory” adopted in some jurisdictions, “which allows for landowners’ airspace rights above 500 feet only when the particular circumstances clearly show that this airspace is required in order for the landowner to use his property without substantial interference” and observing that at least a couple of jurisdictions have seemingly ignored the 500-foot line altogether in resolving disputes between aircraft and landowners). However, most

Most property theorists would likely classify high-altitude airspace as an open-access “commons” resource—a resource in which no one holds rights to exclude.<sup>129</sup> So long as they comply with applicable aviation laws, citizens are free to hover in and pass through such space without permission from the landowners below. The commons regime that governs high-altitude airspace is in many ways the antithesis of the private property regime that applies to surface land<sup>130</sup>: no one owns high-altitude space, and everyone is welcome to use it if they follow certain rules.

The same basic property theory concepts described in the preceding discussion on surface land rights seem to support the use of very different legal rules to govern high-altitude airspace. For instance, consider how Demsetz’s observations regarding the basic conditions that favor the emergence of private property rights in a resource<sup>131</sup> apply to high-altitude space. The gains of internalization of externalities attainable under a private property system for high-altitude airspace would be negligible at best. Externality problems between landowners and high-altitude air flights are relatively infrequent and minor, and such conflicts seldom deter efficient levels of investment in land or in aviation.<sup>132</sup> The intangibility of airspace also makes the resource fairly unsusceptible to overexploitation or commons tragedies of a scale that could practically be addressed through a private property system.<sup>133</sup> And there is not enough air traffic within most high-altitude airspace to generate congestion-related negative externality problems.

Laws that give landowners property rights in the high-altitude airspace above their land would also be relatively costly to implement and enforce. Building walls or fences to keep out unwanted intrusions would generally be more difficult and expensive at high altitudes than it is on or near the Earth’s surface. Surveying three-dimensional columns of space at high altitudes would likely also be pricier than conventional survey work done closer to the ground. And, for similar reasons, adjudicating aerial trespass claims in high-altitude

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jurisdictions have proven hesitant to recognize landowner rights in navigable airspace. *See id.* at 197 (“Very few jurisdictions can be expected to allow recovery for the taking of an avigational easement within ‘navigable airspace’ without an extraordinary showing of the harm caused by such overflights.”).

<sup>129</sup> *See* Frank I. Michelman, *Ethics, Economics, and the Law of Property*, in *ETHICS, ECONOMICS AND THE LAW* 3, 9 (J. Roland Pennock & John W. Chapman eds., 1982) (describing commons resources as “universally distributed” resources to which everyone has a “privilege”).

<sup>130</sup> *See id.* (describing commons regimes as “opposite to” private property regimes).

<sup>131</sup> *See supra* note 108 and accompanying text.

<sup>132</sup> *See* Smith, *Exclusion and Property Rules*, *supra* note 113, at 1026 (stating that “as long as planes are flying too high to interfere with existing uses of the land, it is unlikely that losing the right to control the upper airspace defeats any preexisting investments or expectations of the existing owners”).

<sup>133</sup> *See generally* Garrett Hardin, *The Tragedy of the Commons*, 162 *SCIENCE* 1243 (1968).

space would likely cost more on average than adjudicating surface trespass claims. When these greater costs are weighed against the trifling social gains that a private property system in high-altitude airspace might provide, it is easy to recognize why existing laws govern this resource as a commons rather than allocating it to individual landowners under a private property system.

Basic transaction cost analysis<sup>134</sup> further supports the current governance of high-altitude airspace as a regulated commons. The navigable airspace above the United States accommodates thousands of long-distance flights every day.<sup>135</sup> In light of this reality, the social welfare losses that would result if laws suddenly gave millions of landowners a right to exclude aircraft from the high-altitude space above their parcels would be astronomical. Airlines would have to negotiate voluntary easements with hundreds or even thousands of landowners for each of their flight routes, inevitably encountering severe holdout problems<sup>136</sup> in the process. Even if an airline miraculously secured all of the easements necessary to fly a route, its pilots would have to somehow stay within that narrow easement space throughout the entire flight to avoid trespass liability—a task that could prove difficult at the very high cruise altitudes where jetliners fly, particularly under adverse weather conditions. Laws granting public access to navigable airspace largely avoid these transaction costs, making them more appealing from a policy perspective.<sup>137</sup>

As mentioned above, the regulated commons structure applicable to high-altitude airspace exemplifies a “governance” approach rather than an “exclusion” approach to property.<sup>138</sup> Rather than giving private parties exclusion rights in high-altitude airspace and entrusting them to efficiently manage this resource, aviation laws use detailed statutes and regulations to exert significant governmental control over communally shared space.<sup>139</sup>

The law’s use of a governance approach in high-altitude airspace is fully

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<sup>134</sup> See *supra* notes 120-125 and accompanying text.

<sup>135</sup> See Jad Mouawad & Christopher Drew, *Airline Industry at Its Safest Since the Dawn of the Jet Age*, N.Y. TIMES, Feb. 12, 2013, at A1 (reporting that “two million passengers in the United States board[] more than 30,000 flights every day”).

<sup>136</sup> See James M. Buchanan, *The Institutional Structure of Externality*, 14 PUB. CHOICE 69, 73-74 (1973), cited in Lee Anne Fennell, *Property and Precaution*, 4 J. TORT L. 1, 47 (2011) (describing how holdout problems can arise when a party needs to obtain entitlements from multiple other parties to engage in a particular activity).

<sup>137</sup> Professor Henry E. Smith has also commented on the probable impact of transaction cost problems on the development of modern laws governing navigable airspace. See Smith, *Exclusion and Property Rules*, *supra* note 113, at 1026 (“When high-altitude overflights conflicted with strict application of the *ad coelum* principle that ownership extended indefinitely upward from a parcel of land, courts were ready to define the property rights away from the owner in the face of the enormous transaction costs (and perhaps holdout potential) facing airlines if they had to negotiate with all those owning land lying under the flight path of their airplanes.”).

<sup>138</sup> See generally *supra* notes 112-114 and accompanying text.

<sup>139</sup> See *supra* note 113 and accompanying text.

consistent with Smith's observations regarding the factors that tend to favor governance rules for a given resource.<sup>140</sup> Aviation is unquestionably the most common controllable use of high-altitude airspace and is usually of greater social value than any conflicting, land-based uses of the space.<sup>141</sup> In addition, relatively few citizens ever fly their own airplanes or helicopters, so the class of people engaged in aviation activities in high-altitude space is fairly small. These factors favor legal rules that treat high-altitude airspace as a commons resource for aviation and closely regulate uses of the space. This governance approach "impos[es] a more intense informational burden on a smaller audience of duty holders"—the airlines and pilots involved in aviation.<sup>142</sup> Because the class of "duty holders" who must learn and follow FAA regulations is so small, the aggregate information costs associated with closely regulating their activities are fairly low. Given these and the other advantages of managing high-altitude airspace as a regulated commons, it is hardly surprising that courts and policymakers readily embraced this governance-based approach shortly after the advent of modern flight.

C. *Internally Inconsistent Rules for Low-Altitude Airspace*

Unfortunately, property theory analysis becomes more challenging in the realm of low-altitude airspace—the typically 500-foot-deep layer of space sandwiched between navigable airspace and surface land. Landowners use this airspace in such diverse and nonobvious ways that it is no wonder some legal questions associated with the space remain up in the air. The existing set of laws managing low-altitude airspace awkwardly straddles the fence between exclusion and governance in an attempt to balance a varied set of competing interests. Internal inconsistencies in these rules that have managed to fly under the radar for decades are beginning to draw attention as domestic drones grow ever more common in the nation's skies.

1. A Predominance of Exclusion Rules

Most areas of property law treat low-altitude airspace as equivalent to surface land, using exclusion-based rules to strongly protect landowners' interests in that space. Consider, for example, the common law's treatment of overhang encroachments. If a tree, building, or other structure affixed to the ground extends over the property line and encroaches into the column of airspace directly above a neighboring parcel, the law typically enforces a neighbor's right to exclude the airspace encroachment.<sup>143</sup> In such cases, courts

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<sup>140</sup> See Smith, *Exclusion Versus Governance*, *supra* note 112.

<sup>141</sup> High-altitude airspace is arguably used as a dumping place for gaseous emissions, but cost constraints make it practically impossible to control the use of any particular region of high-altitude space for that purpose. Accordingly, this use as a depository for emissions does not merit inclusion in exclusion-governance analysis.

<sup>142</sup> Smith, *Exclusion Versus Governance*, *supra* note 112, at S455.

<sup>143</sup> See JACQUELINE P. HAND & JAMES CHARLES SMITH, NEIGHBORING PROPERTY OWNERS

need not consider whether the encroachment is within the immediate reaches of the neighbor's airspace or substantially interferes with the neighbor's use or enjoyment of her property. The mere fact that the overhang encroaches into the airspace immediately above the neighbor's parcel is usually enough to warrant an injunction or at least the awarding of damages.<sup>144</sup> There appears to be no vertical limit to the applicability of this rule.

Condominium laws also protect property interests in low-altitude airspace with exclusion-based rules largely akin to those governing surface land.<sup>145</sup> Under modern condominium laws, surveyors measure and carefully describe discrete, three-dimensional cubes of airspace situated completely above the ground.<sup>146</sup> Parties can then buy, sell, and even mortgage these interests despite having no fee interest in the underlying land.<sup>147</sup> Intentional and unauthorized intrusions into condominium units give rise to actionable trespass claims under the same strict liability trespass rules that apply to surface land, requiring no proof of damages or substantial interference with the owner's use.<sup>148</sup>

Even in the context of eminent domain, low-altitude airspace rights receive fairly strong private property protection under an exclusion regime. For instance, governments routinely exercise condemnation authority and pay landowners just compensation to acquire aviation easements<sup>149</sup> in low-altitude airspace near airports for takeoffs and landings.<sup>150</sup> Such activity strongly supports the notion that landowners hold private property interests entitling them to exclude unwelcome intruders from the low-altitude airspace above their land. These practices and the laws just highlighted seemingly adhere to a view that landowners possess exclusion rights in low-altitude airspace that are roughly equivalent to rights in the surface.

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§ 5.03, at 114 (1988) ("If a building is constructed so that part of it projects across the boundary line at a point above the surface, trespass is available. An example would be eaves of a roof that overhang a neighbor's land. Similarly, utility wires cannot be strung across land without the consent of its owner, even though none of the poles or standards are located on the owner's surface." (citations omitted)).

<sup>144</sup> *Id.*

<sup>145</sup> For a useful introductory discussion of the evolution and nature of condominium laws in the United States and a launching point for additional research on this topic, see generally Donna S. Bennett, *Condominium Homeownership in the United States: A Selected Annotated Bibliography of Legal Sources*, 103 LAW LIBR. J. 249 (2011).

<sup>146</sup> *Id.* at 253.

<sup>147</sup> *Id.* at 256.

<sup>148</sup> See, e.g., *Pepitone v. State*, 846 So. 2d 640, 642 (Fla. Dist. Ct. App. 2003) (predicting that an individual who "successfully entered [another's] condominium unit" without permission would be guilty of trespass).

<sup>149</sup> See *supra* note 55.

<sup>150</sup> See Troy A. Rule, *Airspace and the Takings Clause*, 90 WASH. U. L. REV. 421, 429 (2012) (citing multiple sources for the assertion that "takings of airspace easements through eminent domain often accompany airport construction and expansion projects").

## 2. Governance Rules for Conflicts Involving Aircraft

In contrast, a small handful of laws address conflicts over low-altitude airspace through governance rules instead of exclusion rules. Rather than relying on clear rights to exclude and voluntary bargaining among self-interested stakeholders to efficiently allocate entitlements in airspace, these rules depend on policymakers and courts to identify and favor those airspace uses they deem to be of greater social value in any particular context. Such rules can generate confusion and inefficiency because it is difficult to reconcile them with most other laws governing low-altitude airspace.<sup>151</sup>

The common law's nuisance-like rules governing aerial trespass—drafted decades before the recent growth in the domestic drone industry—epitomize this problematic governance approach. Under Restatement (Second) of Torts § 159(2): “Flight by aircraft in the air space above the land of another is a trespass if, but only if, (a) it enters into the immediate reaches of the air space next to the land, and (b) it interferes substantially with the other’s use and enjoyment of his land.”<sup>152</sup>

This aerial trespass rule is unquestionably a governance rule.<sup>153</sup> It essentially requires courts to gather information and subjectively determine which of two competing interests in airspace—the interest of the aircraft user and the interest of the underlying landowner—is more worthy of protection in each given case.<sup>154</sup> Courts applying this rule cannot simply focus on determining whether the defendant truly and intentionally flew an aircraft within some well-defined column of airspace. Instead, they must engage in costly, ad hoc, fact-specific inquiries into what constitutes the “immediate reaches” of the airspace above the plaintiff’s parcel and whether the defendant’s flight “interfere[d]” substantially with the plaintiff’s “use and enjoyment” of its land.<sup>155</sup>

In addition to aerial trespass laws, a handful of other rules that could apply to some drones’ flights in low-altitude airspace take a governance approach.

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<sup>151</sup> In addition to the aerial trespass and takings laws highlighted here, some state “solar rights” statutes arguably create governance rules for airspace by effectively transferring the equivalent of solar access easements through neighbors’ airspace to landowners who install solar panels on their properties. For a critical analysis of these state statutes, see generally Troy A. Rule, *Shadows on the Cathedral: Solar Access Laws in a Different Light*, 2010 U. ILL. L. REV. 851, 876-77 (describing solar access statutes in Wyoming and New Mexico).

<sup>152</sup> RESTATEMENT (SECOND) OF TORTS § 159(2) (1965); see also *Geller v. Brownstone Condo. Ass’n*, 402 N.E.2d 807, 809 (Ill. App. Ct. 1980) (declaring that, “to constitute an actionable trespass, an intrusion has to be such as to subtract from the owner’s use of the property”).

<sup>153</sup> Professor Henry E. Smith has expressly referred to aerial trespass laws as governance rules. Smith, *Exclusion and Property*, *supra* note 113, at 1026 (explaining that, after the birth of modern aviation, courts “redefine[d] overflights as falling under the domain of nuisance rather than trespass,” thereby “[s]ubstituting a governance rule for the exclusion approach”).

<sup>154</sup> See *id.* at 1026-27.

<sup>155</sup> See *United States v. Causby*, 328 U.S. 256, 266 (1946).

As described above, unpredictable ad hoc rules generally govern disputes over alleged takings of avigation easements through private airspace.<sup>156</sup> Most statutory privacy laws that might restrict certain drone uses<sup>157</sup> also lean toward the governance end of the spectrum.<sup>158</sup> And the common law tort of “intrusion upon seclusion,”<sup>159</sup> which a few writers have suggested could be another potential theory for establishing claims against drone users,<sup>160</sup> likewise takes a more governance-like approach. This cadre of fuzzy rules seems ill-suited to address what is likely to be a growing volume of significant conflicts over low-flying drones. The case-by-case nature of these rules could place unjustifiable burdens on courts and deter drone operators and landowners from making efficient investment decisions relating to their respective interests in low-altitude space.

Applying governance rules to low-altitude airspace may have been a reasonable policy strategy in the early days of modern aviation, when domestic drones were still more a science fiction dream than a reality. There was little reason to believe at that point that landowners really needed explicit exclusion rights in low-altitude airspace. Aviation technologies were also still rapidly developing during that period, so it may have seemed prudent to preserve some flexibility in low-altitude airspace rights so that it would be easier to adjust those rights to accommodate new innovations in future years.<sup>161</sup> And there

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<sup>156</sup> See *supra* note 89 and accompanying text.

<sup>157</sup> See Margot E. Kaminski, *Drone Federalism: Civilian Drones and the Things They Carry*, 4 CALIF. L. REV. CIRCUIT 57, 68 (2013), <http://scholarship.law.berkeley.edu/clrcircuit/8/> (explaining that “[s]tate wiretapping laws, Peeping Tom laws, video voyeurism laws, and paparazzi laws all currently regulate privacy-intrusive photography, videography, and sound recordings” and could thus be implicated in certain privacy-related drone disputes).

<sup>158</sup> See, e.g., CAL. CIV. CODE § 1708.8(b) (West 2014) (“A person is liable for constructive invasion of privacy when the defendant attempts to capture, in a manner that is offensive to a reasonable person, any type of visual image, sound recording, or other physical impression of the plaintiff engaging in a personal or familial activity under circumstances in which the plaintiff had a reasonable expectation of privacy, through the use of a visual or auditory enhancing device . . .”). This sort of statute, which requires a court to determine such fact-specific issues as whether the questioned activity would be “offensive to a reasonable person” or whether the plaintiff should have had a “reasonable expectation of privacy,” has strong characteristics of a governance approach. *Id.*

<sup>159</sup> See RESTATEMENT (SECOND) OF TORTS § 652B (“One who intentionally intrudes, physically or otherwise, upon the solitude or seclusion of another or his private affairs or concerns, is subject to liability to the other for invasion of his privacy, if the intrusion would be highly offensive to a reasonable person.”).

<sup>160</sup> See, e.g., Dolan, *supra* note 80, at 10 (describing the tort of intrusion upon seclusion as “the privacy tort most applicable to drone surveillance”); Syed & Berry, *supra* note 10, at 28 (highlighting the possibility for journalistic uses of drones to trigger liability under an intrusion upon seclusion theory in certain circumstances).

<sup>161</sup> At least one Justice in the *Causby* majority publicly expressed this sort of sentiment. See BANNER, *supra* note 60, at 249 (quoting Justice Frank Murphy as saying that airspace

seemed to be an underlying policy interest in preventing landowner rights from unduly constraining a valuable aviation industry that was still in its vulnerable embryonic stages.<sup>162</sup>

Regardless of how it came into place, the existing set of legal rules governing conflicts between landowners and things flying in low-altitude space is considerably less tenable in an age of domestic drones. These innovations arguably necessitate policy adjustments capable of more efficiently balancing the interests of drone operators and landowners. The integration of domestic drone technologies in the United States will be slow and bumpy until those adjustments take shape.

### III. CLARIFYING AIRSPACE EXCLUSION RIGHTS IN RESPONSE TO MODERN DRONES

As mentioned in Part I, the current policy tension surrounding domestic drones is certainly not the first occasion in which shortcomings in existing law have threatened to hinder a promising new industry.<sup>163</sup> History is replete with instances in which disruptive new innovations have exposed gaps or ambiguities in property law, and policymakers have responded by filling in the gaps. The birth of radio broadcasting led to the development of new laws to govern the allocation of broadcast frequencies along the electromagnetic spectrum.<sup>164</sup> The invention of petroleum-fueled engines sparked a dramatic increase in oil demand that eventually led to the creation of compulsory

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law was a “novel field” and declaring: “We should be careful about the air.”). Justice Black’s dissenting opinion in the case also emphasizes this fear. *See* *United States v. Causby*, 328 U.S. 256, 268-69 (1946) (Black, J., dissenting) (warning that the majority’s holding in *Causby* would “limit . . . possible future adjustments through legislation and regulation which might become necessary with the growth of air transportation”).

<sup>162</sup> This sort of fear about adverse impacts on aviation seemed to influence at least one of the dissenting Justices in *Causby*, who would have preferred giving even fewer airspace-related rights to landowners. *See* BANNER, *supra* note 60, at 249 (quoting Justice Harold Burton as fearing that, after *Causby*, an “airport would require the power of eminent domain” to acquire the rights in neighboring parcels necessary to avoid similar takings liability).

<sup>163</sup> Indeed, the advent of modern aviation is one example of such an instance. *See, e.g.*, Marc R. Poirier, *The Virtue of Vagueness in Takings Doctrine*, 24 CARDOZO L. REV. 93, 178 (2002) (observing that “[a]irplane overflight provides an example where a technological advance that blossomed into widespread social use spawned a new type of property use conflict” and that “in the early decades of this new resource use conflict, theories blossomed on how to characterize and resolve the dispute”).

<sup>164</sup> For the author’s own description of the emergence of a property regime after the development of radio broadcasting technologies, see generally Troy A. Rule, *Property Rights and Modern Energy*, 20 GEO. MASON L. REV. 803, 815-16 (2013) (describing Congress’ enactment of the Radio Act of 1927 and the Communications Act of 1934 following the advent of commercially viable broadcast radio technologies).

unitization statutes and other oil and gas laws.<sup>165</sup> And the advent of the Internet necessitated the conception of an entirely new body of law to govern rights in domain names and other online assets.<sup>166</sup> In each of these situations, timely and intelligent new property laws were instrumental in ensuring that the social progress and economic growth made possible by such innovations could proceed unabated.

A. *A Proposal for Greater Precision in Airspace Rights*

Today, as drone technologies create ever more opportunities for new and valuable uses of low-altitude domestic airspace, pressure is mounting once again for property laws to adapt. Arguably, state legislatures could assist in that process by enacting new laws that give landowners clear rights to exclude drones or other aircraft from entering into the low-altitude airspace above their land up to the existing navigable airspace line—a height of 500 feet above the ground in most areas. Such statutes could specify that these exclusion rights were largely equivalent to rights that landowners have long enjoyed on the surface. Holders of such rights would be entitled to bring actionable trespass claims against operators of drones that invaded their column of airspace simply by proving that the operator intentionally flew the drone into their space. Takings law rules applicable to government invasions on surface land would likewise be extended to low-flying government aircraft.

If state legislators prove unwilling to enact statutes clarifying landowners' airspace rights, courts could conceivably clarify them on their own by reasonably extending principles laid out in *Causby*. The majority in *Causby* declared that “the flight of airplanes, which skim the surface but do not touch it, is as much an appropriation of the use of the land as a more conventional entry upon it” and that such invasions of low-altitude airspace “are in the same category as invasions of the surface.”<sup>167</sup> A plain reading of this statement suggests that it would be reasonable to apply surface trespass and takings laws to situations involving low-flying drones.

To preserve a level of privacy and safety comparable to what landowners enjoyed prior to the drones era, laws clarifying landowner airspace rights should define these rights as extending all the way up to the navigable airspace line of 500 feet above-ground in most locations.<sup>168</sup> A rule defining exclusion rights as covering only 100 feet or 200 feet above the ground would arguably

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<sup>165</sup> See generally Miller, *supra* note 15, at 511-34 (describing the transition to oil and gas power as causing a national demand for those resources, resulting in laws facilitating their efficient exploitation).

<sup>166</sup> See generally Rustad & D'Angelo, *supra* note 16 (describing how the rise of the Internet has forced substantial adjustments to substantive and procedural laws, particularly in the area of property).

<sup>167</sup> *United States v. Causby*, 328 U.S. 256, 264-65 (1946).

<sup>168</sup> For a more detailed discussion of the potential privacy conflicts associated with domestic drones, see *infra* notes 175-177 and accompanying text.

be insufficient because it would allow small drones to cheaply hover above land, potentially violating landowners' privacy or threatening their safety from those altitudes. Only a law providing for exclusion rights all the way up to the navigable airspace line would ensure that the sole overflights over which landowners had no control would continue to be high-altitude flights by FAA-licensed pilots. Because navigable airspace designations can vary by location,<sup>169</sup> the exact heights of each parcel's exclusion rights could initially be established based on the FAA's existing navigable airspace designations. After this initial establishment of rights, the FAA could be prohibited from adjusting navigable airspace lines so as to decrease the height of any landowner's column of private space without paying just compensation.

Laws that more plainly defined landowners' interests in the low-altitude airspace above their land would do more than merely simplify aerial trespass and takings claims involving drones. They would also make it easier for courts to adjudicate issues related to law enforcement agencies' use of drone technologies. Armed with clear rules for determining whether the police drone had a "right to be" in a particular area of airspace when it captured an incriminating photo, courts would have less difficulty applying longstanding Fourth Amendment rules to decide admissibility questions involving that evidence.<sup>170</sup>

At least one state legislature has already enacted legislation giving landowners basic drone exclusion rights within a defined column of airspace above their parcels. An Oregon state statute enacted in 2013 included provisions creating a new civil claim for drone trespass.<sup>171</sup> These provisions generally allow real property owners to bring claims against anyone who flies a drone over their parcels a second time at a height of less than 400 feet after being asked not to do so.<sup>172</sup> Plaintiffs who prevail under Oregon's drone trespass statute can recover treble damages for any injuries to persons or property caused by unwanted drones and can also recover attorney fees in cases where the amount pleaded was less than \$10,000.<sup>173</sup> Although Oregon's drone trespass law is fairly narrow in scope, it is at least a step in the right direction toward a simpler, clearer set of rules capable of more effectively governing drone activity in low-altitude airspace.

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<sup>169</sup> In general terms, the FAA presently classifies non-navigable airspace as airspace less than 500 feet above ground level. The precise dimensions of this space vary somewhat depending on location. See 14 C.F.R. § 91.119(a)-(c) (2010) (generally prohibiting the operation of fixed-wing aircraft at altitudes of less than 500 feet above ground level in uncongested areas or 1000 feet above the highest nearby obstacle in congested areas).

<sup>170</sup> To review earlier materials focused on Fourth Amendment issues implicating drones, see *supra* notes 91-100 and accompanying text.

<sup>171</sup> OR. REV. STAT. § 837.380 (2013).

<sup>172</sup> *Id.*

<sup>173</sup> *Id.* § 837.380(3)-(4).

B. *Conditions Ripe for Strengthening Low-Altitude Airspace Rights*

Arguably, the same property theory principles cited in Part II.A in support of the existing strict liability rule for surface trespass point toward giving landowners similar exclusion rights against low-flying domestic drones. Drone technologies are having the very sorts of effects on low-altitude airspace that Professor Harold Demsetz famously identified would favor stronger protection of private property rights in a resource. As Demsetz observed, changes that increase the “gains of internalization” of externalities relating to a resource or decrease the costs of such internalization tend to favor such clarification or strengthening of interests.<sup>174</sup> Both of these types of changes are arguably present in the context of low-altitude airspace and domestic drones.

1. *Sizable Potential Gains through Internalization of Externalities*

Laws giving landowners clear rights to exclude drones from the airspace immediately above their land could generate significant social welfare gains by limiting drone-related negative externality problems. Many landowners rely on the airspace immediately above their land to provide precious seclusion from the eyes of others. This reliance on low-altitude airspace as a seclusion buffer is often taken for granted but can be highly valuable to landowners, particularly in residential areas. It is not uncommon for landowners to strategically place trees, walls, or fences, or to position homes or other buildings on their land so as to create greater solitude and privacy. And height restrictions in zoning ordinances and private subdivision covenants further strengthen landowners’ certainty about their degree of privacy on their parcels by restricting neighbors’ ability to erect structures that could create new vantage points for peering over trees or fences.<sup>175</sup>

Like height restrictions, laws that require conventional aircraft to meet expensive registration and pilot licensing requirements<sup>176</sup> and fly only at high altitudes also help low-altitude airspace to serve as a seclusion buffer for landowners. Such regulations and the generally high costs of owning and operating conventional aircraft limit the frequency and intrusiveness of aircraft

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<sup>174</sup> See Demsetz, *supra* note 108, at 350; *supra* note 108 and accompanying text.

<sup>175</sup> The privacy benefits of land use restrictions have been expressly stated in some zoning ordinances, *see, e.g.*, CHI., ILL., MUN. CODE § 17-1-0509 (2014) (providing that Chicago’s zoning ordinance was adopted for the purpose of “[e]nsuring adequate light, air, privacy, and access to property,” among other things), and acknowledged by at least one court, *see Sandstrom v. Larsen*, 583 P.2d 971, 976 (1978) (finding that a lower court’s interpretation that the “purpose of” a covenant “height restriction was to protect the view and privacy of the homeowners” was “entirely reasonable”).

<sup>176</sup> One reporter determined the total cost of becoming a pilot in the United States to range between \$8000 and \$13,000. *See* Nikhil Hutheesing, *The Real Cost of Becoming a Private Pilot*, BLOOMBERG (Mar. 8, 2013, 5:04 PM), <http://www.bloomberg.com/consumer-spending/2012-03-08/the-real-cost-of-becoming-a-pilot.html#slide15>, *archived at* <http://perma.cc/WP6H-AQ2T>.

overflights. Although someone in a helicopter or airplane within high-altitude airspace could conceivably use a powerful lens to invade the privacy of landowners below, the sheer cost and difficulty of such activity has historically prevented it from creating major policy concerns.

Unfortunately, the growing affordability of drones is jeopardizing the ability for low-altitude airspace to serve in its long-held role as a privacy buffer. Camera-equipped drone flights can enable drone operators to cheaply gaze onto private land areas that would otherwise be visible only from airplanes or helicopters at much higher altitudes. Low-flying drones can also create safety risks for landowners below. It is thus hardly surprising that sixty-three percent of respondents to a recent Pew Research Center survey felt “it would be a change for the worse if personal and commercial drones are given permission to fly through most U.S. airspace.”<sup>177</sup>

Given the potential for regular and substantial privacy and safety conflicts between domestic drones and landowners, there are now substantial potential “gains of internalization” available through embracing a private property system for low-altitude airspace.<sup>178</sup> It is possible to illuminate this argument by more rigorously framing conflicts between landowners and drones as simple externality problems.<sup>179</sup> Suppose that Ann, a real estate agent, recently purchased a domestic drone and is contemplating how often to fly it above others’ property, without permission, to photograph homes that are listed for sale. Ann gains incremental benefits from each additional unit of drone flying activity, expressed as  $MB$  in the graph in Figure A below.<sup>180</sup> Ann also incurs incremental costs in connection with each additional unit of flying, represented as  $MC_p$ .<sup>181</sup> However, Ann does not personally bear certain other costs that her drone flying imposes on sub-adjacent landowners because of her drone’s invasion of their privacy and other interference with their use of their land. The aggregation of those additional, “external” costs and Ann’s own private costs is reflected as  $MC_s$  on Figure A. Based on these assumptions, Ann’s social welfare-maximizing level of drone flying would be  $Q^*$ , the equilibrium point

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<sup>177</sup> See AARON SMITH ET AL., PEW RESEARCH CTR., U.S. VIEWS OF TECHNOLOGY AND THE FUTURE 3 (2014), available at [http://www.pewinternet.org/files/2014/04/PIP\\_US-Views-of-Technology-and-the-Future\\_041714.pdf](http://www.pewinternet.org/files/2014/04/PIP_US-Views-of-Technology-and-the-Future_041714.pdf), archived at <http://perma.cc/DH9J-6GD7> (emphasis omitted).

<sup>178</sup> See Demsetz, *supra* note 108, at 350.

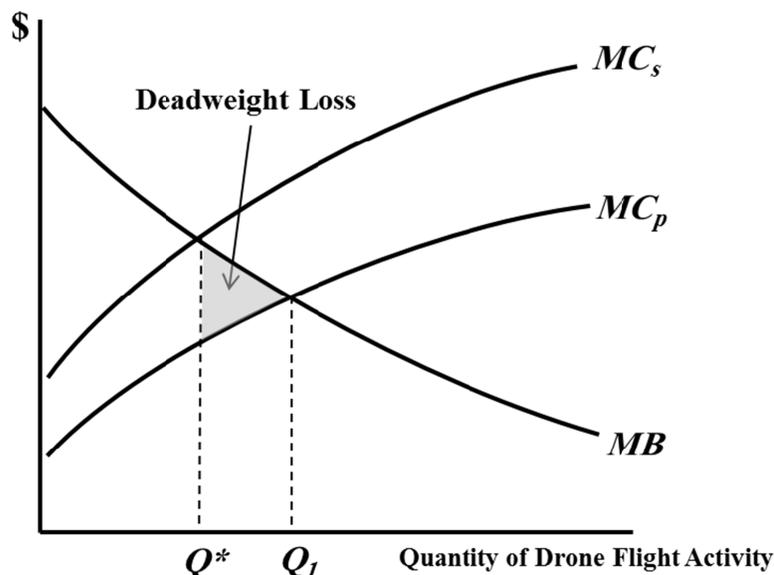
<sup>179</sup> For a simple definition of an externality, see *id.* at 348.

<sup>180</sup> In this simple abstract model, “units” of drone flying could take the form of minutes of flight time, proximity to others’ land or buildings, or some other comparable measure. The marginal benefit curves in Figures A and B slope downward based on an assumption that the marginal benefits of obtaining additional video footage or photographs of neighborhoods and homes ultimately decrease over the duration of a drone flight.

<sup>181</sup> The marginal cost curves in Figures A and B are upward sloping based on an assumption that, because of basic resource constraints, such marginal costs (which might include the imputed value of the agent’s time and the cost of recharging the drone’s batteries) eventually increase as the quantity of total drone activity increases.

at which the marginal social cost ( $MC_s$ ) of her last unit of drone flying equaled her marginal benefit ( $MB$ ) from that last unit of flying.

FIGURE A. Magnitude of Deadweight Loss from Externalities between Landowners and Drones



Unfortunately, assuming that Ann is rational and self-interested, she will instead choose to engage in a quantity of drone flying equal to  $Q_1$ —the point at which her own marginal costs of flying the drone ( $MC_p$ ) equal her marginal benefits of doing so. This sub-optimally high quantity of drone flying, which results because Ann does not internalize all of the costs associated with her drone activity, generates a social welfare loss, or “deadweight loss,” depicted as a shaded triangular area on Figure A.

New laws that clearly entitle landowners to exclude drones from their low-altitude airspace could reduce these welfare losses by requiring drone users to acquire licenses or easements from landowners before flying through their space. In microeconomics terms, this obligation to get easements or licenses would compel drone operators to “internalize,” or bear, more of the costs that their activities impose on landowners.<sup>182</sup> This internalization of externalities would promote levels of drone activity above others’ land that more closely approximates  $Q^*$ , thereby reducing the magnitude of social welfare losses

<sup>182</sup> See JAMES R. KEARL, PRINCIPLES OF ECONOMICS 423-24 (1993) (explaining that “private ownership . . . internalizes many externalities that would otherwise exist” by causing parties to internalize, or “consider all of the costs or benefits associated with decisions”).

associated with drone activities. Such increases in efficiency represent the very sort of welfare gains that Demsetz referenced in his familiar article.<sup>183</sup>

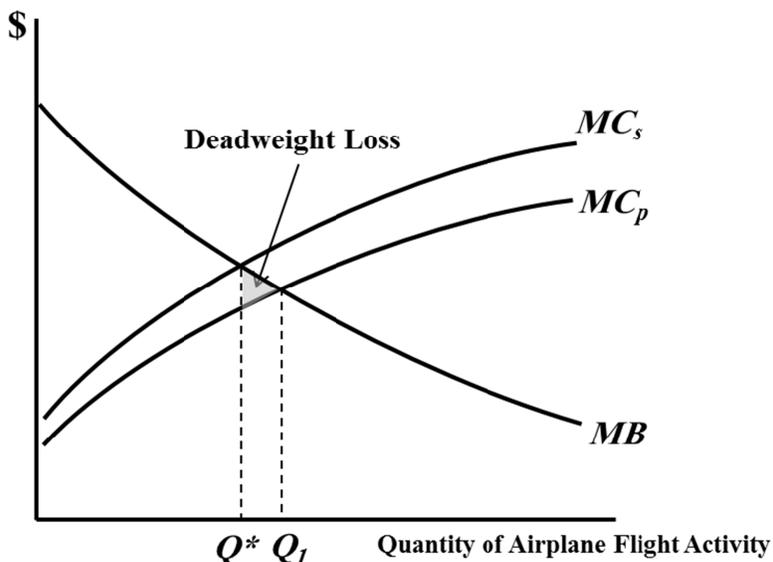
Of course, airplanes flying at high altitudes also create externality problems, yet there is no private property system for high-altitude airspace. Why, then, might such a system arguably be appropriate to address externalities involving drones in low-altitude space but not for airplanes in high-altitude space? The answer to this question lies in the difference in magnitude of the externality problems potentially involved in these two contexts. Externality problems involving low-flying drones and landowners have the potential to be far greater than those involving overflights of ordinary aircraft in navigable airspace. Assuming that potential drone-related externalities are of a larger magnitude, the potential gains from laws that facilitate internalization of those externalities are greater as well.

Figure B below illustrates this point. The graph in Figure B depicts the relatively minor externality problems associated with ordinary airplane flights in navigable airspace. Because such flights occur high above the ground, most do not significantly compromise landowners' privacy or safety interests or otherwise interfere with most landowners' reasonable use of land. The relatively low frequency and severity of such conflicts is reflected in the comparatively small distance between the marginal private cost curve that an airline might face in connection with its high-altitude air flight activity ( $MC_p$ ) and the marginal social cost curve associated with such activity ( $MC_s$ ) in Figure B. Because most high-altitude flights impose relatively few costs that are external to the airline, the airline's chosen quantity of flight activity,  $Q_I$ , would only slightly exceed the socially optimal quantity ( $Q^*$ ). The deadweight losses associated with these minor externalities, shown as the shaded area in Figure B, are also proportionally much smaller than those associated with excessive drone use shown in Figure A. Consequently, the "gains of internalization" attainable from exclusion rules aimed at reducing externality problems involving high-flying airplanes would be far less substantial than those potentially available from exclusion rules against drones in low-altitude space.

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<sup>183</sup> See Demsetz, *supra* note 108, at 356; *supra* note 108 and accompanying text.

FIGURE B. Magnitude of Deadweight Loss from Externalities between Landowners and Conventional Aircraft



## 2. Innovations Driving Down the Costs of Internalization

Of course, the mere fact that drone technologies are increasing the value of low-altitude airspace does not necessarily justify giving landowners rights to exclude drones. As Professor Henry Smith has noted, the rising value of a resource can call for “either more governance or more fine grained exclusion,” depending on the circumstances.<sup>184</sup> One could imagine a very different sort of policy response to drone technologies—an exhaustive set of new regulatory provisions governing when and how drones could be used without giving landowners any definite exclusion rights in the airspace above their land.

However, new technologies that are making it easier and less expensive to exclude drones from specific areas of low-altitude airspace also favor a movement toward exclusion rules for this resource. Demsetz and others have noted that innovations that reduce the costs of implementing and enforcing property rights in a resource can likewise increase the justifiability of protecting it within a private property regime. For example, some have suggested that Joseph Glidden’s nineteenth-century invention of barbed wire—a technology that greatly reduced the cost of enforcing property boundaries in very large parcels—helped to catalyze the parcelization of open grazing lands in much of the American West that had previously been largely a commons resource.<sup>185</sup>

<sup>184</sup> Smith, *Exclusion Versus Governance*, *supra* note 112, at S486.

<sup>185</sup> See Ellickson, *supra* note 110, at 1330 (citing Terry L. Anderson & P. J. Hill, *The*

Interestingly, drone manufacturers are increasingly adding impressive new location control systems to their drones that function similarly to barbed wire on the open range. For example, DJI Innovations, the world's leading manufacturer of small drones,<sup>186</sup> has updated its drone GPS software with programming that precludes its drones from flying into the airspace surrounding 350 different airports throughout the world.<sup>187</sup> If a drone attempts to fly into such space, it automatically loses most of its power and begins drifting toward the ground.<sup>188</sup> Amazon has announced plans to use similar "geo-fence" systems to prevent its experimental delivery drones from traveling off course.<sup>189</sup>

Akin to Glidden's barbed wire in the 1800s, these geo-fence technologies could provide an easy and affordable way to define and enforce property rights in low-altitude airspace, thereby strengthening arguments in favor of clear airspace exclusion rights. Landowners could eventually use such technologies to place low-cost virtual "fences" in the airspace around their parcels to keep unwelcome drones out. By making it much cheaper to draw and enforce property boundary lines in airspace, geo-fence programs and related technologies reduce the "costs of internalization" of externalities and further strengthen arguments in favor of laws creating clear exclusion rights in low-altitude airspace.

### 3. Other Factors Supporting a Switch to Exclusion Rules

Beyond the basic cost-benefit analysis just highlighted, many other property theory concepts seemingly point in the direction of an exclusion approach for low-altitude airspace. For instance, consider the potential information cost

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*Evolution of Property Rights: A Study of the American West*, 18 J.L. & ECON. 163, 172 (1975)).

<sup>186</sup> See Brad Stone, *DJI's Drone Is Simple Enough for Anyone to Use*, BLOOMBERG BUS. WK. (May 15, 2014), <http://www.businessweek.com/articles/2014-05-15/dji-innovations-drone-is-simple-enough-for-anyone-to-use>, archived at <http://perma.cc/XG4Q-RGDA> (reporting that DJI Innovations controls roughly half of the "global market for small, unmanned aerial vehicles").

<sup>187</sup> See Mark Corcoran, *Chinese Manufacturer Programs Phantom Drones with No-Fly Zones to Protect Australian Airports*, ABC NEWS (Apr. 14, 2014, 7:49 AM), <http://www.abc.net.au/news/2014-04-14/chinese-made-drones-programmed-with-no-fly-zones/5388356>, archived at <http://perma.cc/Z647-CKQB>.

<sup>188</sup> Similar technologies could even make it possible to place parameters on a drone's use of cameras or microphones. See Kellington, *supra* note 33, at 45 (explaining that geo-fences could theoretically "allow the operator to fly the UAV in a defined route with specific camera, microphone and other parameters, and if it strays outside of these parameters, an automated program kills the power and the UAV lands").

<sup>189</sup> See Ed Brackett, *Amazon Seeks OK for Testing of 50-MPH Drones*, USA TODAY (July 11, 2014, 10:46 AM), <http://www.usatoday.com/story/money/business/2014/07/10/amazon-drones/12505605/>, archived at <http://perma.cc/UCN7-GGRR>.

burdens that would arise under a governance-based approach to landowner-drone conflicts. Given the fairly low cost of purchasing small drones, there could soon be a very large number of drone owners in the United States. Drone operators will be looking to use them in a wide variety of ways, some of which are more disruptive than others and some of which are more valuable to society than others. Accordingly, the aggregate information costs associated with using governance rules to manage conflicts in low-altitude airspace could be quite high. A large and growing class of drone operators—“duty holders,” as Smith might call them<sup>190</sup>—would have to expend significant resources trying to determine the extent of their rights to fly drones over others’ property based on such factors as the amount of noise the drone makes, the types of land uses affected below, and the duration and frequency of the drone’s flights. Courts would have to engage in similar costly inquiries to adjudicate a growing number of disputes between drone operators and landowners. A legal approach based on simple exclusion rules would avoid most of these information costs.

Transaction cost considerations also arguably favor a switch to exclusion rules for low-altitude airspace. Laws clarifying legal entitlements in low-altitude airspace would also make it easier for parties to negotiate private easements and covenants involving uses of drones in this space. Geo-fencing programs and related technologies could enable landowners to permit certain drone operators to invade the airspace above their land while excluding others, opening up a wide range of possible contractual arrangements tailored so as to balance the interests of drone users and landowners. However, parties are far less likely to negotiate drone flight easements if it is unclear whether a drone operator even needs easement rights to legally fly a small drone over a landowner’s property. The Coase Theorem suggests that laws that clearly assign initial entitlements relating to a resource promote allocative efficiency by making it easier for parties to bargain over those entitlements in ways that can ultimately allocate them to their highest valued users.<sup>191</sup> Laws providing more precise landowner exclusion rights in airspace would allocate many of the entitlements involved in conflicts between drone users and landowners, enabling creative and efficient contracting over those interests.

The potential holdout problems associated with most easement negotiations for drone flights through low-altitude airspace would not seem great enough to justify governing the resource as an open-access commons. Unlike conventional aircraft, most small civilian drones are not designed to travel

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<sup>190</sup> See *supra* note 142 and accompanying text.

<sup>191</sup> See Coase, *supra* note 109, at 15 (“[I]t has to be remembered that the immediate question faced by courts is *not* what shall be done by whom *but* who has the legal right to do what. It is always possible to modify by transactions on the market the initial legal delimitation of rights. And, of course, if such market transactions are costless, such a rearrangement of rights will always take place if it would lead to an increase in the value of production.”).

even a single mile away from their operators.<sup>192</sup> Consequently, the number of easements or licenses required for such flights would likely be much lower on average than would be required for the average conventional airplane flight, and holdout problems would be comparatively less severe. In fact, some drone operators could conceivably use GPS-based technologies to program their drones to fly solely above public roads for the entire duration of their flights because many small drones are only a few feet or less in diameter.<sup>193</sup> In certain settings, such practices could be a valuable way to avoid having to negotiate easements at all.

Governments could also exercise their eminent domain authority to condemn public drone pathways or corridors through private airspace upon payment of just compensation to sub-adjacent landowners in situations where such an approach makes economic sense. The eminent domain power has long been recognized as a way for governments to overcome the holdout problems associated with developing public thoroughfares.<sup>194</sup> Fortunately, no asphalt or paint would be needed to develop public drone pathways over private land, so the budgets for such projects would consist of little more than the costs of easements. The just compensation requirement associated with eminent domain procedures for public drone pathways would have the same potential efficiency-promoting effects as it does on land.<sup>195</sup> Drone easements through

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<sup>192</sup> For example, DJI's Phantom 2 Vision+ drone—a recently released drone from a popular manufacturer with a price tag of roughly \$1,300—has a signal range of less than half a mile. See Neil Hughes, *Review: Using the DJI Phantom 2 Vision+ Camera Drone with Apple's iPhone*, APPLE INSIDER (Aug. 3, 2014, 3:55 PM), <http://appleinsider.com/articles/14/08/03/review-using-the-dji-phantom-2-vision-camera-drone-with-apples-iphone>, archived at <http://perma.cc/C7D2-LEPE> (stating that, “thanks to a newly enhanced signal booster,” operators of the DJI Phantom 2 Vision+ drone “can maintain a connection of about 700 meters” with the device).

<sup>193</sup> See Farber, *supra* note 3 at 13 (describing “the Raven” drone’s size, weighing “4.2 pounds [with] a wingspan of 4.5 feet, and . . . three feet long,” as “common among manufacturers and hobbyists”).

<sup>194</sup> See, e.g., STEVEN SHAVELL, *FOUNDATIONS OF ECONOMIC ANALYSIS OF LAW* 124-27 (2004) (describing eminent domain’s capacity to overcome holdout problems); Peter J. Boettke et al., *Takings*, 8 *GEO. J.L. & PUB. POL’Y* 327, 327 (2010) (“Acquiring adjacent pieces of property may confront a holdout problem whereby a project is delayed by a small number of owners who refuse to sell their property to the government. Granting the government the right to confiscate the holdout property overcomes this problem.”); Thomas W. Merrill, *The Economics of Public Use*, 72 *CORNELL L. REV.* 61, 75 (1986) (highlighting the value of eminent domain authority as a means of addressing holdout problems in public projects involving multiple private parcels).

<sup>195</sup> See Nestor M. Davidson, *The Problem of Equality in Takings*, 102 *NW. U. L. REV.* 1, 13 (2008) (“One common argument is that compensation—whether in direct eminent domain or for the economic impact of regulation—forces the government to internalize the costs of its actions. Absent [a just compensation requirement], the argument goes, governmental actors will tend to overregulate, leading to an inefficient allocation of resources.” (citation omitted)).

airspace directly above expensive homes with private swimming pools would likely entail higher just compensation payments than those over warehouses in industrial areas. By forcing governments to internalize most of the costs associated with establishing public drone pathways, the just compensation requirement would encourage governments to more optimally balance costs and benefits in making condemnation decisions.<sup>196</sup> Given the GPS-connected nature of drones, it might even be relatively inexpensive to establish and administer toll systems to help recoup the costs of establishing public drone pathways in some contexts.

Even if small domestic drones someday advanced to the point that they could safely travel dozens of miles away from their operators, policymakers would still have room to adapt under this Article's proposed landowner exclusion rights approach. For example, the FAA could conceivably accommodate such innovations by designating certain airspace between 500 and 600 feet above the ground as a publicly shared commons reserved solely for moderate-distance drone flights. Professor Robert Ellickson has noted the efficiency-enhancing benefits of existing laws that vertically divide airspace to accommodate different scales of use at different altitudes.<sup>197</sup> A future layer of space for larger, mid-distance drones would merely be a further extension of this strategy. In sum, the additional cost burdens that would face domestic drone users under laws that gave landowners rights to exclude drones from low-altitude airspace do not seem great enough to warrant foregoing such a policy approach.

#### IV. AIRSPACE EXCLUSION RIGHTS LAWS AS PART OF A COORDINATED REGULATORY REGIME FOR DOMESTIC DRONES

How might laws giving landowners definite exclusion rights in the non-navigable airspace above their land impact broader policy efforts relating to drone technologies? As the following subsections describe, such laws could also serve as an integral part of a larger, coordinated system of federal, state, and local drone laws that promote more efficient use of the nation's precious airspace resources.

##### A. *Federal Safety Standards and GPS Registration Requirements*

The changes to airspace rights advocated in this Article could fit neatly within a broader drone regulatory strategy that placed distinct and appropriate limits on the scope of the FAA's jurisdiction over low-altitude airspace. Under

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<sup>196</sup> *See id.*

<sup>197</sup> *See* Ellickson, *supra* note 110, at 1363-64 ("Aviation . . . activities are generally most efficiently undertaken over an area whose horizontal scope is much larger than that optimal for agriculture, housing, and other basic land-surface operations. Groups have responded by imposing vertical limits on the standard rights and privileges conferred on surface landowners . . . . Dividing space into layers facilitates exploitation of the varying returns to horizontal scale that are available in different layers.").

such a strategy, the FAA would continue to have near-exclusive control over aviation activities within navigable airspace—the nation’s long-recognized public highway for air travel.<sup>198</sup> The FAA would likewise continue to possess regulatory authority over manned aircraft flights at altitudes of less than 500 feet and over any other non-navigable activities to the extent reasonably necessary to protect flights within navigable space from material safety risks.<sup>199</sup> Otherwise, however, the agency would not have power to regulate any activities occurring below the typical 500-foot navigable airspace line.

Political factors could make it difficult to place optimal limits on the FAA’s involvement in drone regulation. Regulatory inertia problems<sup>200</sup> within Congress and the FAA, borne out of decades of the agency’s near-exclusive management of aviation, are arguably already stalling the advancement of sound drone-related policies in the United States. The FAA has long served as the nation’s primary regulatory agency for aviation activities, exercising wide-sweeping authority over nearly every aspect of the industry.<sup>201</sup>

However, the fact that the FAA has historically overseen aviation activities does not necessarily entitle it to regulate the whereabouts and activities of small, low-flying drones. As one commentator has observed, the extraordinarily heavy federal involvement in aviation regulation has always been premised on the notion that “air travel is inherently interstate”<sup>202</sup> and thus falls within federal jurisdiction under the Commerce Clause.<sup>203</sup> Most flights of small domestic drones are not inherently interstate, staying well below 500 feet and covering less than a mile, and yet the FAA appears to be presently taking the position that its airspace jurisdiction above the United States reaches all the way down to the ground. Much of the recent media attention involving drones has focused on the FAA’s efforts to enforce a 2007 policy notice providing that “no person may operate a [drone] in the National Airspace System without

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<sup>198</sup> See *United States v. Causby*, 328 U.S. 256, 264 (1946); *supra* text accompanying notes 126-128.

<sup>199</sup> As specifically required in the Federal Aviation Act of 1958, preserving safety has long been a primary focus of federal aviation regulation. See, e.g., 49 U.S.C. § 40101(a)(1) (2006) (providing that “maintaining safety” is to be given “the highest priority in air commerce”).

<sup>200</sup> See William P. Albrecht, *Regulation of Exchange-Traded and OTC Derivatives: The Need for a Comparative Institution Approach*, 21 J. CORP. L. 111, 123 (1995) (defining “regulatory inertia” as “the unwillingness of regulators to relax rules when changing conditions make them obsolete or inefficient”).

<sup>201</sup> For a detailed discussion of the federal government’s history of very heavy involvement in aviation law, see generally Jeffrey A. Berger, Comment, *Phoenix Grounded: The Impact of the Supreme Court’s Changing Preemption Doctrine on State and Local Impediments to Airport Expansion*, 97 NW. U. L. REV. 941, 963-68 (2003).

<sup>202</sup> *Id.* at 965.

<sup>203</sup> See U.S. CONST. art. 1, § 8, cl. 3 (providing that the United States Congress shall have power to “regulate commerce . . . among the several States”).

specific authority.”<sup>204</sup> Only “hobbyists” who fly their drones at heights of less than 400 feet and keep the devices “within visual line-of-sight” are presently exempted from the FAA’s purported policy.<sup>205</sup> Based on this policy notice, the FAA has mailed cease-and-desist letters to several citizens in recent years challenging their commercial uses of drones without certificates of waiver or authorization.<sup>206</sup> In most instances, the citizens targeted in these letters appeared to have been flying drones well below the 500-foot navigable airspace line.

The FAA’s increasing attempts to assert airspace jurisdiction all the way down to the ground are arguably inconsistent with existing law.<sup>207</sup> As mentioned above, the National Transportation Safety Board recently ruled that the FAA lacked regulatory authority to fine a citizen for flying a drone in non-navigable airspace for a commercial purpose.<sup>208</sup> The Constitution expressly reserves broad police powers to the states under the Tenth Amendment,<sup>209</sup> and one common justification for this reservation of state power is a belief that state and local officials tend to have a better sense of the particular needs and preferences of citizens where they live. Just as federal regulatory authority over national park lands largely ends beyond the park exit sign,<sup>210</sup> it seems reasonable and logical for the FAA’s regulatory jurisdiction to essentially end at 500 feet—the lower boundary of the nation’s public air travel area.

Even if the FAA conceded that it possessed no regulatory jurisdiction over low-altitude drone flights, the agency could still retain significant authority

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<sup>204</sup> Unmanned Aircraft Operations in the National Airspace System, 72 Fed. Reg. 6689, 6690 (2007) (to be codified at 14 C.F.R. pt. 91).

<sup>205</sup> *Id.*

<sup>206</sup> See, e.g., Michael Berry, *The Drones are Coming*, 36 PA. LAW., Mar.-Apr. 2014, at 50, 52 (describing cease-and-desist letters sent to a University in Arkansas that was using drones to research the development of drought-resistant soybeans, to a dry cleaner in Pennsylvania that was using drones to deliver laundry items, to journalism schools that were using drones to research drone journalism issues, and to an online news company that had published drone-captured footage of Alabama tornadoes).

<sup>207</sup> At least one local government has adopted a resolution opposing the FAA’s attempts to extend its jurisdiction downward. See Chad Cain, *Northampton City Council Resolution Targets Drones, Airspace*, GAZETTENET.COM (July 2, 2013), <http://www.gazettenet.com/news/7214349-95/northampton-city-council-resolution-targets-drones-airspace>, archived at <http://perma.cc/CRB2-CJ7J>.

<sup>208</sup> See generally Rafael Pirker, Docket No. CP-217 at 3 (N.T.S.B. Mar. 6, 2014) (decisional order).

<sup>209</sup> U.S. CONST. amend. X (“The powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people.”).

<sup>210</sup> See Michael I. Jeffrey, *Public Lands Reform: A Reluctant Leap Into the Abyss*, 16 VA. ENVTL. L.J. 79, 140 (1996) (explaining that most federal public lands in the United States are “under the direct control of the federal government and administered by various federal departments and agencies”).

over certain aspects of the drone industry. For instance, the FAA would retain regulatory power over flights of larger drones within navigable airspace.<sup>211</sup> The FAA or some other federal government entity would likewise have power to regulate small drones flying near and above federally controlled lands—areas such as national parks and navigable waters.<sup>212</sup> The agency could also continue to regulate small drone activity near airports to the extent necessary to maintain aviation safety.<sup>213</sup> And it would seem within the FAA's regulatory authority to adopt regulations preventing small drones from flying within 100 feet of any navigable airspace line, so as to create a reasonable safety buffer between small drones and conventional aircraft.<sup>214</sup>

In addition, the FAA is seemingly well positioned to establish and enforce federal drone safety and performance standards. Existing federal statutes<sup>215</sup> authorizing the National Highway Traffic Safety Administration to issue federal motor vehicle safety standards and regulations<sup>216</sup> generally enable auto manufacturers to produce and sell vehicles throughout the United States in compliance with identical federal specifications rather than a patchwork of state standards.<sup>217</sup> For similar reasons, the FAA already issues federal standards for conventional aircraft.<sup>218</sup> Given the FAA's expertise in this area, it

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<sup>211</sup> See Unmanned Aircraft Operations in the National Airspace System, 72 Fed. Reg. 6689, 6689 (2007) (to be codified at 14 C.F.R. pt. 91) (setting forth safety and certification requirements for large drones used as public aircrafts and issuing five experimental certificates for civil uses).

<sup>212</sup> See Noise Policy for Management of Airspace over Federally Managed Lands, JO 7400.2K, Order (April 3, 2014), available at [https://www.faa.gov/air\\_traffic/publications/atpubs/AIR/airapp9.html](https://www.faa.gov/air_traffic/publications/atpubs/AIR/airapp9.html), archived at <http://perma.cc/A7D7-XPCY> (“It is the policy of the FAA in its management of the navigable airspace over locations in national parks and other federally managed areas . . . to exercise leadership in achieving an appropriate balance between efficiency, technological practicability, and environmental concerns, while maintaining the highest level of safety.”).

<sup>213</sup> See, e.g., 49 U.S.C. § 40101(a)(7) (2006) (requiring the FAA to “develop[] and maintain[] a sound regulatory system that is responsive to the needs of the public and in which decisions are reached promptly to make it easier to adapt the air transportation system to the present and future needs of” the United States).

<sup>214</sup> Such safety buffer regulations would convert airspace between the heights of 400 and 500 feet into what Professors Abraham Bell and Gideon Parchomovsky have labeled a “conservation commons”—a “commons whose most efficient use is nonuse.” Abraham Bell & Gideon Parchomovsky, *Of Property and Antiproperty*, 102 MICH. L. REV. 1, 39 (2003); see also Troy A. Rule, *Airspace in a Green Economy*, 59 UCLA L. REV. 270, 296-97 (2011).

<sup>215</sup> See 49 U.S.C. §§ 30101-83 (2012)

<sup>216</sup> See 49 C.F.R. §§ 571.101-500 (2012).

<sup>217</sup> See H.R. Rep. No. 89-1776, at 17 (1966) (stating that the National Traffic and Voter Vehicle Safety Act was “intended to result in uniformity of standards so that the public as well as industry will be guided by one set of criteria rather than by a multiplicity of diverse standards”).

<sup>218</sup> See 49 U.S.C. § 44701(a)(1) (2012) (authorizing the FAA to issue federal safety

would make sense for the agency to undertake the task of formulating and enforcing safety and performance standards for small drones, even if such devices are not intended for use within navigable airspace.

Numerous valuable safety features that are currently available or in development might eventually serve as good candidates for inclusion in a set of FAA-issued drone performance standards. Among them are ground-based and airborne “sense and avoid” technologies, which can enable drones to automatically sense objects in their path and change course so as to avoid collisions.<sup>219</sup> Lost-link or return-to-base programming could also be a valuable standard feature for small drones. These programs are designed to automatically maneuver drones down to safety in the event that they become disconnected from their operators’ signals.<sup>220</sup> Anti-hacking systems, which seek to prevent others from using rogue signals to seize control of a flying drone, could also be a standard requirement.<sup>221</sup> And the FAA could require that all domestic drones use specified types of GPS software and registration systems designed to make it easy to track any drone’s location. Such federal registration requirements could ultimately enable government officials and even landowners to quickly identify the owner of an unwelcome drone or to retrieve data about recent drone overflights in specific geographic areas.

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standards for “the design, material, construction, quality of work, and performance of aircraft, aircraft engines, and propellers”).

<sup>219</sup> See Thomas Black, *Amazon’s Drone Dream Sets Off Race to Build Better Sensor*, BLOOMBERG (June 6, 2014), <http://www.bloomberg.com/news/2014-06-06/amazon-s-drone-dream-sets-off-race-to-build-better-sensor.html>, archived at <http://perma.cc/3K36-YLSS> (describing sense and avoid technologies as “one of the biggest opportunities in the industry”). Research goals associated with such technologies are also included within the FAA’s own “Integration Roadmap” for drones. See JOINT PLANNING AND DEV. OFFICE, FED. AVIATION ADMIN., UNMANNED AIRCRAFT SYSTEMS (UAS) COMPREHENSIVE PLAN: A REPORT ON THE NATION’S UAS PATH FORWARD 12 (2013), available at [http://www.faa.gov/about/office\\_org/headquarters\\_offices/agi/reports/media/UAS\\_Comprehensive\\_Plan.pdf](http://www.faa.gov/about/office_org/headquarters_offices/agi/reports/media/UAS_Comprehensive_Plan.pdf), archived at <http://perma.cc/6C2Y-WKY5> (explaining the existence of goals and metrics for each of the nine drone development areas including: certification requirements for both airworthiness and the drone’s pilot and crew, ground based sense and avoid, air based sense and avoid, control and communications, small UAS, test ranges, air traffic interoperability, and miscellaneous).

<sup>220</sup> See Kellington, *supra* note 33, at 625 (explaining that drone navigation systems often “include programmed maneuvers to be automatically deployed if a command and control link is disrupted”)

<sup>221</sup> See Syed & Berry, *supra* note 10, at 26 (listing “information-assurance mechanisms to prevent hacking” as a means of promoting drone safety). An engineering professor recently successfully hacked a U.S. Department of Homeland Security drone as part of a department-issued challenge to the professor’s college class. See Chris Francescani, *Damn the Regulations! Drones Plying US Skies Without Waiting for FAA Rules*, REUTERS, Mar. 4, 2013, [http://investigations.nbcnews.com/\\_news/2013/03/04/17181948-damn-the-regulations-drones-plying-us-skies-without-waiting-for-faa-rules?lite](http://investigations.nbcnews.com/_news/2013/03/04/17181948-damn-the-regulations-drones-plying-us-skies-without-waiting-for-faa-rules?lite), archived at <http://perma.cc/MV37-B5YK>.

B. *State-Level Property and Privacy Legislation*

Statutes providing that landowners hold rights to exclude drones up to the navigable airspace line above their property would be most appropriately adopted at the state government level. A uniform or model law designed to institute such changes could be drafted to aid states in the enactment process. Such statutes would establish a clear and consistent foundation of exclusion rights in low-altitude airspace comparable to the existing exclusion-based foundation for land. Policymakers and private parties could then fine-tune and tailor legal relationships involving low-altitude space by layering narrow governance rules and contractual arrangements on top of this new exclusion regime, much like they have long done with surface land.<sup>222</sup>

State legislatures could easily structure new airspace rights statutes so as not to preclude the reasonable use of drones and other low-flying aircraft in certain emergency response settings. For example, statutory exceptions could allow for emergency helicopter flights through private low-altitude airspace to continue as they always have, much like well-established traffic immunity rules for emergency responders.<sup>223</sup> Carefully drafted provisions in state statutes could similarly enable law enforcement officers, firefighting units, life flight helicopters, and disaster response groups to freely fly drones at low altitudes over private land in genuine emergency situations such as in the aftermath of natural disasters or in the active pursuit of assailants.

New state statutes giving landowners clear exclusion rights in low-altitude airspace might also necessitate updates to state criminal laws. For instance, many state criminal trespass statutes already provide that trespassers may be guilty of a misdemeanor if they come onto land or remain on land in direct disobedience to the demands of law enforcement or the landowner.<sup>224</sup> A policy

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<sup>222</sup> A similar sort of exclusion-based foundation and supplemental governance regime already exists in nuisance law applicable to the surface of land. *See* Smith, *Exclusion and Property Rules*, *supra* note 113, at 998-99 (explaining that “the law of private nuisance . . . rests on an exclusionary foundation supplemented by governance rules”).

<sup>223</sup> *See* WENDY L. HICKS, *POLICE VEHICULAR PURSUITS: CONSTITUTIONALITY, LIABILITY AND NEGLIGENCE* 32 (2007) (“Many jurisdictions grant emergency vehicles limited statutory immunity for any violations of state or municipal traffic regulation incurred during an emergency response.”). Laws immunizing drivers of active emergency response vehicles from trespass liability are also relatively common. *See, e.g.*, LANE COUNTY, OR., CODE § 6.405(3) (2014) (providing that the “driver of an authorized emergency vehicle, when responding to an emergency call or when in pursuit of an actual or suspected violator of the law or when responding to, but not returning from, a fire alarm, may park or stand irrespective of the provisions of” the county’s public trespass ordinance).

<sup>224</sup> *See, e.g.*, ARIZ. REV. STAT. ANN. § 13-502 (2013) (“A person commits criminal trespass in the third degree by . . . [k]nowingly entering or remaining unlawfully on any real property after a reasonable request to leave by a law enforcement officer, the owner or any other person having lawful control over such property, or reasonable notice prohibiting entry.”). For an exhaustive list of state criminal trespass statutes, see 3 WAYNE R. LAFAVE, *SUBSTANTIVE CRIMINAL LAW* 225 nn.21-22 (2d ed. 2003).

approach of giving landowners definite rights to exclude in low-altitude airspace would logically call for legislation extending these surface criminal trespass protections to similarly cover aerial trespasses.<sup>225</sup> In addition, some states have already enacted statutes that criminalize hacking into a drone's signal<sup>226</sup> or firing projectiles from drones.<sup>227</sup> These sorts of laws could offer a valuable layer of additional protection to landowners as well.

State governments would likewise seemingly be best suited to establish licensing processes for small drones and their operators comparable to existing requirements for automobile driving.<sup>228</sup> The average distance of a small drone flight is surely considerably shorter than that of an average automobile trip, so it would make little sense to administer licensing at the federal level rather than the state level.<sup>229</sup> Through drone operator license tests, periodic safety inspections, liability insurance criteria, and related means, such licensing systems could do a great deal to promote drone safety and to ensure that drone users are familiar with laws relating to the devices.

### C. Local "Drone Zoning" Ordinances

In addition to federal and state governments, local governments could play a valuable role in the regulation of drone activity. States have long delegated substantial regulatory authority over land use and comparable activities to municipal entities through state zoning enabling acts and similar statutes.<sup>230</sup> Many municipalities thus regulate a whole host of activities, ranging from the lighting of fireworks<sup>231</sup> to the raising of backyard chickens,<sup>232</sup> that impact

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<sup>225</sup> At least one local government has already adopted the equivalent of a criminal trespass ordinance. *See* CONOY, PA., ORDINANCE No. 1-3-14, § 2(f) (2013) (prohibiting the flying of drones over others' property without their permission and allowing for fines of up to \$300 against violators).

<sup>226</sup> *See* H.B. 2710, 77th Legis. Assemb., Reg. Sess. § 13(2) (Or. 2013).

<sup>227</sup> *See id.* § 13(1)(a).

<sup>228</sup> Regulators in the Philippines have already adopted registration requirements for drones and licensing requirements for drone operators. *See generally* Nina P. Calleja, *Drones Must be Registered, Their "Pilots" Licensed*, INQUIRER.NET (July 25, 2014, 7:46 AM), <http://newsinfo.inquirer.net/623268/drones-must-be-registered-their-pilots-licensed>, archived at <http://perma.cc/9UE7-6B38>.

<sup>229</sup> *See supra* notes 202-206 and accompanying text.

<sup>230</sup> For an introductory discussion of states' delegation of authority to localities under state zoning enabling acts, see generally ROBERT C. ELLICKSON & VICKI L. BEEN, *LAND USE CONTROLS* 74-76 (2005).

<sup>231</sup> *See* 7A EUGENE MCQUILLIN, *THE LAW OF MUNICIPAL CORPORATIONS* § 24:471, at 35 (3d ed. 2014) ("Fireworks ordinances enacted by municipalities are ordinarily sustained as a valid exercise of their police power." (citation omitted)).

<sup>232</sup> *See* Jaime Bouvier, *Illegal Fowl: A Survey of Municipal Laws Relating to Backyard Poultry and a Model Ordinance for Regulating City Chickens*, 42 ENVTL. L. REP. 10888, 10903-17 (2012) (surveying residential chicken-raising ordinances in the 100 most populous U.S. cities and determining that backyard chicken raising is permitted under certain

neighbors but are unlikely to materially affect those living outside of a city or town. State delegations of authority over such activities can be efficiency-promoting because local residents tend to have the most complete information about the unique issues and preferences within their communities.<sup>233</sup> Because of their information advantages, municipal governments are often better equipped than state or federal governments to determine when, where, and under what conditions such intrinsically local activities are allowed.

Some local governments may eventually engage in “drone zoning”—the practice of using zoning maps and ordinance provisions to designate geographic areas, altitudes, and circumstances within which parties may legally fly drones over land. This sort of spatial planning has long been a powerful means of limiting negative externalities and promoting synergies between various uses of a community’s land and other resources.<sup>234</sup> Like lighting fireworks or raising backyard chickens, the flying of small drones is not inherently disruptive but can be very disruptive at certain locations or times.<sup>235</sup> Drone zoning laws and other local drone-related ordinances could account for these location and time differences.

The basic analysis involved in crafting drone zoning ordinances would likely mirror the analysis that is already employed in most other spatial planning contexts. Local officials would essentially compare the expected costs that drone flying would impose in a given area to the expected benefits that such drone flying would bring. In much of a community’s low-altitude airspace, the highest valued use of the space may be as a “conservation commons” in which no drone flights are allowed.<sup>236</sup> However, in certain areas,

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conditions in residential areas within most of the nation’s largest cities).

<sup>233</sup> See, e.g., Richard Briffault, *Home Rule for the Twenty-First Century*, 36 URB. LAW. 253, 258-59 (2004) (“If all political decisions were centralized at the state level, it would be difficult to vary these policies to take into account varying local needs, circumstances, and preferences . . . Home rule permits cities and suburbs, liberal communities and conservative communities, ethnically diverse and ethnically homogeneous settings, to adopt policies that reflect their differing values and conditions. It thus increases the likelihood that people will be happy with their government.”).

<sup>234</sup> See ELLICKSON & BEEN, *supra* note 230, at 74-76 (explaining that zoning is a “tool local governments have traditionally used most heavily to control land development patterns” by considering “the character of the district and its peculiar suitability for particular uses, and with a view to conserving the value of buildings and encouraging the most appropriate use of land throughout such municipality” (quoting STANDARD STATE ZONING ENABLING ACT (U.S. Dep’t of Comm. 1926))).

<sup>235</sup> The Supreme Court first gave a general stamp of approval to the practice of zoning, when Justice Oliver Wendell Holmes famously used the example of a barn animal to illustrate how greatly the location of an activity can affect its relative impact on others. See *Vill. of Euclid v. Ambler Realty Co.*, 272 U.S. 365, 388 (1926) (explaining that a “nuisance may be merely a right thing in the wrong place,—like a pig in the parlor instead of the barnyard”).

<sup>236</sup> See *supra* note 214.

the potential benefits of allowing drone flying might greatly exceed the costs.

#### 1. Areas Most Suited for Drone Flying

The categories of places where drone flying offers the greatest potential net benefits seem to occupy the opposite ends of a simple spectrum. On one end of the spectrum are very remote, sparsely populated locations that are difficult or expensive to reach on the ground. Because of the high costs of alternatives to drone use, drones could offer sizable benefits to their users and to the community generally in these settings.<sup>237</sup> Drone flights are also less likely to cause costly disruptions to underlying land uses in these areas because they are so remote and rugged that relatively few humans reside on or even visit them. Given the high social benefits and low social costs associated with drone activities in these locales, it is hardly surprising that they have been among the first to receive FAA approvals for commercial drone use. For instance, the FAA recently authorized oil giant British Petroleum to use drones to survey pipelines in the frigid oil fields of Prudhoe Bay in northern Alaska.<sup>238</sup> Drones promise to add substantial net value in this context because of the near-constant snow, ice, and bitterly cold temperatures that would face surveyors operating on the land's surface. For similar but less dramatic reasons, drones could ultimately gain wide acceptance as tools for large-scale agriculture in rural areas.<sup>239</sup> Accordingly, county ordinances allowing rural drone flights under certain conditions could eventually emerge to support these agricultural drone uses.

On the opposite end of the spectrum sits another category of places where the cost-benefit analysis may tip in favor of allowing widespread use of drones: the most densely occupied and congested locations on the planet. In these places, drones could prove highly valuable as means of delivering relatively small items over the top of traffic-congested roads. Suppose, for example, that a lawyer has an office on the north side of Chicago's downtown area and needs to deliver a document to another law office on the south end of downtown as soon as possible. It is the late afternoon, and paralyzing traffic has cars throughout much of the city crawling at a virtual standstill. A drone could potentially soar above city streets, past stoplights and over crawling cars and make the lawyer's urgent delivery in minutes. Well-heeled urbanites in the lawyer's situation might be willing to pay significant premiums for such speedy delivery service in light of the alternatives. The downtown core areas of major cities are also places where the airspace above land provides relatively little seclusion value because windows on nearby buildings directly face most parcels in all directions. Consequently, the privacy-invasion costs that drones might impose on landowners in these places might be acceptable so long as there were rules requiring delivery drones to constantly continue moving until

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<sup>237</sup> See Krishnamurthy, *supra* note 24.

<sup>238</sup> See *supra* note 24 and accompanying text.

<sup>239</sup> See *supra* notes 30-33 and accompanying text.

they reached their destination so that they didn't hover outside high-rise windows.

Jeff Bezos—the founder of Amazon, which has applied for federal authorization to engage in commercial drone testing<sup>240</sup>—has apparently drawn similar conclusions regarding the potential advantages of drones in dense urban cores. As of July 2014, Bezos was reportedly in negotiations for the purchase of a large facility in Midtown Manhattan that would be situated quite well for experimenting with drone delivery technologies.<sup>241</sup> Eventually, drone-zoning ordinances could allow for companies like Amazon to make drone deliveries within downtown areas in many major cities, adding significant value for those living and working in these places.

## 2. Areas Least Suited for Drone Flying

The least desirable locations for extensive drone use are probably the nation's sprawling suburban residential areas, especially those in warm parts of the country. Drone delivery services could be comparatively more difficult and expensive to offer in low-density suburban communities than in downtown urban settings because of greater geographic distances between destinations. The delivery time savings available through drones might also be less significant in the suburbs than in downtown areas because ordinary trucks are probably less likely to encounter severe traffic congestion on suburban roads. And suburban residential landowners probably place a greater value on protecting backyard privacy against drone overflights than do inner-city landowners, particularly in regions where private swimming pools and outdoor decks are commonplace. Even if drones flew only above roads in these areas, they might have vantage points into backyards and decks that create significant landowner privacy concerns.<sup>242</sup>

Because of these factors, some suburban communities might ultimately adopt "NAMBY" ("Not Above My Back Yard")<sup>243</sup> ordinances—provisions

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<sup>240</sup> See Jack Nicas, *Corporate News: Amazon Asks FAA for Permission to Test Drones*, WALL ST. J., July 11, 2014, at B4.

<sup>241</sup> See Lois Weiss, *Amazon Eyes Midtown Lair on Avenue of the Americas*, N.Y. POST (July 16, 2014, 6:42 AM), <http://nypost.com/2014/07/16/amazon-eyes-midtown-lair-on-avenue-of-the-americas/>, archived at <http://perma.cc/98KM-9GUA> (suggesting that the 285,000 square foot facility Amazon was purportedly targeting would allow Bezos to "test[] out drone deliveries—perhaps to rooftops in the Diamond District").

<sup>242</sup> Minimum speed requirements for drones flying above public roads could help to limit the risk of drones hovering in particular locations long enough to materially invade the privacy of nearby landowners. Relatively small drones can already travel at speeds of up to fifty miles per hour—plenty of speed for urban deliveries. See Brackett, *supra* note 189.

<sup>243</sup> Claire Serant, *LaGuardia Plan up in Air Astoria Opposes El Add-on*, N.Y. DAILY NEWS (Dec. 23, 1998, 12:00 AM), <http://www.nydailynews.com/archives/boroughs/laguardia-plan-air-astoria-opposes-el-add-on-article-1.807381st> (coining term to describe resident opposition to a proposed elevated train).

that prohibit or severely restrict drone flying in low-density residential zones. Eventually, such ordinances might even be enforced through use of the same geo-fencing technologies that are already beginning to protect airports from drone flights. These NAMBY ordinances could conceivably provide for exceptions that allowed very limited drone flying through temporary use permit or special use permit process. Alternatively, a municipality could designate a one-hour period each week or month when drones were permitted to fly, subject to landowners' exclusion rights. Such time-based ordinances, which are comparable to existing laws permitting fireworks displays only on certain days of the year,<sup>244</sup> would allow some valuable drone use by real estate photographers and hobbyists while limiting the privacy-related costs such activities would impose on landowners. If everyone in a community knew that drone flying was permitted from 4:00 PM to 5:00 PM on the first Thursday of every month, they could plan accordingly and thereby minimize privacy-related conflicts.

Local drone regulatory decisions would likely be the least straightforward in areas that were zoned for industrial or commercial use under ordinary zoning laws. The costs and benefits of allowing drone flying are likely to be the most location-specific and difficult to estimate in these areas. Fortunately, city planners have already developed a long list of land use regulatory strategies and many of those strategies are potentially adaptable for use in the context of drone zoning. For instance, in municipalities where regulating drone use and land use from the same zoning map became too limiting, officials could create an overlay zone map to separately and more precisely tailor drone zones.<sup>245</sup> It is easy to imagine how other common land use regulatory tools, such as setbacks, height restrictions, variances, and conditional use permits, could ultimately be tailored to address particular drone issues as well. Indeed, if domestic drone use catches on as much as some believe, drone zoning could one day emerge as a hot topic for planning theorists.

#### CONCLUSION

Innovations in the domestic drone industry are making it possible for citizens to access low-altitude airspace like never before. Although these technological advances have the potential to greatly benefit humankind, they

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<sup>244</sup> See, e.g., VANCOUVER, WASH., MUN. CODE § 16.30.050.B (2012) (generally providing that “consumer fireworks may only be used or discharged within the City of Vancouver . . . [b]etween the hours of nine o’clock a.m. and 11:59 p.m. on July 4th of any year”).

<sup>245</sup> See Edward H. Ziegler, Jr., *Special Zoning, Overlay, and Planned Development Districts*, in 1 RATHKOPF’S THE LAW OF ZONING AND PLANNING § 10:3 (4th ed. 2013) (explaining that “[t]o provide for greater flexibility and discretion in the control of land use and development in certain areas of the community, modern zoning ordinances often provide for numerous special zoning or overlay districts” and that “[c]ourts generally have upheld the validity of special zoning and overlay districts so long as the classification and restrictions imposed further some legitimate public purpose”).

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are also creating new and unprecedented conflicts involving the space through which they fly. Prior to the advent of modern drones, there was no pressing need to precisely define the scope of landowners' property interests in low-altitude airspace. Unfortunately, as a growing flock of domestic drones stands ready for takeoff, ambiguous airspace rights laws are now threatening to impede the growth of an important new industry.

In the midst of these pressures, principles of microeconomics and property theory call for new laws giving landowners more definite rights to exclude drones from the airspace directly above their land. These exclusion rights would be most effective if they were treated as equivalent to rights that landowners have long enjoyed in surface land and if they extended all the way up to the navigable airspace line where the public highway for air travel begins. Laws establishing such rights would create a simple "exclusion" regime for low-altitude airspace that is better suited to handle aerial trespass and takings questions involving domestic drones. They could also be an integral part of a broader system of new federal, state, and local laws tailored to drones' unique characteristics. By enacting clear and efficient drone laws, policymakers can help to ensure that the sky is the limit for the domestic drone industry in the twenty-first century.