

Regulating Drone Delivery



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Executive Summary

For over a decade, drone delivery has been heralded as the next frontier of commercial transportation and logistics. Currently, however, drone delivery companies are unable to scale their operations. This is due partly to technological limitations, and partly to federal regulations that prohibit unmanned aircraft systems (UAS) from carrying the property of another—i.e., making deliveries—beyond the visual line of sight (BVLOS). With the aim of expanding UAS viability, lawmakers in Congress and officials at the Department of Transportation (DOT) and Federal Aviation Administration (FAA) have introduced proposals to create new rules governing drone delivery, including some that became law in the FAA Reauthorization Act of 2024.

The problem is that scaling up drone delivery services across the country will likely come with serious downsides: congestion and public nuisance, abuses of economic power and harms to innovation, widespread surveillance, and consequences for workers and the environment. Without attention to these problems, regulators tempted to let drones scale quickly may make a disastrous policy choice, ushering in an era of commercial delivery marked by skies flooded with relatively unrestricted drones. Such a situation might not only threaten public safety—it might also lead to widespread backlash, potentially limiting drone delivery's public acceptance and thus the success of the industry.

This paper offers solutions to these problems—a pathway for how to regulate drone delivery services. It recommends the creation of a new, comprehensive licensing system that includes a set of regulations to prevent abuses of economic power, ensure innovative markets, protect privacy and property rights, promote safety, and prevent nuisances. This system would involve federal regulators working in collaboration with local governments to develop and approve plans that address these issues in a way that accords with the needs and preferences of individual communities. It also suggests that the U.S. Postal Service explore creating a public drone delivery network, as a complement to its existing parcel delivery service. While focusing primarily on the regulatory questions regarding drone delivery, this paper also recommends that policymakers commission a report to further study drone delivery's intermodal effects across last-mile delivery, and that they consider industrial policy tools to promote the domestic production of this new technology when it is used. These policies, if pursued, may contribute to a healthy, innovative, and socially responsible system of American last-mile delivery.

Introduction

For over a decade, drone delivery has been heralded as the next frontier of commercial transportation and logistics.¹ The industry has seen rapid worldwide growth, and drone delivery businesses have developed services that, in future iterations, could potentially transform online retail and package delivery.² Indeed, some of the biggest corporations in the United States—including Amazon, Google, Walmart, and UPS—are invested in competing for this market.³

Currently, however, drone delivery companies are unable to scale their operations in the U.S., due partly to technological limitations and partly to federal regulations that prohibit unmanned aircraft systems (UAS) from carrying the property of another—i.e., making deliveries—beyond the visual line of sight (BVLOS). The drone delivery networks that are currently able to make deliveries are only permitted to do so in an experimental context under waivers and exemptions granted by the FAA, under regulations that govern either commercial piloted aircraft or drones not used for delivery. As the FAA’s UAS BVLOS Aviation Rulemaking Committee put it in a 2022 report, “Nonwithstanding . . . benefits for the American public, current regulations do not enable the domestic U[nmanned] A[ircraft] beyond visual line-of-sight (BVLOS) industry to scale and achieve meaningful results from those benefits.”⁴

¹ Jeff Bezos, then the CEO of Amazon, announced that his company would pursue drone delivery in 2013. See 60 Minutes Staff, *Amazon unveils futuristic plan: Delivery by drone*, CBS News (Dec. 1, 2013), <https://www.cbsnews.com/news/amazon-unveils-futuristic-plan-delivery-by-drone/>.

² Tore Johnston, Stephan Lidel, Sarina Mahan, Robin Riedel & Leonard Tusch, *Drone Delivery: More Lift than you Think*, MCKINSEY & Co. (Mar. 15, 2022), <https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/future-air-mobility-blog/drone-delivery-more-lift-than-you-think>.

³ See, e.g., Amazon Staff, *How Amazon Is Building Its Drone Delivery System*, ABOUT AMAZON (Aug. 16, 2022), <https://www.aboutamazon.com/news/transportation/how-amazon-is-building-its-drone-delivery-system>; *Sky High Ambitions: Walmart To Make Largest Drone Delivery Expansion of Any U.S. Retailer*, WALMART (Jan. 9, 2024), <https://corporate.walmart.com/news/2024/01/09/sky-high-ambitions-walmart-to-make-largest-drone-delivery-expansion-of-any-us-retailer>; John Koetsier, *Inside Google’s Plan To Deliver Almost Everything To Almost Everyone Via Drone*, FORBES (Aug. 30, 2022), <https://www.forbes.com/sites/johnkoetsier/2022/08/30/inside-googles-plan-to-deliver-almost-everything-to-almost-everyone-via-drone/>; Max Garland, *UPS gains critical exemption to operate drones beyond line of sight*, SUPPLYCHAINDIVE (Sept. 8, 2023), <https://www.supplychaindive.com/news/ups-flight-forward-faa-drones-beyond-visual-line-of-sight-matternet/693144/>.

⁴ FED. AVIATION ADMIN., UNMANNED AIRCRAFT SYSTEMS BEYOND VISUAL LINE OF SIGHT AVIATION RULEMAKING COMMITTEE FINAL REPORT 8 (2022), https://www.faa.gov/regulations_policies/rulemaking/committees/documents/media/UAS_BVLOS_ARC_FINAL_REPORT_03102022.pdf [hereinafter UAS BVLOS ARC REPORT].

With the aim of expanding the commercial viability of UAS, lawmakers in Congress and officials in the executive branch have introduced proposals to create new rules governing drones. In 2023, for example, Senators Mark Warner of Virginia and John Thune of South Dakota introduced the Increasing Competitiveness for American Drones Act, which would reform the certification process for drone operators to enable more companies to offer drone delivery services.⁵ Meanwhile, the Federal Aviation Administration has signaled that “a new regulatory framework” is necessary to “capitalize on UAS, enhance safety, and promote sustainable transportation solutions” while “ensuring America’s continued leadership in aviation innovation.”⁶ These efforts most recently culminated in the FAA Reauthorization Act of 2024, which directed the FAA to develop new rules governing drone delivery.⁷

The problem is that scaling drone delivery across the country could have serious downsides: congestion and public nuisance, abuses of economic power and harms to innovation, widespread surveillance, and consequences for workers and the environment—in addition to the generally recognized safety risks of commercial drone flight. Without attention to these problems, regulators tempted to simply let drones scale quickly may make a disastrous policy choice, ushering in an era of commercial delivery marked by skies flooded with relatively unrestricted drones. Such a situation might not only threaten public safety: it might also lead to widespread backlash, limiting drone delivery’s public acceptance and thus the success of the drone delivery industry.⁸

This paper offers solutions to these challenges—a pathway for how to regulate drone delivery services. It begins in Part I.1 with an overview of how drone delivery works, including the relevant technology and logistics systems.⁹ Drone delivery relies on a highly complex and integrated technology stack, which include not only the drones themselves (and their component parts, such as cameras and propellers) but also docking stations, landing pads, chargers, logistics networks, and storage hubs. It

⁵ S. 307, 118th Cong. (1st Sess. 2023); Press Release, Senator Mark Warner, *Warner, Thune Introduce Legislation to Support Integration of Drones into Airspace* (Feb. 8, 2023), <https://www.warner.senate.gov/public/index.cfm/2023/2/warner-thune-introduce-legislation-to-support-integration-of-drones-into-airspace> [hereinafter Warner Press Release].

⁶ UAS BVLOS ARC REPORT, *supra* note xx, at 8.

⁷ See FAA Reauthorization Act of 2024, H. R. 3935, 117th Cong. (2nd Sess. 2024).

⁸ *Americans Are Worried About Unregulated Drone Delivery Services*, VAND. POLY ACCELERATOR (2024) [hereinafter *VPA Polling Report*].

⁹ See *infra* Part I.1.

surveys the current state of the drone delivery market, which in its nascency is dominated by the six companies with the regulatory authorization necessary to offer BVLOS deliveries: Prime Air, Wing, DroneUp, Zipline, Flytrex, and UPS Flight Forward. Some of America's biggest companies, including Amazon, Walmart, and Google, are among those most heavily invested in drone delivery, including through their ownership, investment in, or contracts with several of these companies. Part I.2 proceeds to offer two potential scenarios for how unrestricted drone delivery might eventually scale, given the economic dynamics at play in its industrial organization.¹⁰ The first and more likely scenario is a *network paradigm*, defined by highly integrated and concentrated networks offering point-to-point deliveries or operating out of large delivery hubs. The second and less likely scenario is a *commodity paradigm*, wherein businesses of all different sizes procure drones as tools that they incorporate into their regular delivery operations. Though scaled drone delivery may not exhibit one of these scenarios exclusive of the other, and each involves an inherent degree of speculation, thinking of drone delivery this way may help policymakers imagine the full range of problems that such scenarios might pose for policymakers, and identify the solutions that might be necessary to forestall them. It should be noted that though this paper deals extensively with drone delivery, it does not deal with drone *production*, or drones in other use cases, in any great depth.¹¹

Without careful regulation, scaled-up drone delivery is likely to lead to serious problems for the public and for the industry itself. Part II explores these drawbacks in detail. Unrestricted entry in drone delivery would likely result in congestion and might spark backlash among communities who view the drones as a nuisance.¹² Operating drone delivery networks may also enable companies to distort markets by abusing their economic power over rivals, as some of drone delivery's incumbents have done in other industries.¹³ Concentration in the sector may also harm innovation in retail, logistics, and delivery.¹⁴ Drone delivery will also involve privacy risks, as drones use cameras to navigate, analyze, and record flights.¹⁵ Drone delivery companies have the ability both to surveil peoples' homes and property and collect data on their consumer behavior, like their order history, product preferences, addresses, and payment

¹⁰ See *infra* Part I.2.

¹¹ It does, however, recommend that policymakers consider an industrial strategy for American drone production as an important corollary to regulating drone delivery. See *infra* Part IV.4.

¹² See *infra* Part II.1.

¹³ See *infra* Part II.2.

¹⁴ *Id.*

¹⁵ See *infra* Part II.3.

information. If the companies poised to dominate drone delivery replicate the practices that they have deployed in other sectors, they are likely to capitalize on these types of data to further entrench their power.¹⁶ Drone delivery may also portend labor displacement and pose risks to the environment, as ecosystem disruption disturbs wildlife and energy usage increases with new patterns of consumer behavior.¹⁷

If none of these drawbacks are immediately evident, it is largely because drone delivery services are prohibited from scaling without a waiver or exception from the FAA. As Part III details, current regulations governing drones are designed for those not intended for commercial delivery, or alternatively for piloted commercial aviation. Drone delivery services fit uncomfortably into both categories, and the FAA has, as a result, granted limited, experimental waivers to existing regulations for drone delivery companies.¹⁸ Part III discusses the current regulatory regime and efforts to reform it, including administrative reports, proposed legislation, and provisions included in the FAA Reauthorization Act of 2024 requiring the FAA to reform drone regulations. This paper argues that without additional regulatory action, these efforts are likely to exacerbate the harms described in Part II rather than address them.¹⁹ In their near-exclusive focus on granting BVLOS approval to a greater number of UAS, under the guise of “increasing American competitiveness” or “promot[ing] industry growth,” these proposals forgo entry restriction in favor of a narrow “risk-based approach” meant to address certain safety issues while promoting the potential benefits of UAS.²⁰ By neglecting the structural forces that may prompt drone delivery companies to act in certain ways, and without offering a workable method for placing an upper limit on drone delivery in American neighborhoods, these plans risk backlash from the communities drone delivery might otherwise serve.

Part IV offers a better way forward—a pathway for how to regulate drone delivery services. It argues that rather than relying simply on risk management, technical standards, or behavioral regulations, drone delivery should be regulated more like a public utility or an infrastructural service. A licensing system that functions as a genuine entry restriction, as is typical in infrastructural industries, can ensure that drone delivery networks do not overwhelm American neighborhoods, and *do* comply with a simple set of rules to protect privacy, prevent abuses of economic power, and

¹⁶ *Id.*

¹⁷ See *infra* Part II.4.

¹⁸ See *infra* Part III.1.

¹⁹ See *infra* Part III.2.

²⁰ See, e.g. Warner Press Release, *supra* note xx; UAS BVLOS ARC REPORT, *supra* note xx, at 11.

keep communities safe.²¹ Here's how it works: The FAA would design a licensing system in which local governments choose between one of two models of drone delivery governance: (1) a *contract model*, wherein a locality grants a single drone delivery provider a contract to operate there based on a competitive bid, and (2) a *utility model*, wherein local governments grant a limited number of providers certification to operate, coupled with cost-of-service rate regulation. In both cases, drone delivery companies would be required to adhere to neutrality mandates, limitations on surveillance, and common-sense safety regulations. Upon approval from the federal government, firms complying with these regulations—which may include additional rules not found federal regulations, according to local preferences—would be eligible for licenses to operate from the FAA. This “opt-in” approach will ensure that local communities, which may have different preferences on the degree to which they want drone services, are empowered to ensure that regulations meet those preferences. By addressing the issues of congestion and nuisance through fairly allocating service, they may also promote the public acceptance of drone delivery and thus the health of the industry.

In addition to the regulatory options that the FAA and local governments may implement, this paper suggests that the U.S. Postal Service explore another option for organizing drone delivery services: a public drone delivery network.²² Such a network could coexist, complement, and compete with private providers to offer affordable services in certain localities, just like the Postal Service's existing package delivery service does. In fact, the idea of a public drone delivery network is one that USPS has explored before: Under the Trump Administration, it put out a request for information about how it could set one up, but it later dropped the project.²³ Initiating a new round of planning for public drone delivery could help policymakers address some of the issues with drone delivery's market structure, and it might even lead to a service that some members of the public might consider a preferable alternative to private offerings.

Beyond regulation and integration with the postal service, drone delivery raises other important questions that policymakers should consider. Is it socially optimal to offer drone services for last mile delivery, as opposed to traditional delivery via trucks, especially considering the labor and environmental costs? If so, how might these effects be mitigated? To tackle these challenges, this paper suggests policymakers

²¹ See *infra* Part IV.1.

²² See *infra* Part IV.2.

²³ *Id.*

commission a report on last-mile delivery to explore the intermodal effects of expanded drone delivery, which may inform additional recommendations to policymakers in Congress and in the executive branch.²⁴ There are also a set of questions that deal not with drone *delivery*, but rather with the design, manufacturing, and purchasing of the drones themselves. Will expanding drone delivery services make U.S. logistics systems dependent on the foreign production of essential technologies? What might the consequences be, and how can we avoid them? This paper proposes that policymakers assess the U.S.'s industrial strategy with respect to the production of drones.²⁵ While there remain these and potentially many other problems to address given the onset of drone delivery at scale, policymakers will have a good starting point from which to assess them under a regulatory framework that advances the public interest and a healthy, fair drone delivery industry.

I. Drone Delivery: An Overview

Any discussion of how best to regulate a technology, mode of transportation, or any other locus of economic activity must start with how it works. Of course, how it works may be in large part *shaped* by the regulatory framework under which it operates—and this is certainly true of drone delivery. That said, different sectors have different basic organizational characteristics, and a workable understanding of these characteristics is necessary to govern them effectively. This Part will undertake that analysis for drone delivery. It begins with an overview of how drone delivery currently operates in the few places where it is authorized to do so. Then, it turns to a consideration of how a fully scaled drone delivery industry might develop in the future. Imagining how drone delivery is likely to develop over time, given the organization of similarly situated industries, may help policymakers understand the full range of potential risks and determine what regulatory tools may be required to prevent them, which will be covered in Parts II and IV, respectively.

A. How Drone Delivery Works

Drone delivery is the autonomous transportation of goods to businesses and consumers by aircraft known as unmanned aerial vehicles (UAVs)—which, in combination with each other and the ancillary technologies that enable them to operate, constitute the unmanned aerial *systems* (UAS) at the center of current policy

²⁴ See *infra* Part IV.3.

²⁵ See *infra* Part IV.4.

discussions.²⁶ As the FAA defines them, UAS are “an unmanned aircraft and the equipment necessary for the safe and efficient operation of that aircraft.”²⁷ An unmanned aircraft, in turn, is defined by statute as an aircraft that is operated without the possibility of direct human intervention from within or on the aircraft.²⁸ Importantly, while the aircraft are unmanned and therefore highly automated for much of their operational capacity, UAS are not *autonomous* systems in a strict sense, as they include a remote human operator.²⁹

In the areas where they are permitted to operate, UAVs—drones—may be used to deliver medical supplies, groceries, household items, takeout orders from restaurants, and other goods to consumers and between businesses.³⁰ To assist in navigation, UAVs rely on a technology stack of cameras, GPS navigation chips, RADAR/SONAR technology, and “flight controllers,” which synthesize information from all the other components to direct a drone along its path.³¹ They also require other technology to operate, including chargers, docking stations, and landing pads.³² Businesses offering drone delivery for consumers often offer an application for users to select items, initiate payments, and provide an address for drop-off.³³ Items are loaded into the drones from a centralized delivery hub or a business, transported to the drop-off point, and released via hooked tethers, compartment doors, or dropping the packages, before the drone returns to a delivery hub to charge and be sent out for its next

²⁶ Sarah Lewis, *Definition: delivery drone*, TECHTARGET (Dec. 2018), <https://www.techtarget.com/whatis/definition/delivery-drone>; Jamie Cole, *How Does Drone Delivery Work*, DISCOVERY OF TECH (Aug. 23, 2023), <https://discoveryoftech.com/how-does-drone-delivery-work/>. For key documents of these policy discussions, see *infra* Part III.2.

²⁷ *What is unmanned aircraft system (UAS)?*, FED. AVIATION ADMIN., <https://www.faa.gov/faq/what-unmanned-aircraft-system-uas> (last visited September 13, 2024).

²⁸ *Id.*

²⁹ Michael L. Slack, II, *Automation in Transportation*, 2018 ADV. INTELL. PROP. L. 1, 4.

³⁰ Eli Khazzam, *Business Modeling for Delivery Drone Transport*, THE TOPOLOGY PROJECT (July 1, 2017), <http://topologyproject.com/home/delivery-drones-business-models-and-transport-economics>.

³¹ Ronit Banerjee, *How Does Drone Delivery Work: Explore the Future*, IDEAUSHER, <https://ideausher.com/blog/how-does-drone-delivery-work-explore-the-future> (last visited Oct. 11, 2023).

³² Jack Daleo, *Alphabet Drone Division Wing has New Plan for Citywide Delivery Networks*, FREIGHTWAVES (Mar. 9, 2023), <https://www.freightwaves.com/news/alphabet-drone-division-wing-has-new-plan-for-citywide-delivery-networks>.

³³ Jacob Biba, *Is Drone Delivery on the Horizon?*, BUILTIN (Sep. 30, 2012), <https://builtin.com/drones/drone-delivery>.

delivery.³⁴

Importantly, the technology itself is limited in several important respects. Drones used for home delivery can carry only small loads, typically of weights between two and eight pounds.³⁵ They are also limited by distance, being optimized for “last-mile” delivery from a local storage hub to their destination.³⁶ When making deliveries, drones require large areas where they can safely land or release packages via tether, which they can do with an accuracy of an area the size of around two parking spaces.³⁷ Currently, drones are also required to be controlled by human operators, under the provisions of the FAA regulations governing drone delivery.³⁸ Different ratios of operators to drones, however, may be granted in different levels of certification, and thus between different companies receiving waivers.³⁹

Despite these limitations, commercial drone delivery has been the subject of considerable investment and growth in recent years. In 2022, the market was valued at \$8.77 billion globally, and is projected to grow to \$58.41 billion by 2030.⁴⁰ Some of the largest companies in the U.S. are among those most heavily invested in drone delivery, including Amazon, Google, Walmart, and UPS.⁴¹ The six companies which possess the regulatory authorization from the FAA necessary to operate drone delivery networks in the U.S. are Wing (a subsidiary of Alphabet, the parent company of Google), Zipline, DroneUp, Flytrex, Prime Air (a subsidiary of Amazon), and UPS Flight Forward (“UPSFF”)

³⁴ *Id.* For good visual demonstrations of drone deliveries taking place—one a promotional material, the other a journalistic report which also covers the likely risks of expanded operations for local communities—see Wing, *Walmart drone delivery | by Wing* 🍷, YouTube (June 10, 2024), <https://www.youtube.com/watch?v=a2OSiE2M4g4> [hereinafter Wing Video]; The Wall Street Journal, *Google Drones Can Already Deliver You Coffee In Australia*, YouTube (Jan. 8, 2019), <https://www.youtube.com/watch?v=prhDrfUgpB0> [hereinafter Wall Street Journal Video].

³⁵ Khazzam, *supra* note xx.

³⁶ *Id.*

³⁷ Gary Mortimer, *Drop, Lower or Land How Do Delivery Drones Deliver*, SUAS NEWS (Jan. 5, 2023), <https://www.suasnews.com/2023/01/drop-lower-or-land-how-do-delivery-drones-deliver/>; Andrea Cornell, Brian Miller & Robert Riedel, *Solving the “Last-Meter” Challenge in Drone Delivery*, MCKINSEY & CO. (May 5, 2023), <https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/future-air-mobility-blog/solving-the-last-meter-challenge-in-drone-delivery>.

³⁸ See *infra* Part III.1.

³⁹ *Package Delivery by Drone (Part 135)*, FED. AVIATION ADMIN., https://www.faa.gov/uas/advanced_operations/package_delivery_drone (Mar. 17, 2023).

⁴⁰ *Commercial Drone Size, Share | Global Forecast [2023]*, FORTUNE BUS. INSIGHTS (May 2023), <https://www.fortunebusinessinsights.com/commercial-drone-market-102171>.

⁴¹ See *infra* 14.

(a subsidiary of UPS).⁴² Certainly, the industry has not been without its internal challenges: Several drone delivery companies, including Prime Air and Wing, executed a wave of layoffs in 2023.⁴³ But given that these paralleled a wave of layoffs across the tech industry, it is unclear whether they were triggered primarily by drone delivery itself performing below expectations.⁴⁴ At least one company signaled that its layoffs were meant rather to shift focus *towards* its drone delivery business and away from enterprise services it had once intended to subsidize drone delivery.⁴⁵

Due partly to regulatory restrictions and partly to technical limitations, drone delivery remains a nascent industry that has not yet scaled. Pilot programs have started in only a select few regions of the country. Wing's domestic operations, for example, are limited to Christiansburg, Virginia.⁴⁶ Prime Air operates in only two towns: Lockeford, California and College Station, Texas⁴⁷—though after receiving an FAA waiver in May 2024, it said that it planned to expand its operations.⁴⁸ Prime Air's drones travel no farther than a 4-mile radius surrounding Prime storage hubs, and in the first half of 2023, the company made only around 100 deliveries.⁴⁹ Flytrex operates in four cities

⁴² *Package Delivery by Drone (Part 135)*, *supra* note xx.

⁴³ Annie Palmer, *Amazon's drone delivery unit hit with layoffs just as 10-year-old project finally launches*, CNBC (Jan. 20, 2023), <https://www.cnbc.com/2023/01/20/amazon-drone-unit-hit-with-layoffs-as-long-awaited-program-launches.html>;

Abner Li, *Google layoffs are wide-ranging as Larry Page, Sergey Brin consulted on AI future*, 9TO5GOOGLE (Jan. 20, 2023), <https://9to5google.com/2023/01/20/google-layoffs-wide/> (noting that Wing was among the divisions of Google that were impacted by a company-wide wave of layoffs).

⁴⁴ Asia Martin, *The month of January 2023 has already seen more tech layoffs than the entire first half of 2022 combined*, Bus. Insider (Jan. 20, 2023), <https://www.businessinsider.com/tech-layoffs-january-versus-first-half-2022-2023-1>.

⁴⁵ Annie Palmer, *Walmart-backed DroneUp is cutting jobs as drone delivery market struggles*, CNBC (May 16, 2023), <https://www.cnbc.com/2023/05/16/walmart-backed-drone-delivery-startup-droneup-is-cutting-jobs.html>.

⁴⁶ *Learn About How Wing Delivery Works*, WING, <https://wing.com/about-delivery/> (last visited Sept. 4, 2024).

⁴⁷ Sheena Vasani, *Amazon's Started to Deliver Orders by Drones in California and Texas*, THE VERGE (Dec. 28, 2022, 3:14 PM), <https://www.theverge.com/2022/12/28/23529705/amazon-drone-delivery-prime-air-california-texas>.

⁴⁸ Amazon Staff, *Amazon drones can now fly farther and deliver to more customers following FAA approval*, ABOUT AMAZON (May 30, 2024), <https://www.aboutamazon.com/news/transportation/amazon-drone-prime-air-expanded-delivery-faa-approval>.

⁴⁹ Katie Tarasov, *Amazon's 100 Drone Deliveries Puts Prime Air Far Behind Alphabet's Wing and Walmart Partner Zipline*, CNBC (May 18, 2023, 9:57 AM), <https://www.cnbc.com/2023/05/18/amazons-100-drone-deliveries-puts-prime-air-behind-google-and-walmart.html>.

across Texas and North Carolina,⁵⁰ while Zipline services customers within 50 miles of the Walmart in Pea Ridge, Arkansas, and near Intermountain Healthcare in Salt Lake City, Utah.⁵¹ UPS Flight Forward, with its partner Matternet, have focused on delivering medical supplies in North Carolina and Florida.⁵² Other businesses, such as certain locations of fast-food chain Chick-fil-a, have experimented with direct-to-consumer delivery using drones.⁵³ It is unclear whether these efforts have been undertaken in conjunction with one of the established third-party drone delivery networks, or using drone technology that the companies have procured themselves. In total, figures from McKinsey and Co. indicate the first half of 2023 saw half a million drone deliveries worldwide, of which North America contributed around 15 percent, or 75,000 deliveries.⁵⁴ Compared to the 21.2 billion parcels delivered in the U.S. alone in 2022, drone delivery has nowhere near the scale of other delivery methods in the U.S.⁵⁵

The drone delivery market in its nascency is highly concentrated among the few corporations whose regulatory authorization and partnerships with larger firms enable them to successfully offer drone delivery services in the United States. Of the six companies with the necessary FAA waiver, only Zipline and Flytrex are independent companies whose core business is in drone delivery. The remaining four are either subsidiaries of, or dependent on significant investment from, major retailers and

⁵⁰ *The Food You Love, Drone Delivered in 5 Minutes*, FLYTRET, <https://www.flytrex.com/> (last visited July 1, 2024).

⁵¹ Tom Ward, *Walmart and Zipline Team Up to Bring First-of-Its Kind Drone Delivery to the United States*, WALMART (Sept. 14, 2020), <https://corporate.walmart.com/news/2020/09/14/walmart-and-zipline-team-up-to-bring-first-of-its-kind-drone-delivery-service-to-the-united-states>; Art Raymond, *The Future is Here: Intermountain Launches Drone Delivery Service, First of its Kind in the West*, DESERETNEWS (Oct. 4, 2022, 5:21 PM), <https://www.deseret.com/2022/10/4/23385813/drone-delivery-intermountain-healthcare-zipline-utah-south-jordan>.

⁵² *Matternet Partner UPS Flight Forward Receives FAA Authorization to Operate Matternet M2 Delivery Drones Beyond Visual Line of Sight*, BUSINESSWIRE (Sept. 6, 2023, 4:05 PM), <https://www.businesswire.com/news/home/20230906895698/en/Matternet-Partner-UPS-Flight-Forward-Receives-FAA-Authorization-to-Operate-Matternet-M2-Delivery-Drones-Beyond-Visual-Line-of-Sight/>.

⁵³ Samantha Neely, *Chicken sandwiches falling from sky? This Florida Chick-fil-A offers delivery by drone*, SARASOTA HERALD-TRIBUNE (Nov. 16, 2023), <https://www.heraldtribune.com/story/news/2023/11/16/florida-chick-fil-a-free-drone-delivery/71602824007/>.

⁵⁴ Andrea Cornell, Sarina Mahan, & Robin Riedel, *Commercial drone deliveries are demonstrating continued momentum in 2023*, MCKINSEY & CO. (Oct. 6, 2023), <https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/future-air-mobility-blog/commercial-drone-deliveries-are-demonstrating-continued-momentum-in-2023>.

⁵⁵ *Parcel shipping volume in the United States from 2016 to 2022*, STATISTA (Oct. 11, 2023), <https://www.statista.com/statistics/1178991/parcel-shipping-volume-united-states/>.

package carriers whose core business lies elsewhere: Wing is a subsidiary of Alphabet, the parent company of Google; Prime Air is a subsidiary of Amazon; UPSFF is a subsidiary of United Parcel Service (UPS); and DroneUp is dependent on significant investment from Walmart. Notably, Walmart also contracts with other players besides DroneUp to offer drone delivery services to its customers, including Zipline, Flytrex, and Wing.⁵⁶ UPSFF, meanwhile, leases its drone technology from Matternet, the European company whose proprietary M2 drone delivery system is one of the leading UAS on the global market and also seeks to develop its own drone delivery networks.⁵⁷ These partnerships and ownership arrangements often result in integration between a company's drone delivery operations and its parent entity's other proprietary technologies. Wing, for example, offers a mobile application called OpenSky, whose interface incorporates satellite imagery from Google Maps, enabling flight controllers to gain real-time authorization to fly and navigate flight paths.⁵⁸ Prime Air is integrated into Amazon's larger logistics and delivery operations, while UPSFF uses drones to augment its parent company's established truck-based package delivery service. Thus, these technologies may be thought of as constituting independent layers within the drone delivery tech stack.

B. How Drone Delivery's Market Structure Might Develop

It is perhaps no wonder that drone delivery's market structure is currently highly concentrated, given the regulatory and geographic restrictions that help make it so. But should regulatory changes permit drone delivery to scale, it is worth considering how its market structure might develop. Of course, there is an inherent degree of speculation in imagining what its industrial organization might look like under a set of

⁵⁶ See *Walmart Now Operates Drone Delivery in 7 States, Completes 6,000 Drone Deliveries*, BUSINESSWIRE (Jan. 5, 2023, 3:28 PM), <https://www.businesswire.com/news/home/20230105005929/en/Walmart-Now-Operates-Drone-Delivery-in-7-States-Completes-6000-Drone-Deliveries>; Wing Video, *supra* note xx.

⁵⁷ Alison Coleman, *Matternet's Vision For Drones To Become A Mainstream Delivery Channel*, FORBES (Jul. 12, 2023, 9:43 AM), <https://www.forbes.com/sites/alisoncoleman/2023/07/12/matternets-vision-for-drones-to-become-a-mainstream-delivery-channel/>; *Matternet Launches World's Longest Urban Drone Delivery Route Connecting Hospitals and Laboratories in Zurich, Switzerland*, BUSINESSWIRE (Dec. 12, 2022, 8:00 AM), <https://www.businesswire.com/news/home/20221212005097/en/Matternet-Launches-World%E2%80%99s-Longest-Urban-Drone-Delivery-Route-Connecting-Hospitals-and-Laboratories-in-Zurich-Switzerland>.

⁵⁸ Brian Heater, *Alphabet's Wing Launches Opensky Drone Airspace Authorization App in US*, TECHCRUNCH (June 29, 2021, 7:00 AM), <https://techcrunch.com/2021/06/29/alphabets-wing-launches-opensky-drone-airspace-authorization-app-in->.

conditions that do not yet exist. But assuming drone delivery turns into a market with relatively unrestricted entry and counting on the continued participation of the current incumbents, some reasonable conjectures can be drawn about how it might operate, including by analogy to similarly situated industries.

It is helpful to imagine two hypothetical market structures: a *network paradigm* defined by fleets of drones operating out of big storage hubs or making point-to-point deliveries between multiple businesses and consumers, which is in effect highly concentrated; and a *commodity paradigm* defined by individual businesses procuring and operating their own drones, where the likelihood of concentration is less clear on its own terms—though, just like other markets, it may tend towards consolidation. Even though drone delivery might not fall into one of these buckets exclusively of the other, thinking of it this way illustrates the range of possibilities for how it *could* develop, thereby helping us better understand what policy tools may be required to prevent drone delivery's likely risks in either scenario.

1. The Network Paradigm. Under a network paradigm, drone delivery would operate in *networks*—large integrated systems with many drones that would transport goods from large storage hubs to consumers or make point-to-point deliveries between businesses and consumers. This is essentially how drone delivery behaves under the current waiver-based regulatory framework, though obviously at a far smaller scale. In this mode of organization, drone delivery would be likely to exhibit many of the characteristics of traditional public utility or infrastructural industries, including network effects, economies of scale, and high barriers to entry.⁵⁹ Drone delivery services, like telephone networks or online marketplaces, would only be useful insofar as other businesses and consumers used them, and both retailers and end customers would naturally prefer a drone delivery network that most other retailers and customers also use. Consequently, drone delivery networks would exhibit economies of scale—the more points it could serve, the more valuable it would be. These network effects—coupled with the high capital costs involved in organically developing a network⁶⁰—would serve as a high barrier to entry for would-be entrants, making drone delivery under the network model unlikely to flourish into a competitive industry of

⁵⁹ MORGAN RICKS, GANESH SITARAMAN, SHELLEY WELTON, & LEV MENAND, NETWORKS, PLATFORMS, & UTILITIES: LAW & POLICY 7-10 (2022) (on the characteristics typical of network, platform, and utility [NPU] industries).

⁶⁰ One study commissioned by the United Kingdom's National Infrastructure Commission found that, if drones are to "take off significantly," a "network of hubs" may require significant investment. NAT'L INFRASTRUCTURE COMM'N, THE IMPACT OF TECHNOLOGICAL CHANGE ON FUTURE INFRASTRUCTURE SUPPLY AND DEMAND 19 (2022), https://nic.org.uk/app/uploads/2905991-NIC-TECHNICAL-v0_5-ACCESSIBLE-3.pdf.

many firms. Thus, like other networks, drone delivery would likely be highly concentrated: A small number of companies, whose position derives from their possession of large storage hubs, logistics networks, ancillary technologies, and/or fleets of drones, would be likely to dominate drone delivery both nationally and within local areas. In this sense, drone delivery would operate similarly to Amazon and Walmart's existing delivery operations as large hub-and-spoke systems, or to delivery platforms like DoorDash or UberEats, which make point-to-point deliveries. Indeed, at least one drone delivery network—Wing—has already partnered with DoorDash to offer deliveries alongside its usual vehicles.⁶¹

Indications of the network model taking hold are already evident in the way drone delivery operates under the waiver-based regulatory system. At present, Walmart—the country's largest retailer⁶²—is perhaps best positioned to dominate the drone delivery market, through its contracts with Zipline, Flytrex, and Wing and its significant investment in DroneUp.⁶³ One contributing factor to Walmart's dominance is the scale of its physical presence across the country: 90 percent of Americans live within 10 miles of one of Walmart's over 4,600 U.S. locations.⁶⁴ Walmart's omnipresence enables its drone delivery networks to essentially integrate with an established storage and logistics business, thereby granting it significant power in the downstream drone delivery market.⁶⁵ Indeed, marketing materials from Walmart's collaboration with Wing depict its drone delivery operations with all the characteristic features of a network: The Walmart store as a hub, from which large numbers of drones take off from landing pads in the store's parking lot, making deliveries to multiple different points—i.e. consumers' homes—throughout the surrounding suburban neighborhoods.⁶⁶ Similar

⁶¹ *DoorDash and Wing Announce Drone Delivery Pilot in the US*, DOORDASH (March 21, 2024), <https://ir.doordash.com/news/news-details/2024/DoorDash-and-Wing-Announce-Drone-Delivery-Pilot-in-the-US/default.aspx>.

⁶² *Leading 100 retailers in the United States in 2023, based on U.S. retail sales*, STATISTA (July 2024), <https://www.statista.com/statistics/195992/usa-retail-sales-of-the-top-retailers/>.

⁶³ *Walmart Now Operates Drone Delivery in 7 States, Completes 6,000 Drone Deliveries*, *supra* note 20. For more on the risks of self-preferencing, see *infra* Part II.2.

⁶⁴ Kiri Masters, *Inside Amazon And Walmart's Decades-Long Battle For Digital Dominance*, FORBES (June 20, 2023), <https://www.forbes.com/sites/kirimasters/2023/06/20/inside-amazon-and-walmarts-decades-long-battle-for-digital-dominance/?sh=6e57153a5bf8>.

⁶⁵ And the results are clear: Walmart and its partners offer drone delivery across a much wider geographical range than its competitors, including in Arizona, Arkansas, Florida, North Carolina, Texas, Utah, and Virginia. See Max Garland, *Walmart Made Over 6,000 Drone Deliveries in 2022*, RETAILDIVE (Jan. 6, 2023), <https://www.retaildive.com/news/walmart-6000-drone-deliveries-droneup-flytrex-zipline-2022/639837/>.

⁶⁶ Wing Video, *supra* note xx.

dynamics are likely to apply for Walmart’s leading competitors: Though Prime Air has underperformed initial expectations,⁶⁷ and Wing has limited distribution at present like the other companies, the dominance of their parent entities—Amazon and Alphabet/Google, respectively—in e-commerce, online search, maps, and advertising may also aid in expanding their reach in drone delivery, given the integration of these proprietary technologies into the drone delivery tech stack.⁶⁸ Each of these businesses, as well as industry startups, intend their services to function as networks, either by operating an independent point-to-point delivery service or by leasing their technology to larger delivery, logistics, and retail companies for their own networked services.⁶⁹

2. The Commodity Paradigm. Under a commodity paradigm, drone delivery would be characterized by the drone as a *commodity*—an object that individual businesses procure and use to make their own deliveries without integration within a larger network. In this scenario, the drone is much like a vehicle that a pizzeria, for example, would own to make local deliveries. While not as common as the network model in drone delivery’s current state, there are also hints of drones being used in this way, such as by Chick-fil-a restaurants in Florida making deliveries directly to consumers, where it is not clear that they have integrated with larger networks.⁷⁰

Should drone technology eventually enable drone delivery to scale this way, the risks of concentration are not as immediately clear as they are in a traditional network paradigm. Yet there is reason for caution. Just like other commodity markets, a market for business-to-consumer drones could become highly concentrated. But more importantly, in the presence of coexisting large networks, the commodity model is less likely to take hold at scale, for several reasons. First, though the point may be

⁶⁷ See, e.g., Patrick Lucas Austin, *Amazon Drone Delivery Was Supposed to Start By 2018. Here's What Happened Instead*, Time (Nov. 2, 2021), <https://time.com/6093371/amazon-drone-delivery-service/>; Kris Holt, *Amazon's drones have reportedly delivered to fewer houses than there are words in this headline*, ENGADGET (Feb. 2, 2023), <https://www.engadget.com/amazon-drone-deliveries-faa-restrictions-205756349.html>; Paresh Dave, *Amazon's Drone Delivery Dream Is Crashing*, WIRED (Apr. 4, 2023), <https://www.wired.com/story/crashes-and-layoffs-plague-amazons-drone-delivery-pilot/>.

⁶⁸ For a detailed account of Amazon and Google’s dominance in these markets, see generally Investigation of Competition in Digital Markets: H. Comm. On The Judiciary, 117th Congress (2020), <https://www.govinfo.gov/content/pkg/CPRT-117HPRT47832/pdf/CPRT117HPRT47832.pdf>; see also Harrison Wolf, *Who Are The Big 3 In U.S. Drone Delivery?*, Forbes (Jan. 31, 2024), <https://www.forbes.com/sites/harrisonwolf/2024/01/26/who-are-the-big-3-in-us-drone-delivery/?sh=b24cc254e201>.

⁶⁹ Coleman, *supra* note xx.

⁷⁰ Neely, *supra* note xx.

rudimentary, drone delivery is a *service*: It is not an end unto itself (i.e. the ownership and operation of drones), but rather a means to other commerce—delivering products to consumers—and thus is more likely to develop as a service than as a commodity market.⁷¹ Second, incumbents and startups in the drone delivery sector are evidently intent on establishing drone delivery as a networked business. Their business model is characterized by integration with large storage hubs and logistics networks. Even if making point-to-point deliveries from third parties to consumers, they intend to offer large fleets of drones which they own and operate themselves or on behalf of others.⁷² Third, drone delivery relies on inputs over which drone delivery incumbents have considerable power, ranging from satellite imaging and maps to e-commerce and physical retail. Those companies with control over those inputs—including companies like Amazon, Google, and Walmart—are likely, then, to exert power vertically throughout the drone technology stack. Fourth, it may be more cost-effective for a small business to outsource drone delivery services, rather than insource them. The infrastructure required to operate drones—landing pads, chargers, the aircraft themselves—are expensive, and the benefits of outsourcing these fixed costs may override the costs of owning and operating drones on a per-business basis. Should large drone delivery networks exist alongside the commodity paradigm, it is likely that they would outcompete smaller drone companies given their economies of scale and consequent ability to charge lower prices.

To restate the obvious, it is not possible to be entirely certain about how drone delivery with unrestricted entry across the country might operate, given that the precise conditions for such operations do not yet exist. As its technology develops, its industrial organization may ultimately occupy some point in the middle of these two poles, or different services and geographical areas may adopt different models. Regardless, this theoretical distinction reveals that in any conceivable organization of drone delivery's market structure, whether highly concentrated (“networked”) or highly decentralized (“commoditized”), entry restriction and other structural regulations will be required, given the risks that unrestricted entry and consolidation may pose to communities across America. The question then becomes not whether to limit entry

⁷¹ Being means to other commerce is a key feature of network, platform, and utility industries that distinguish them from exchange in ordinary commodities. See Ricks *et al.*, *supra* note xx, at 8.

⁷² See *supra* Part I.1 (“Items are loaded into the drones from a centralized delivery hub or a business, transported to the drop-off point, and released via hooked tethers, compartment doors, or dropping the packages, before the drone returns to a delivery hub to charge and be sent out for its next delivery”).

into drone delivery, but *how* to do so. For why such an upper limit is necessary, let us consider some likely problems with unrestricted drone delivery.

II. Problems with Unrestricted Drone Delivery

While innovative, drone delivery's growth raises significant concerns. The problems of congestion, nuisance, surveillance, and dangers to property, workers, and the environment are all likely to emerge as the industry expands. Understanding and proactively addressing these issues is not only in the public interest, but also in the interest of a healthy and successful drone delivery industry.

A. Congestion and Nuisance

The first and most obvious consequence of a significant expansion in the number of drones eligible for regulatory approval would be the large numbers of new drones flying around making deliveries. With unrestricted entry by firm and by time of day, companies offering drone delivery may deploy large fleets of drones in American neighborhoods. In fact, they may be incentivized to do so: Should drone delivery exhibit network effects, expanded BVLOS approval may prompt networks competing against each other to take full advantage of unrestricted entry by deploying ever-larger fleets of drones, despite the risks involved.⁷³ Ultimately, whether drone delivery is ultimately dominated by the network paradigm or the commodity paradigm, unrestricted entry is likely to lead to congestion without some upper limit on local operations.⁷⁴

While it is difficult to determine exactly how many drones could be expected to operate within a given geographic area absent entry restriction, it is not hard to imagine that large numbers of what are essentially flying robots might be a great nuisance to many communities. Drones may substantially increase ambient noise levels, thereby contributing to noise pollution. In fact, the public health literature on drones and noise emission suggests that noise from drones is “substantially more annoying than road traffic or aircraft noise” due to several unique acoustic

⁷³ Indeed, at least one drone delivery company has already been alleged to neglect safety regulations in order to edge out competitors. See Matt Day & Spencer Soper, *Amazon Drone Crashes Hit Jeff Bezos' Delivery Dreams*, BLOOMBERG (Apr. 10, 2022, 4:00 PM), <https://www.bloomberg.com/news/features/2022-04-10/amazon-drone-crashes-delays-put-bezos-s-delivery-dream-at-risk>

⁷⁴ See *supra* Part I.2.

properties.⁷⁵ Annoyance may be a measure of more or less subjective evaluation—but recordings of Wing’s drones from a 2019 pilot program, to use just one example, do not bode well for their eventual public acceptance.⁷⁶ Delivery drones may be disturbing to children, pets, wildlife, those with sensitivity to sound, and those who simply enjoy the quiet of their neighborhood. As one Arizona resident told a reporter regarding her experience with drones in her neighborhood, “You are supposed to have a reasonable enjoyment of your property in sort of a peaceful and quiet manner—obviously, we know there’s a road and those kinds of things—but most people don’t think there’s going to be a loud vehicle essentially hovering over their house for an unknown amount of time ... I mean, if it’s like [Amazon] Prime, they can be up past your house dozens of times a day. It’s very loud and very disruptive.”⁷⁷

Drones may also be visually unappealing, especially in large numbers. Collisions and crashes may be dangerous, and might destroy private property, leave debris obstructing traffic or walkways, or even injure people on the ground. One crash of an Amazon delivery drone even ignited a wildfire that spread up to 25 acres.⁷⁸ Though it was not a factor in that particular case, part of the reason drone delivery is so risky is the method of package release. Many drones drop packages via the use of tethers hung from the aircraft, and current technology enables these tethers to drop them with an accuracy of a space around the size of two parking spots.⁷⁹ Depending on the nature of the delivery area, this may be a large margin of error. Even in places where this is not the case, or when drones deliver packages a different way, malfunctions could be quite dangerous.⁸⁰

For those concerned with respecting private property, drones may also run the risk of chronic trespassing: To navigate to and from their destinations, they may have to fly

⁷⁵ Beat Schäffer, Reto Pieren, Kurt Heutschi, Jean Marc Wunderli, & Stefan Becker, *Drone Noise Emission Characteristics and Noise Effects on Humans—A Systematic Review*, 18 INT’L. J. ENVIRON. RSCH. PUB. HEALTH 5940 (2021).

⁷⁶ See Wall Street Journal Video, *supra* note xx, at 2:36, 3:31. In the video, from 2019, it is claimed that Wing was in the process of developing less noisy propellers. Whether these have since been introduced is unclear. *Id.*

⁷⁷ Chris Latella, *I have no rights: Valley residents concerned over Walmart delivery drones*, 12NEWS (Jan. 6, 2023), <https://www.12news.com/article/news/local/arizona/walmart-drone-delivery-program-in-arizona-raises-questions-over-privacy-safety/75-414ac616-19ab-43db-98ed-08eed2c6a7d9>.

⁷⁸ Ishveena Singh, *Amazon drone delivery crash sparked acres-wide fire in Oregon: FAA*, DRONEDJ (March 25, 2022), <https://dronedj.com/2022/03/25/amazon-delivery-drone-crash-oregon/>.

⁷⁹ Cornell *et al.*, *supra* note xx.

⁸⁰ Mortimer, *supra* note xx.

over private property without authorization from its owners, infringing on the privacy and property rights of individuals in ways that traditional modes of delivery that travel on public roads, such as the postal service and delivery trucks, do not. Wing's drones, for example, fly at an altitude of approximately 150 feet—not all that high up, all things considered.⁸¹ One way to address this might be to clarify the scope of landowners' property rights in low airspace, through a rule requiring drones to fly above a certain altitude except when arriving at their destination.⁸² Such a proposal would accord with the precedent set by *United States v. Causby*, a 1946 case in which a landowner sued the federal government for violating the Takings Clause of the Fifth Amendment by flying military airplanes from a nearby airport over his farm. In that case, the Supreme Court held that "if the landowner is to have full enjoyment of the land, he must have exclusive control of the immediate reaches of the enveloping atmosphere."⁸³ Though it would not necessarily involve a question of constitutional takings by the state, similar logic could well apply to drones being flown by private corporations. But given that remedies to individual violations of a minimum-altitude rule would necessarily be *ex post*, and there might be many such violations, such a behavioral regulation may not be sufficient to prevent the harms of congestion and nuisance without a larger scheme of entry restriction in a landowner's geographic area.⁸⁴

In short, without careful regulations, American neighborhoods may be subject to a cacophony of noisy, obtrusive objects traveling over private property to deliver ever-larger numbers of consumer goods—a situation that, for many, would be highly undesirable. Indeed, a poll commissioned by the Vanderbilt Policy Accelerator (VPA) in June 2024 found that 70% of Americans are worried that more drones will disturb their neighborhoods and may be unsafe.⁸⁵ Drones used for parcel delivery in particular are viewed with greater skepticism than any other UAS use case, as indicated by one recent review of the literature on the public acceptance of drones, which found that "scenarios likely to infringe on daily lives receive least support, for example, 'retail use such as package delivery.'"⁸⁶ This suggests that congestion and nuisance might also make it more difficult for the drone delivery industry to gain public trust, scale, and

⁸¹ *Learn About How Wing Delivery Works*, *supra* note xx.

⁸² For such a proposal, see Troy A. Rule, *Drones, Airspace, and the Sharing Economy*, 84 OHIO ST. L.J. 157 (2023).

⁸³ *U.S. v. Causby*, 328 US 256, 264 (1946).

⁸⁴ See *infra* Part IV.1.

⁸⁵ *VPA Polling Report*, *supra* note xx.

⁸⁶ Angela Smith et al, *Public acceptance of the use of drones for logistics: The state of play and moving towards more informed debate*, 68 TECH. IN SOC'Y 1, 3 (Jan. 22, 2022), <https://www.sciencedirect.com/science/article/pii/S0160791X22000240#bib24>.

remain economically viable over the long term. Should drone delivery introduce greater efficiency or convenience as a method of last-mile delivery, it would be less likely that those benefits would reach the American public if the industry were associated with widespread nuisance. Regulations governing drone delivery should therefore be designed to avoid these problems, thereby promoting both the public interest and the eventual success of the drone delivery industry.

B. Abuses of Power and Harms to Innovation

Controlled by only a few firms, an unrestricted and consolidated drone delivery market is susceptible to the usual risks of concentrated markets: monopoly or oligopoly pricing, reduced quality, self-preferencing, discrimination against customers and rivals, and harms to innovation.⁸⁷ Since it is early in drone delivery's technology cycle, it is difficult to determine exactly how or whether dominant firms currently abuse their power over this specific market. But the conduct of Amazon, Google, and Walmart in other markets they control is instructive. Business owners that depend on Amazon's platform services, like its online marketplace and cloud computing infrastructure, have routinely complained of Amazon deplatforming or copying their products and self-preferencing their own, or engaging in discriminatory pricing and terms—all because Amazon is their primary competitor.⁸⁸ Walmart's alleged use of its buyer power to squeeze discounts from suppliers not offered to other companies may also carry over to its conduct in drone delivery, shutting out would-be competitors from the market through preferential deals with Zipline, Flytrex, DroneUp, or other companies.⁸⁹ Its

⁸⁷ See Ricks *et al.*, *supra* note xx, at 13-19.

⁸⁸ For one example, see Jordan Novet, *Amazon's Cloud Business is Competing with its Customers*, CNBC (Nov. 30, 2018), <https://www.cnbc.com/2018/11/30/aws-is-competing-with-its-customers.html>. Amazon's abuses of economic power, enabled by its business structure, are well-documented in the legal literature. See, e.g., Lina Khan, *Amazon's Antitrust Paradox*, 126 YALE L.J. 564 (2017) [hereinafter Khan, *Amazon*]; Lina Khan, *The Separation of Platforms and Commerce*, 119 COLUM. L. REV. 973 (2019) [hereinafter Khan, *Separation*]. Amazon has also been sued by the Federal Trade Commission for illegally maintaining monopoly power with the aid of these and other anticompetitive practices. See *FTC Sues Amazon for Illegally Maintaining Monopoly Power*, FED. TRADE. COMM'N. (Sept. 26, 2023), <https://www.ftc.gov/news-events/news/press-releases/2023/09/ftc-sues-amazon-illegally-maintaining-monopoly-power>.

⁸⁹ See Brian Callaci, Daniel A. Hanley, & Sandeep Vaheesan, *The Robinson-Patman Act as a Fair Competition Measure*, TEMPLE L. REV. (forthcoming 2024) ("In the retail sector, Walmart and Amazon have risen to dominance using means that are likely illegal under the [Robinson-Patman Act], squeezing suppliers for discounts unavailable to other retailers. Walmart sought, and received, deep discounts from a wide range of suppliers, who were so wary of offending the massive buyer that many of them established headquarters in Bentonville, creating a 'Vendorville' in Walmart's hometown.").

investment in DroneUp, meanwhile, may incentivize that company to give preferential treatment to Walmart's products over those of competing retailers—or it may enable Walmart, a major retailer, to give preferential treatment to DroneUp over its competitors. Google, meanwhile, has been found guilty of maintaining an illegal monopoly in online search, and is the subject of a separate lawsuit from the Department of Justice for abusing its market power to harm competition in online advertising.⁹⁰ Much of Google's monopolistic conduct, these cases alleged, consisted of preferential deals that limited user engagement with rivals and stifled competition through serial acquisitions and abuses of dominance—practices which could well translate into drone delivery.⁹¹

Beyond enabling discrimination against a firm's customers and rivals, unregulated concentration in drone delivery may also harm innovation. This can happen in two ways. First, self-preferencing and discrimination against retail competitors harms innovation in the downstream retail marketplace. In other words, it creates a dynamic innovation problem. Think of it this way: If DroneUp—a drone delivery network dependent on significant investment from Walmart—has a functional monopoly on point-to-point drone delivery in an area and can charge monopoly prices to non-Walmart retailers or refuse to serve them, those retail businesses suffer compared to Walmart. These higher prices are akin to paying a tax on every purchase, making those businesses less competitive. Over time, lower profits and thus higher barriers of entering retail markets ultimately discourages innovation and investment in the retail ecosystem.⁹² To put it differently, when platforms—in this case drone services—are

⁹⁰ United States v. Google LLC, 687 F.Supp.3d 48 (2024); Press Release, OFF. OF PUB. AFFAIRS, U.S. DEP'T OF JUST., Justice Department Sues Google for Monopolizing Digital Advertising Technologies (Jan. 24, 2023), <https://www.justice.gov/opa/pr/justice-department-sues-google-monopolizing-digital-advertising-technologies>; Press Release, OFF. OF PUB. AFFAIRS, U.S. DEP'T OF JUST., Justice Department Sues Monopolist Google For Violating Antitrust Laws, (Oct. 20, 2020), <https://www.justice.gov/opa/pr/justice-department-sues-monopolist-google-violating-antitrust-laws>.

⁹¹ *Id.* For more on Google's history of abusive conduct, see generally Khan, *Separation*, *supra* note xx; Investigation of Competition in Digital Markets, *supra* note xx.

⁹² See Mark A. Lemley and Matthew Wansley, *Coopting Disruption* 12 (forthcoming 2024), <https://ssrn.com/abstract=4713845> (discussing how tech platforms sustain their dominance, and thereby threaten competition and innovation, in part through self-preferencing); Khan, *Amazon*, *supra* note xx ("Amazon is positioned to use its dominance across online retail and delivery in ways that involve tying, are exclusionary, and create entry barriers. That is, Amazon's distortion of the delivery sector in turn creates anticompetitive challenges in the retail sector." [citations omitted]).

integrated with commercial activities, there is a conflict of interest that harms innovation in the commercial sector.⁹³

Second, in the longer run, the dominance and influence of parent companies or investors can also disincentivize innovation in the drone sector itself. Economists have described a phenomenon called “kill zones,” in which venture capitalists are discouraged from investing in innovative startups likely to be acquired by large firms, thereby chilling technological innovation and potentially forestalling future generations of delivery technology.⁹⁴ Business scholars have also shown that large monopolistic firms, by virtue of their scale and power, tend to have a greater incentive towards profit-seeking in their existing businesses rather than investing in innovation.⁹⁵ These dynamics may play out in the network paradigm of drone delivery, in which several of the leading networks are either subsidiaries of or dependent upon investment or business from large firms whose core business lies elsewhere. In this market structure, new companies face high barriers to entry, and are thus hindered from bringing innovative products and services to market.

C. Surveillance and Data Commodification

To operate, UAVs use cameras and sensors to navigate from storage hubs to their destinations.⁹⁶ These cameras and sensors record images and videos of peoples’ homes and other property—raising significant concerns about personal privacy and property rights. Public opinion polling has shown that a large majority of Americans are concerned about companies using drones to collect personal data and are outright opposed to them recording images or video of their homes.⁹⁷ A poll commissioned by

⁹³ See Khan, *Separation*, *supra* note xx, at 1008-1015; Ricks *et al.*, *supra* note xx, at 35 (on technological change and dynamic innovation in platform industries).

⁹⁴ Sai Krishna Kamepalli, Raghuram Rajan & Luigi Zingales, *Kill Zone*, NBER WORKING PAPER (2021), <https://www.nber.org/papers/w27146>. For a related discussion of monopoly’s chilling effect on innovation, see Derek Thompson, *America’s Monopoly Problem: How big business jammed the wheels of innovation*, *The Atlantic* (Oct. 2016), <https://www.theatlantic.com/magazine/archive/2016/10/americas-monopoly-problem/497549/>. See also Lemley and Wansley, *supra* note xx; Investigation of Competition in Digital Markets, *supra* note xx, at 35-39.

⁹⁵ Maxwell Wessel, *Why Big Companies Can’t Innovate*, *HARV. BUS. REV.* (Sept. 27, 2012), <https://hbr.org/2012/09/why-big-companies-cant-innovate>.

⁹⁶ See *supra* Part I.1.

⁹⁷ Susan Meyer, *Could delivery drones be the next tech privacy violation? 88% of Americans Think So*, *THE ZEBRA* (April 13, 2023), <https://www.thezebra.com/resources/home/delivery-drones-survey/>.

VPA found that 66 percent of Americans oppose drones taking videos or images of their homes.⁹⁸

Homeowners have also expressed concerns that without a reasonable expectation of privacy in their homes and in their yards, they feel that their property rights are violated. One Arizona resident articulated a feeling of helplessness when complaining to DroneUp about drones flying around her property: “The gentleman from DroneUp delivery basically told me I had, essentially, no legal rights . . . They could be wherever they wanted, as long as it was above a blade of grass, anywhere on my property. Front yard, back yard, above your roof, in front of your windows; I had no rights.”⁹⁹ From one perspective, these concerns should be taken seriously as infringements on “the right to be let alone,” both for individual property owners and the communities they live in.¹⁰⁰ But such concerns may also harm the drone delivery industry itself, given that constant surveillance may hinder public acceptance of drone delivery, resulting in lower service demand or a broader public backlash or resistance. It may even provoke violent responses that threaten community safety, as one Florida man demonstrated when, under suspicion of surveillance, he fired a gun at a Walmart delivery drone flying over his house.¹⁰¹ This recalled a similar incident in 2015, when a Kentucky man shot down a drone flying over his property, claiming he “was justified in taking down the drone saying he was protecting his privacy rights.”¹⁰²

Another related concern is the use of surveillance data to entrench drone delivery companies’ market power. Drone delivery companies have the ability both to record peoples’ homes and property *and* collect data on their consumer behavior, like their order history, product preferences, addresses, and payment information. Companies poised to dominate drone delivery, including Amazon and Google, have a well-documented history of capitalizing on these types of consumer data to strengthen their market power. Google, for example, shares data collected from its proprietary platform services—like Search or Maps—with its other verticals, like its advertising business, allowing it to create “detailed user profiles by connecting activity data to the user’s Google Account.”¹⁰³ Amazon, likewise, has been granted a patent that would

⁹⁸ VPA Polling Report, *supra* note xx.

⁹⁹ Latella, *supra* note xx.

¹⁰⁰ See Samuel D. Warren and Louis D. Brandeis, *The Right to Privacy*, 4 HARV. L. REV. 193, 193 (1890).

¹⁰¹ Rob Thubron, *72-year-old Florida man arrested after admitting he shot a Walmart delivery drone*, TECHSPOT (July 12, 2024, 8:43 a.m.), <https://www.techspot.com/news/103638-72-year-old-florida-man-arrested-after-admitting.html>.

¹⁰² Slack, *supra* note xx, at 9.

¹⁰³ Investigation of Competition in Digital Markets, *supra* note xx, at 223.

allow it to capitalize on data scraped from drones, capturing and processing information on peoples' homes and other property to provide real-time and future purchase recommendations.¹⁰⁴ The massive amounts of consumer data that tech platforms collect and analyze enables them to lock in customers and insulate themselves from competition by innovative startups—including, potentially, drone delivery companies—thereby chilling innovation and enabling abuses of market power.¹⁰⁵

D. Costs to Labor and the Environment

Other concerns with expanded drone delivery involve costs for workers and the environment. In the process of adopting drone delivery, companies may displace traditional delivery workers, like postal workers and truck drivers.¹⁰⁶ Though the figures on this are sketchy and may not be up to date, analysts predicted as late as 2017 that drone delivery is expected to accelerate job automation, with projected losses of \$127 billion in human labor.¹⁰⁷ Should drone delivery replace trucking in certain areas, these losses may also jeopardize significant advances in pay, benefits, and conditions made in recent bargaining efforts between union truck drivers and delivery companies.¹⁰⁸

¹⁰⁴ U.S. Patent No. 9,714,089(B1) (issued July 25, 2017), <https://patents.google.com/patent/US9714089B1/en>; Matthew Stern, *Amazon's Drones May Collect Valuable Data on Their Fly-Overs*, FORBES (Aug. 28, 2017) <https://www.forbes.com/sites/retailwire/2017/08/28/amazons-drones-may-collect-valuable-data-on-their-fly-overs/?sh=513c17776cbe>.

¹⁰⁵ See Kenneth A. Bamberger and Orly Lobel, *Platform Market Power*, 32 BERK. TECH. L.J. 1051, 1083-1087 (2017) (noting that “the view among both regulators and many scholars is that the data held by a platform—especially one with a large market share—can both be used to limit competition and to harm consumers.” In the case of one such platform, the risks include “enabling the possibility of anticompetitive price discrimination, and exacerbated lock-in effects by personalizing the platform experience, enhancing the value of review systems, and targeting services”); see generally Maurice E. Stucke, *Should We Be Concerned About Data-opolies?*, 2 GEO. TECH. L. REV. 275 (2018); SHOSHANA ZUBOFF, *THE AGE OF SURVEILLANCE CAPITALISM* (2019).

¹⁰⁶ Researchers have also developed systems wherein drones would assist traditional delivery vehicles and their drivers in last-mile delivery. Cf. Chase C. Murray and Amanda G. Chu, *The flying sidekick traveling salesman problem: Optimization of drone-assisted parcel delivery*, 54 Transp. Rsch. Pt. C 86 (2015).

¹⁰⁷ PRICEWATERHOUSECOOPERS, CLARITY FROM ABOVE: TRANSPORT INFRASTRUCTURE: THE COMMERCIAL APPLICATIONS OF DRONE TECHNOLOGY IN THE ROAD AND RAIL SECTORS 1 (2017), <https://www.pwc.com/gr/en/publications/assets/clarity-from-above-transport-infrastructure.pdf>; Chris Weller, *Drones could replace \$127 billion worth of human labor*, BUS. INSIDER (May 11, 2016), <https://www.businessinsider.com/drones-could-replace-127-billion-of-human-labor-2016-5>.

¹⁰⁸ Elizabeth Napolitano, *UPS says drivers to make \$170,000 in pay and benefits following union deal*, CBS NEWS (Aug. 15, 2023), <https://www.cbsnews.com/news/ups-drivers-170000-pay-benefits-compensation/>.

They may also allow Amazon, the owner of Prime Air, to elude a recent judgment of the National Labor Relations Board declaring it a joint employer of franchised delivery workers, whose labor might also be at risk of displacement from drone delivery.¹⁰⁹ Costs to workers are an active concern for the vast majority of Americans: VPA's June 2024 polling found that nearly 3 in 4 Americans are worried about traditional delivery workers losing their jobs due to drone delivery.¹¹⁰ And even without conclusive evidence that it would take place in every case, it may be better to act cautiously in the face of rapid, large-scale labor displacement, given its socially harmful effects, than to let it proceed uninhibited.¹¹¹

Current regulatory proposals and drone delivery companies also claim that adopting drone delivery will provide environmental benefits; in fact, it is one of the principal claims used to market the technology.¹¹² Drones are usually electric-powered, with batteries charged on the electric grid much like other electric vehicles, though DroneUp has invested in the development of a fleet powered using hydrogen fuel cells.¹¹³ Proponents of drone delivery assert that electric-powered drones are likely to contribute to lower carbon emissions relative to the internal combustion engines of traditional last-mile delivery vehicles.¹¹⁴

But upon scrutiny, claims that widespread drone delivery adoption will constitute a net benefit to the environment may be too optimistic, as it is not yet clear that the purported benefits will outweigh likely costs. While there is some evidence confirming

¹⁰⁹ See Haleluya Hadeo, *US labor regulator says Amazon is a joint employer of subcontracted delivery drivers in California*, AP NEWS (Aug. 22, 2024, 4:55 PM), <https://apnews.com/article/amazon-nlrb-delivery-drivers-3214680ef8c8b060184964412f378128/>.

¹¹⁰ VPA Polling Report, *supra* note xx.

¹¹¹ See, e.g., Jennie Brand, *The Far-Reaching Impact of Job Loss and Unemployment*, 41 ANNU. REV. SOCIOL. 359 (2015).

¹¹² See, e.g., Jeff Wilke, *A Drone Program Taking Flight*, ABOUT AMAZON (June. 5, 2019), <https://www.aboutamazon.com/news/transportation/a-drone-program-taking-flight> ("Our drones are safe, efficient, stable, and good for the environment.") (emphasis added); Margaret Nagle, *Drone Delivery Regulations In The U.S. That Support Safe, Scaled Delivery*, WING BLOG (Sept. 12, 2023), <https://blog.wing.com/2023/09/drone-delivery-regulations-supporting-safe-delivery.html> ("The technology has a lot of societal benefits: it's fast and reliable; it reduces traffic accidents and road congestion; and it's much better for the environment.") (emphasis added).

¹¹³ Jack Daleo, *DroneUp Is Testing Hydrogen Fuel Cells—Will Other Drone Firms Follow?*, FLYING (Apr. 18, 2023), <https://www.flyingmag.com/droneup-is-testing-hydrogen-fuel-cells-will-other-drone-firms-follow/>.

¹¹⁴ See, e.g., Wilke, *supra* note xx ("When it comes to emissions and energy efficiency, an electric drone, charged using sustainable means, traveling to drop off a package is a vast improvement over a car on the road."); UAS BVLOS ARC REPORT, *supra* note xx, at 49-51.

that electric UAVs may reduce greenhouse gas (GHG) emissions under certain circumstances, other environmental assessments have shown drones resulting in far greater GHG emissions than electric trucks, and at shorter distances even more than diesel trucks.¹¹⁵ One reason drone delivery might eventually present additional environmental risks is shifting consumer behavior. Consumers expect their packages to be delivered quickly, and given that drones can accommodate only relatively light loads, users may end up ordering more frequent deliveries of smaller sizes.¹¹⁶ More drones in the sky are the result, and because they are powered by an electric grid whose generation remains largely dependent on non-renewables,¹¹⁷ the cumulative effect may not necessarily be a cleaner alternative to fleets of traditional delivery vehicles which carry larger loads—many of which, like postal trucks, are already being converted to EVs.¹¹⁸ Greater demand for storage may also lead to increased energy usage on the part of the buildings that function as delivery hubs.¹¹⁹ In other words, more frequent drone delivery may offset clean energy gains made by drones relative to other modes of delivery, unless more fundamental transformations in electricity generation take place across the grid. Likely environmental costs also extend to wildlife. Reporting has indicated that birds view drones as threats to their safety and that of their nests, which may lead to physical confrontations leading to injury or

¹¹⁵ Compare Wen-Chyuan Chiang, Yuyu Li, Jennifer Shang, & Timothy L. Urban, *Impact Of Drone Delivery on Sustainability and Cost: Realizing the UAV Potential Through Vehicle Routing Optimization*, 242 APPLIED ENERGY 1164 (2019) (proposing a model of route optimization that would reduce carbon emissions) with Aishwarya Raghunatha, Emma Lindkvist, Patrik Thollander, Erika Hansson, & Greta Jonsson, *Critical Assessment of Emissions, Costs, and Time for Last-Mile Goods Delivery by Drones Versus Trucks*, 13 SCI. REPORTS 11814, 2-3 (2023), <https://doi.org/10.1038/s41598-023-38922-z> (describing an environmental assessment in which drones underperformed electric trucks and even, at shorter distances, deisel-fueled trucks).

¹¹⁶ This dynamic has some predicate in consumers shifting their behavior after adopting Amazon Prime and the consequent environmental effects. See Sally French, *Is Amazon Drone Delivery Really All That Environmentally Friendly?*, CALLAWAY CLIMATE INSIGHTS (Oct. 10, 2020), <https://www.callawayclimateinsights.com/p/is-amazon-drone-delivery-really-all>.

¹¹⁷ *Electricity Explained: Electricity Generation, Capacity, and Sales In the United States*, U.S. ENERGY INFO. ADMIN. (July 16, 2024) (citing U.S. ENERGY INFO. ADMIN., *ELECTRIC POWER MONTHLY* (Feb. 2024)), <https://www.eia.gov/todayinenergy/detail.php?id=48896> (showing preliminary data on the percentage shares of utility-scale net electricity generation by major energy sources in 2023, of which renewables made up only 21.4%).

¹¹⁸ See Umar Shakir, *US Postal Service To Purchase 66,000 Electric Delivery Vehicles in Major Shift*, THE VERGE (Dec. 20, 2022), <https://www.theverge.com/2022/12/20/23518692/us-postal-service-ev-electric-delivery-trucks-biden-infrastructure-2026>.

¹¹⁹ Austin, *supra* note xx (“Now you have to heat, light and power those warehouses, and that amount of energy degrades the benefits from that [drone delivery].”).

death.¹²⁰ For these reasons, though drone delivery may have environmental benefits under certain circumstances, it also has probable costs that should be given due consideration. Such uncertainty calls for a careful regulatory approach.

III. Current Law and Proposed Reforms

Policy debates regarding drone delivery regulations have not yet sufficiently addressed these problems. While there is a general acceptance of the safety risks inherent in drone delivery, existing proposals tend not to adequately address the other risks outlined above in favor of advocating industry growth. This section describes both the current state of the law regarding drone delivery services and survey recent efforts at regulatory reform.

A. Current Law

Two separate federal regulations govern entry into the drone delivery business. One, 14 C.F.R. § 135 (“Part 135”), regulates all commercial delivery aircraft operation in the United States, which includes commercial aircraft with pilots on board.¹²¹ The FAA offers four different types of certificates under Part 135 based on the type of aircraft—single pilot, single pilot command, basic, and standard—of which the standard certificate is, according to analysts, the “most coveted as it places no restrictions on the size and scope of operations” for commercial air delivery.¹²² Part 135 is currently the only regulation that expressly permits aircraft operators to “carry the property of another for compensation beyond the visual line of sight [BVLOS].”¹²³ But Part 135 certification involves standards that are not applicable to drones—for example, a requirement that aircraft carry on-board manuals—making it an awkward fit for drone delivery.¹²⁴ This has meant that drone delivery companies seeking Part 135 certification

¹²⁰ See Tina Shaw, *Keeping Wildlife Safe From Drones*, U.S. FISH & WILDLIFE SERV., <https://www.fws.gov/story/keeping-wildlife-safe-drones#> (last visited Sept. 12, 2024) (on the threats drones pose to bald eagles); Michael Levenson, *Angry Birds Take on Drones at New York City Beach*, N. Y. TIMES (July 13, 2024), <https://www.nytimes.com/2024/07/13/nyregion/nyc-beaches-drones-angry-birds.html> (describing shorebirds attacking drones in defense of their nests).

¹²¹ *Package Delivery by Drone (Part 135)*, *supra* note xx (“Part 135 certification is the only path for small drones to carry the property of another for compensation beyond visual line of sight.”).

¹²² *Everything You Need to Know About Part 135 for Drone Delivery*, PILOT INST. (May 31, 2021), <https://pilotinstitute.com/part-135-drone-delivery/> [hereinafter PILOT INST.].

¹²³ *Unmanned Aircraft System (UAS) or Drone Operations*, FED. AVIATION ADMIN., https://www.faa.gov/hazmat/air_carriers/operations/drones (May 31, 2024).

¹²⁴ PILOT INST., *supra* note xx.

must obtain waivers for these extraneous requirements, rather than fully complying with the regulation as written. As of 2023, FAA records indicate that these waivers for BVLOS certification were obtained by five companies: Wing, UPS Flight Forward, Amazon, Zipline, and Flytrex.¹²⁵ In 2024, DroneUp announced that it too had received approval for BVLOS drone deliveries.¹²⁶

The other regulation—14 C.F.R. § 107 (“Part 107”)—is specifically geared towards drones, rather than piloted aircraft, but it constrains drone *delivery* by mandating that the drone remains within its operator’s visual line of sight (“VLOS”), and that it travels no further than three miles away.¹²⁷ But Part 107 also contains some important safety requirements. It establishes a licensing regime under which drone operators are required to obtain a remote pilot certification.¹²⁸ Drones certified under Part 107 are also required to fly below an altitude of 400 feet, preventing drones and some piloted aircraft from sharing airspace.¹²⁹

As under Part 135, drone companies seeking certification under Part 107 must also seek waivers to operate—in this case, to waive the VLOS requirement, which is the only way to navigate drones to customers’ homes and offices at scale. Obtaining these waivers is a lengthy and complex process, involving an initial application to the FAA, information about the responsible parties and pilots, safety documentation, and operational information including the geographic and temporal parameters of planned flights.¹³⁰ Once it has solicited this information, the FAA renders a decision on the waiver and whether to grant the operator a certificate—an approval so far granted to only 1 percent of the 1,200 submitted waiver applications.¹³¹ These waivers—which are, importantly, regulatory *exceptions*¹³²—are what have allowed drone delivery

¹²⁵ *Package Delivery by Drone (Part 135)*, *supra* note xx.

¹²⁶ *DroneUp Awarded Landmark FAA Approval for Beyond Visual Line of Sight (BVLOS) in the U.S.*, DRONEUP (Jan. 18, 2024), <https://www.droneup.com/news/droneup-awarded-bvlos>.

¹²⁷ 14 C.F.R. § 107.31, 107.51 (2016).

¹²⁸ *Id.*, Subpart C.

¹²⁹ *Id.*, § 107.51.

¹³⁰ *See Part 107 Waivers*, FED. AVIATION ADMIN., https://www.faa.gov/uas/commercial_operators/part_107_waivers (Aug. 27, 2024).

¹³¹ Allison Ferguson, *Opening the Skies to Beyond Visual Line of Sight Drone Operations*, PRECISION HAWK 3, <https://cdn2.hubspot.net/hubfs/2420841/Assets/PrecisionHawk%20Beyond%20Visual%20Line%20of%20Sight%20Drone%20Operations%202018.pdf> (last visited Sept. 12, 2024).

¹³² *Cf.* David J. Barron and Todd D. Rakoff, *In Defense of Big Waiver*, 113 COLUM. L. REV. 265 (2011) (discussing the use of waivers in the Obama administration).

companies to operate to date, albeit in narrowly limited capacities, subject to the FAA's significant discretionary authority over waiver recipients and their flight plans.

In addition to federal regulations, drone delivery companies must also comply with state, municipal, and tribal regulations. Some states, like Arizona and Florida, restrict drones from flying over or near critical facilities such as hospitals, prisons, power plants, and dams.¹³³ In some states, including Texas and Arizona, municipalities are generally preempted from enforcing their own regulations over drone delivery, with certain limited exceptions.¹³⁴ But in others, municipalities may place additional restrictions on drone flight, like in California, where the city of Malibu, for example, only allows unmanned aircraft to fly if the operator obtains a permit to use it in filmmaking.¹³⁵

B. Proposed Reforms

Recognizing the difficulty that drone delivery services have faced in scaling their business nationwide, policymakers in both Congress and the executive branch have proposed changes to the current regulatory structure. While aimed at promoting growth in the drone delivery industry, these proposals do not adequately address the problems posed by a significant expansion of drone delivery, including congestion and nuisance, abuses of economic power, surveillance, and costs for workers and the environment. If implemented without addressing those concerns, such proposals are likely to lead to undesirable outcomes for both the health of the drone delivery market and the public.

1. Executive Branch Analyses and Actions. In 2017, the Trump Administration issued a memorandum to establish the Unmanned Aircraft Systems (“UAS”) Integration Pilot Program (“IPP”).¹³⁶ This program, housed at the FAA, partnered with states, cities, and tribes to study how to safely integrate UAS into the system of federal airspace regulations, including tests conducted on package delivery and BVLOS drone flights. Its final report, issued in 2021, said that the program “highlighted the need for a transition

¹³³ ARIZ. REV. STAT. ANN. § 13-3729 (2016); FLA. STAT. § 330.41 (2023).

¹³⁴ TEX. GOV'T CODE ANN. § 423.009 (West 2023); ARIZ. REV. STAT. ANN. § 13-3729(c) (2016).

¹³⁵ City of Malibu, *Permission to Use Private Property for Filming, Parking, or State Photography*, <https://malibucity.org/DocumentCenter/View/407/Film-Application-and-Permit?bidId=> (last visited July 1, 2024).

¹³⁶ Unmanned Aircraft Systems Integration Pilot Program-Announcement of Establishment of Program and Request for Applications, 82 Fed. Reg. 51,903 (Nov. 8, 2017).

away from waivers and exemptions to more permanent solutions like certifications and revised regulations.”¹³⁷ Following this program, the FAA established a new program called BEYOND to work towards streamlining BVLOS approval for drones. That program is expected to complete its operations as early as October 2024.¹³⁸

While the recommendations made in the program’s report generally lacked specificity—that the FAA should “consider the type of standards and regulations to broadly enable safe, secure, and routine BVLOS operations and the effects on future regulatory strategy” is a representative example¹³⁹—they focused on the need for UAS operations to scale, while neglecting the likely drawbacks. For example, while several of its findings and recommendations note that existing regulations hinder UAS scalability, not even one discusses market structure—even though drone delivery’s industrial organization would be a critical factor for regulators to consider if it were to rapidly scale.¹⁴⁰ With a nearly singular focus on allowing the commercial drone industry to grow—and a stated priority of “[quantifying] the societal and economic benefits of UAS operations,” without a similar quantification or public consideration of risks not having to do with aircraft safety—it is not clear that the IPP prompted the FAA to consider potential harms associated with a rapid expansion of the drone delivery industry.¹⁴¹

In 2021, the FAA under the Biden Administration chartered the UAS BVLOS Aviation Rulemaking Committee, which subsequently completed its work in March 2022.¹⁴² Over nearly 400 pages, its final report makes a case for significant regulatory overhaul, characterizing commercial drone flight as an industry that “seeks to provide significant economic, environmental, and equity benefits to the public, but finds itself held back due to bureaucratic hurdles.”¹⁴³ The report rightly advocates for crafting regulations tailored to BVLOS drones rather than fitting them into pre-existing regulations for

¹³⁷ FAA UNMANNED AIRCRAFT SYSTEMS INTEGRATION PILOT PROGRAM FINAL REPORT, FED. AVIATION ADMIN. 22 (Mar. 10, 2022),

https://www.faa.gov/sites/faa.gov/files/uas/programs_partnerships/completed/integration_pilot_program/IPP_Final_Report_20210712.pdf [hereinafter UAS IPP REPORT].

¹³⁸ BEYOND, FED. AVIATION ADMIN., https://www.faa.gov/uas/programs_partnerships/beyond (Mar. 22, 2024) (“The BEYOND program launched October 26, 2020, as a four-year initiative.”).

¹³⁹ UAS IPP REPORT, *supra* note xx, at 29.

¹⁴⁰ *Id.* at 27-30.

¹⁴¹ *Id.* at 31.

¹⁴² UAS BVLOS ARC CHARTER, FED. AVIATION ADMIN. (2021),

[https://www.faa.gov/regulations_policies/rulemaking/committees/documents/media/UAS%20BVLOS%20ARC%20Charter%20\(eff.%206-8-2021\).pdf](https://www.faa.gov/regulations_policies/rulemaking/committees/documents/media/UAS%20BVLOS%20ARC%20Charter%20(eff.%206-8-2021).pdf).

¹⁴³ UAS BVLOS ARC REPORT, *supra* note xx, at 12.

commercial air travel, proposing a new “Part 108”.¹⁴⁴ But like the IPP’s final report, with its focus on fostering industry growth, it focuses on a myriad of social benefits purportedly associated with drone delivery, while neglecting to balance its analysis with an equal consideration of its potentially harmful consequences—that is, other than safety considerations focused on determining an “acceptable level of risk.”¹⁴⁵ Indeed, the two “guiding principles” that it describes as informing the entire scope of its work are “safety” and “societal benefits.”¹⁴⁶ What could have been an opportunity for substantive inquiry into the risks of airspace congestion, a realistic study of public opinion not simply seeking to promote the integration of UAS, an analysis of the drone industry’s market structure, and an evenhanded assessment of the risks and benefits for labor and the environment was instead given to a comparatively simple balancing act between “acceptable risk” and the many societal benefits scaled drone flight might offer. With the arguments accumulated in this report, the FAA may be poised to significantly amend UAS regulations without a comprehensive structural approach to an otherwise relatively unrestricted drone delivery market.

2. Legislative Proposals and Actions. Several legislative efforts in recent years have aimed to direct the FAA to reform the regulations governing drone delivery, and thereby rapidly increase the number of drones eligible for regulatory approval.¹⁴⁷ In 2023, Senators Mark Warner and John Thune and Representatives Rudy Yakym and Rob Menendez introduced one such bill, the Increasing Competitiveness for American Drones Act.¹⁴⁸ It would direct the FAA to establish a “risk methodology,” which would grant different levels of regulatory scrutiny to different drone operators based on aircraft weight.¹⁴⁹ But by simply creating different tiers based on safety risks—these risks themselves evaluated solely on the narrow metric of aircraft weight—the

¹⁴⁴ *Id.* at 161-187.

¹⁴⁵ *Id.* at 9. *See also id.* at 11 (“It has become evident that the current aviation regulatory framework is not capable of accommodating UA operations at the existing levels, and certainly not at the levels anticipated as the industry grows. Consequently, regulatory changes are necessary to support industry growth.”).

¹⁴⁶ *Id.* at 16-20.

¹⁴⁷ It should be noted that there has been a raft of additional legislative proposals to promote the adoption of drone technology in specific use cases, including in law enforcement and emergency medical services. While these fall outside the scope of this paper, which focuses on the regulation of drone delivery, they demonstrate legislative enthusiasm for the broader adoption of drone technology. *See, e.g.,* Drones for First Responders Act, H.R. 8416, 118th Cong. (2nd Sess. 2024); DETECT Act, S. 3758, 118th Cong. (2nd Sess. 2024); Drone Research and Innovation for Law Enforcement Act, H.R. 5879, 118th Cong. (1st Sess. 2023).

¹⁴⁸ S. 307, *supra* note xx; H.R. 3459, 118th Cong. (1st Sess. 2023).

¹⁴⁹ Warner Press Release, *supra* note xx.

legislation neglects other likely risks posed by the rapid scaling of drone delivery, including those posed by its market structure. Other bills include the UAS National Airspace Integration Act, sponsored by Senator Gary Peters, which would require the FAA to submit to Congress a “comprehensive integration strategy” for integrating drones into national airspace, along with periodic updates on its implementation.¹⁵⁰ Yet another was a bill introduced by Representatives Garret Graves and Nina Titus, “To provide for a rulemaking on operation of unmanned aircraft beyond visual line of sight, and for other purposes.”¹⁵¹ Much like the Warner-Thune bill, it sought to grant the FAA the authority to craft new regulations regarding drones, including airworthiness and safety standards.¹⁵² Parts of it were also incorporated into the FAA Reauthorization Act as passed by the House of Representatives in 2023.¹⁵³

The central provision of several legislative efforts—a requirement that the FAA adopt a risk-based methodology to allow a higher volume of BVLOS operations—was incorporated into the FAA Reauthorization Act of 2024.¹⁵⁴ The law requires that the FAA propose a rule on BVLOS operations no later than four months following the Act’s enactment.¹⁵⁵ It mandates that the regulations establish “acceptable levels of risk” based on weight and flight speed, and requires the FAA to develop a risk-based methodology to determine these acceptable levels.¹⁵⁶ It also includes provisions that: require the FAA to establish guidelines related to the transportation of hazardous materials;¹⁵⁷ require the development of procedures to approve “third-party service suppliers,” defined as entities other than the FAA who provide services that may affect UAS operations, including data and infrastructure providers (including private UAS air traffic control);¹⁵⁸ authorize temporary restrictions on drones flying above large public gatherings;¹⁵⁹ prohibit DOT’s procurement or use of drones from foreign entities;¹⁶⁰

¹⁵⁰ S. 1927, 118th Cong. (1st Sess. 2023).

¹⁵¹ H.R. 3969, 118th Cong. (1st Sess. 2023).

¹⁵² *Id.*

¹⁵³ See Press Release, Representative Nina Titus, House Passes Bipartisan FAA Reauthorization, with Numerous Provisions Championed by Rep. Titus (July 20, 2023), <https://titus.house.gov/news/documentsingle.aspx?DocumentID=3473>.

¹⁵⁴ FAA Reauthorization Act of 2024, H. R. 3935, 117th Cong. (2nd Sess. 2024).

¹⁵⁵ *Id.*, § 930.

¹⁵⁶ *Id.*, § 930, 931.

¹⁵⁷ *Id.*, § 933.

¹⁵⁸ *Id.*, § 932.

¹⁵⁹ *Id.*, § 935. Eligible public gatherings include those held in large stadiums or similar venues, or outdoor events that otherwise have over 100,000 estimated attendees. Requests must be placed with the FAA no fewer than 30 days in advance of the gathering and must be requested by local law enforcement. *Id.*

¹⁶⁰ *Id.*, § 936. Exceptions are made for certain types of research activities. *Id.*

encourage the FAA to work with international organizations to establish rules governing drone operations over the high seas;¹⁶¹ and establish a test range for drone operations over the Gulf of Mexico.¹⁶² It does not include any specific provisions related to market structure or preventing congestion and nuisance, abuses of economic power, harms to innovation, widespread surveillance, disruptive effects on labor, or environmental harms. However, by specifying that it only enumerates *minimum* requirements for the new BVLOS approval rules, it may authorize the FAA to enact other regulations—including the ones proposed in Part IV—that it may determine necessary to protect American neighborhoods and the health of the drone delivery industry.¹⁶³ Indeed, additional regulatory measures *will* be necessary to meet these ends.

The steady progression of proposals in recent years to loosen restrictions on drone delivery evidences a desire by the drone delivery industry and its allies to allow the industry to grow. But while they routinely celebrate drone delivery's potential benefits as justifications, they too often neglect the likely risks—not only those of accidents, such as is implied by the search for “acceptable level of risk,” but also those that are likely to arise because of unrestricted entry. These include risks involving the areas like consumer experience and environmental effects where drone delivery is said to have its greatest benefit. There has therefore been a significant gap in the proposals offered to regulate drone delivery in the public interest.

IV. How to Regulate Drone Delivery

The drone delivery sector has at least three features that render a more comprehensive approach to regulation essential. First, there is a significant public interest in restricting entry. Just as it is important to ensure that the broadcasting spectrum is not overcrowded with signals, neighborhoods are not crowded with power lines, or busy airspace is not congested with an unlimited number of airplanes, it is important to ensure that the number of drones in the sky does not exceed an amount determined to be both safe and desirable for the communities they serve. There is a strong public interest in ensuring that drones do not crash into each other, create nuisances with noise pollution and surveillance, or otherwise threaten public safety. As a result, there must be some upper limit on how much drone delivery there can be within a given geographical area and at what times. The task for policymakers is to

¹⁶¹ *Id.*, § 934.

¹⁶² *Id.*, § 937.

¹⁶³ *Id.*, § 930(b) (“The proposed rule . . . shall, *at a minimum*, establish the following[.]” [emphasis added]).

determine how to design and enforce such limits, and how to allocate service among prospective providers.

Second, there is a strong likelihood that drone delivery services, if permitted to scale, will continue to function as networks with the traditional features of networked industries.¹⁶⁴ These network effects may incentivize drone delivery companies to deploy large fleets of drones to serve the maximum number of both retailers and customers and would thereby incentivize drone delivery firms to trend towards consolidation and conglomeration.¹⁶⁵

Third, and importantly, drone delivery services are infrastructural services. Drone delivery is not a means unto itself, but rather a means to other commerce: transporting goods from businesses to end consumers.¹⁶⁶ This puts dependent businesses in a precarious position: Their profits and access to the service can be expropriated, restricted, or eliminated by service providers. The danger to the marketplace of a drone operator foreclosing reasonable access is considerable—especially in combination with high barriers to entry and the strong public interest in preventing unlimited entry, which make competition alone unlikely to regulate firms effectively. Together, these three factors—drone delivery’s infrastructural nature, its network effects, and the public interest in restricting entry—necessitate structural regulatory solutions to prevent some of drone delivery’s likely harms. And, importantly, it critical to get out ahead of the likely problems associated with drone delivery, thereby avoiding the “Collingridge dilemma”—that once new technologies have become entrenched in society, they will be more difficult to regulate than it would have been in advance of their entrenchment.¹⁶⁷

This Part offer four ideas for how to regulate drone delivery in the public interest. First, it outlines a comprehensive licensing system for drone delivery services. This system would require drone operators obtain certification both from the FAA to operate in general—subject to structural rules that apply to all operators—and from local governments to operate within particular areas. Local governments would submit plans to the FAA to license operators under either a *contracting model*, with competition on price schedules in exchange for a contract to serve the area, or a *utility model*, with cost-of-service rate regulation to prevent monopoly pricing and terms. It

¹⁶⁴ See *supra* Part I.2.

¹⁶⁵ *Id.*

¹⁶⁶ *Id.*

¹⁶⁷ See DAVID COLLINGRIDGE, *THE SOCIAL CONTROL OF TECHNOLOGY* (1980).

discusses potential challenges with these models and how their policy design and implementation might address them. Second, it recommends that the U.S. Postal Service consider operating a public drone delivery network. It discusses the reasons why USPS is well-positioned to operate a public drone delivery network alongside its existing package delivery service and note some considerations for implementing the service. Third, it proposes that the President or the Secretary of Transportation commission an expert report on drone delivery's intermodal effects across our system of last mile-delivery and how to avoid disruptive consequences. Finally, it suggests that policymakers consider developing an industrial strategy to promote domestic drone production, to protect national security and promote competition and innovation in this new technology.

A. Comprehensive Licensing System with Structural Regulations

Licensing is one of the most important policy tools commonly used in infrastructural industries, including those involved in transportation and shipping. The FAA already grants a type of license to drone operators through waivers to Part 107 and Part 135.¹⁶⁸ But, as the agency's UAS IPP report itself contends, the regulatory framework governing drones should "transition away from waivers and exemptions to more permanent solutions like certifications and revised regulations."¹⁶⁹ Either through legislation or administrative rulemaking, Part 107 should be revised to create a framework for licensing and regulating BVLOS drone delivery, or a new, separate regulation should be created.¹⁷⁰ The provisions of the FAA Reauthorization Act of 2024 indeed provide for a new regulatory regime.

A licensing system for drone delivery will not be workable, however, unless it functions as a genuine *entry restriction*. In general, there are two types of licenses. One type function the way drivers' licenses do: Anyone who meets certain minimum

¹⁶⁸ See *supra* Part III.1.

¹⁶⁹ UAS IPP REPORT, *supra* note xx, at 22.

¹⁷⁰ Ideally, drone delivery should be regulated under a reformed Part 107, or a new regulation altogether, rather than Part 135. Part 135 is not a good fit for drone delivery. As detailed earlier in this paper, it contains many requirements geared towards commercial piloted aircraft that, while important for those aircraft, are not applicable to drones. A reformed Part 107 could allow drones to carry the property of another for compensation beyond the visual line of sight, as Part 135 does for other commercial aircraft, while ensuring that the regulations with which companies are required to comply are based on how drone networks operate as distinct from piloted aircraft. See *supra* Part III.1.

requirements gets a license to do something—in this case, operate a motor vehicle. There are an unlimited number of such licenses to be granted, and an unlimited number of applicants who might receive them. But other licensing regimes, such as those found in public utility or infrastructure industries, *do not* simply allow anyone who meets certain requirements to do something. Instead, the public grants a designated party a license or a certification to perform a particular service, subject to strict conditions to provide the service at fair terms and ensure broad access. Not all of those who meet the minimum requirements will be granted certification: There are a limited number of certifications to be granted—sometimes no more than one. This type of licensing system functions as an *entry restriction*—and it is the type of licensing system that FAA ought to consider for drone delivery operators.¹⁷¹

Why entry restriction? Put simply, without it, the problems this paper describes in Part II—congestion and nuisance, abuses of economic power and harms to innovation, surveillance and data commodification, and threats to labor and the environment—will all be exacerbated or more difficult to deal with. Without any upper limit on the number of drones allowed to operate in a particular locality, large fleets of drones are likely to be noisy and unsafe, and without the regulatory oversight that comes with entry restriction, they may be permitted to entrench the power of large corporations over local and national commerce. In addition, by incorporating restrictions on surveillance as well as labor, safety, and environmental standards directly into the licensing system, policymakers can increase the likelihood that violations are not only effectively policed but are prevented from happening in the first place.

In addition to the requirements enumerated within the FAA Reauthorization Act of 2024, a revised licensing system should include a set of minimum requirements that all drone operators *must* meet to receive FAA certification, along with other regulations that localities might deem necessary. Though not sufficient for an operator to earn a license, these requirements would form a baseline set of rules that drone delivery services must follow, to which local governments may add additional rules based on the needs of their communities. In effect, this would mean that to operate, drone delivery companies would need both FAA certification to operate in general *and* a license from the local government to operate in a particular area. The minimum federal requirements should include the following:

¹⁷¹ For more on the theory of entry restrictions in regulation, see Ricks *et al.*, *supra* note xx, at 29-30.

- **Uniform safety, design, and training requirements.** The FAA already has some safety requirements for drone operators, both in its current waiver-based system and in each of its proposals for reform. In fact, as this paper argues in Part III, existing proposals to govern drone delivery consist primarily of safety and “risk-based” regulations, while neglecting other important concerns.¹⁷² Nonetheless, ensuring drone delivery services abide by a common set of safety rules is essential. As drone technology develops, it will be critical to monitor and update design and safety specifications on an ongoing basis. As part of this process, the FAA should require that all companies seeking licenses disclose to regulators their flight manuals, design plans, and other information regulators need to stay informed about UAV capabilities, whether such documents originate with the delivery network operator or with the subcontracted drone manufacturer.¹⁷³ In addition, to establish a minimum baseline for operator competence, all personnel involved in piloting drones should complete a certified training program, just as airline pilots, vehicle drivers, and other transportation personnel are required to do.¹⁷⁴
- **Minimum flying altitudes, noise minimization, and airspace routing.** To protect against trespassing on private property and dangerous collisions, drones should be required to fly above a height determined by transportation analysts and community leaders not to disturb people on the ground below and to avoid other classes of aircraft. Policymakers should also consider rules to limit the noise that drone propellers emit. Legal scholars have also introduced several intriguing and creative solutions to provide unobstructive airspace for drones, including by restricting their travel to the space above highways and above repurposed railroad tracks, though it is unclear just how feasible these solutions are for last-mile delivery in various locations.¹⁷⁵

¹⁷² See *supra* Part III.2.

¹⁷³ The FAA already does this to some extent in its waiver-based system. It should retain it as a consistent requirement in a new license-based system and expand it as necessary to gain a full understanding of the relevant technology. See, e.g., FED. AVIATION ADMIN., WAIVER LETTER FOR UPS FLIGHT FORWARD 66 (Sept. 6, 2023), <https://www.faa.gov/media/70421>.

¹⁷⁴ The FAA also already does this to some extent. It should retain it as a consistent requirement in a new license-based system. See, e.g. *id.* at 77.

¹⁷⁵ See, e.g., Daniel Thompson, *Rethinking the Highway: Integrating Drone Delivery Services into Airspace Above Highways*, 95 IND. L.J. SUPP. 8 (2020); Danaya Wright and Ethan Moore, *DARC Matters: Repurposing Nineteenth-Century Property Law for the Twenty-First Century*, 107 IOWA L. REV. 2247 (2022).

- **Neutrality mandates and/or structural separations.** The DOT and FAA should condition drone delivery licenses on a neutrality mandate. A neutrality mandate would prohibit drone delivery services from favoring particular retailers, customers, or other third parties with preferential prices or terms—including, importantly, companies that may be competitors of the drone delivery company in other markets.¹⁷⁶ Such a mandate would fulfill the Secretary of Transportation’s duty to ensure that policies governing the transportation sector “[prevent] unfair, deceptive, predatory, or anticompetitive practices” and “[avoid] unreasonable industry concentration, excessive market domination, monopoly powers, and other conditions that would tend to allow at least one air carrier or foreign air carrier unreasonably to increase prices, reduce services, or exclude competition in air transportation.”¹⁷⁷ Enacting a neutrality mandate or nondiscrimination rule would also be highly popular, as VPA polling from June 2024 indicates, finding that 78% of Americans believe drone delivery networks should not discriminate on prices and 73% support a federal ban on price discrimination in drone delivery.¹⁷⁸

It is important to distinguish the neutrality mandate proposed here from the universal service requirements common carriers are subject to in other industries, because drone delivery may not be suitable for every geography or wanted by every locality.¹⁷⁹ However, mandates for nondiscriminatory service within the geographical locations where a drone delivery provider is licensed may be implemented. Upon periodic review, regulators should consider whether universal service mandates would be feasible within specified geographic areas.

Should policymakers wish to be bolder, they could also consider conditioning drone delivery licenses on structural separations between drone delivery networks and retailers. Structural separations are a tool often used to regulate industries that operate like utilities or infrastructure.¹⁸⁰ They address the same problem that neutrality mandates do—that is, the discriminatory or preferential

¹⁷⁶ For an overview of the abuses of economic power and harms to innovation that are likely to arise in unrestricted drone delivery, *see supra* Part II.2.

¹⁷⁷ 49 U.S.C. § 40101(a)(9-10).

¹⁷⁸ *Americans Are Worried About Unregulated Drone Delivery Services*, VAND. POL’Y ACCELERATOR (forthcoming 2024).

¹⁷⁹ For an overview of equal access rules and universal service requirements across network, platform, and utility (NPU) industries, *see RICKS et al., supra* note xx, at 26.

¹⁸⁰ *See generally* RICKS et al., *supra* note xx, at 28-29; Khan, *Separation, supra* note xx.

treatment of suppliers and downstream businesses—but they are a *structural* solution, meaning that violations are not just prohibited, but prevented from happening in the first place.¹⁸¹ They are also the classic tool in the American regulatory tradition to deal with the problem of the concentrated economic power held by infrastructural industries.¹⁸² Functionally, they prohibit integration between distinct lines of business, so as to mitigate conflicts of interest that could lead to discriminatory business practices or other harmful outcomes.¹⁸³ In the case of drone delivery, vertical integration between drone operators and retailers—whether online platforms like Amazon and Google or physical businesses like Walmart locations—may incentivize such businesses to use their market power to stifle competition, either by acquiring competitors or giving their own services unfair advantages through preferential pricing or terms.¹⁸⁴ It may also allow retailers to use consumer data collected by drone companies to bolster their power, and vice versa. Prohibiting such vertical integration as a condition of receiving a license might allow for smaller retailers to compete more effectively and keep drone delivery from being used as a tool to reinforce the market power of dominant corporations.

- **Crash and malfunction reporting.** All collisions, near collisions, flight disruptions, technology malfunctions, or other accidents should be immediately, and ideally, automatically, reported to the FAA. In accident reporting, regulators at FAA have a chance to do even better than those overseeing autonomous vehicles at the National Highway Traffic Safety Administration (NHTSA). As of 2023, NHTSA requires commercially-available vehicles with advanced driver-assistance programs (ADAS) to report crashes within 30 seconds of their occurring—but they do not include off-market, fully autonomous vehicles in these requirements, allowing developers to game a patchwork of different state

¹⁸¹ See, e.g., Khan, *Separation*, *supra* note xx, at 1036 (“Separations differ from rate regulation and several other regulatory tools in that separations are *ex ante* rules whose application does not require continuous government intervention or constant monitoring.”).

¹⁸² See, e.g., RICKS *et al.*, *supra* note xx, at 13-17 (on the monopoly and oligopoly abuses often found in infrastructural industries), 28-29 (on the use of structural separations to curb them). For an accessible overview of the American regulatory tradition of networks, platforms, and utilities, see GANESH SITARAMAN, *WHY FLYING IS MISERABLE AND HOW TO FIX IT* 28-36 (2023).

¹⁸³ RICKS *et al.*, *supra* note xx, at 28-29.

¹⁸⁴ Amazon is already the subject of a lawsuit from the Federal Trade Commission which alleges that it has used its platform power—including in delivery—to stifle downstream competition in commerce and distort markets to its advantage. The FTC seeks structural relief as a remedy in that case. See *Fed. Trade Comm’n v. Amazon.com, Inc.*, No. 2:23-cv-01495 (W.D. Wash. filed Sept. 26, 2023). See also *supra* Part II.2.

regulations with different reporting requirements.¹⁸⁵ One scholar has proposed that the NHTSA ought to expand universal crash reporting to fully autonomous vehicles; the FAA should do the same for delivery drones.¹⁸⁶ In addition to reporting requirements, collision sites should remain unaltered, to the degree possible, to enable investigations to commence promptly. At least one drone delivery company, Amazon, has been reported to clear accident sites prematurely and thereby preempt investigation by public authorities.¹⁸⁷

- **Data minimization and prohibition on data monetization.** Drones are necessarily equipped with cameras to assist in navigation, but licenses should be conditional on operators deleting all live footage, photographs, or other recorded data involving private persons or property within a reasonable time following the conclusion of a delivery. These sorts of data should only be retained by the company in the case of an accident to assist investigators or to address consumer complaints related to theft or damage. In addition to a requirement to continuously delete these sorts of data, drone operators should also be prohibited from selling, licensing, distributing, or otherwise monetizing data and images collected during drone deliveries.

In addition to those enumerated in the FAA Reauthorization Act of 2024, these rules could serve as a minimum baseline for drone delivery services receiving FAA licenses to operate nationally. But what of operating locally? How does the FAA balance its mandate for federal regulation with the equally compelling need for local input and oversight? After all, drones are aircraft that are designed to be flown locally, even when engaged in interstate commerce, and not across the country as passenger or commercial airplanes are. Different communities, whether rural, suburban, or urban, may therefore have vastly differing needs, preferences, and tolerance levels for drone delivery. This is a fact that must be accounted for within the FAA's regulatory framework. As one legal scholar has noted:

¹⁸⁵ *Standing General Order on Crash Reporting*, U.S. DEP'T OF TRANSP. NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., <https://www.nhtsa.gov/laws-regulations/standing-general-order-crash-reporting> (last visited Sept. 9, 2024); Matthew T. Wansley, *Regulating Driving Automation Safety*, 73 EMORY L.J. 505, 559-563 (2024).

¹⁸⁶ Wansley, *supra* note xx, at 580-582.

¹⁸⁷ Katherine Long, *When Amazon Drones Crashed, the Company Told the FAA to Go Fly a Kite*, BUS. INSIDER (May 27, 2022), <https://www.businessinsider.com/amazon-prime-air-faa-regulators-investigation-drone-crashes-2022-5>.

[The] historical model of regulating aircraft and operators at the federal level simply will not work, in the long run, to adequately address safety, privacy and security issues appropriate for each locality—urban or rural, sprawling or densely populated—with highly variable political and cultural systems. ... Unless the FAA recognizes that local governments can and should play a significant role in shaping drone rules to address the specific safety, security and privacy needs of their communities and they are included in the enforcement scheme, the affected local interests will simply react by banning local usage.¹⁸⁸

Not only is including the specific needs of local communities in the enforcement scheme essential as a point of policy design: It is also something that most Americans would demand. According to a poll commissioned by VPA in June 2024, 77 percent of Americans oppose the preemption of state and local laws governing drone delivery and believe that local governments should be allowed to add their own more restrictive rules governing the service.¹⁸⁹ Doing so may also resolve ambiguities in the case law surrounding the federal preemption of certain local regulations governing drone delivery, because mechanisms of local governance are incorporated into the federal regulations themselves and thus would not qualify for either conflict or field preemption by courts.¹⁹⁰ By incorporating both local governance and federal oversight, these models would be systems of cooperative federalism, wherein local governments have a leading role in crafting policy that affects their communities in cooperation with the federal government.

Though state and local governments may promulgate additional regulations governing drone delivery, the task in which local governments will have to play the crucial role in is in the allocation of service between providers. Even if several drone delivery services might meet the above minimum requirements, localities will still have to determine how best to allocate service among them. But this task raises several problems: Without entry restriction, multiple competing drone delivery services would likely exacerbate congestion and nuisance issues; but *with* entry restriction would come the

¹⁸⁸ Slack, *supra* note xx, at 8.

¹⁸⁹ VPA Polling Report, *supra* note xx.

¹⁹⁰ *Compare* National Press Photographers Association v. McCraw, 504 F.Supp.3d 568 (W.D. Tex. 2020) (holding that the Federal Aviation Act did not preempt state statutes regulating operation of UAVs over certain structures) *with* Singer v. City of Newton, 284 F.Supp.3d 125 (D. Mass. 2017) (holding that a local ordinance's provisions prohibiting pilotless aircraft flight beyond the visual line of sight of the operator were subject to conflict preemption).

risks of monopoly and oligopoly power, including high prices, reduced quality, and unfair treatment of business rivals and customers. Thus, what is needed is a system of service allocation to balance at least three competing demands: (1) discipline on price and quality, (2) limitations on congestion and nuisance, and (3) adaptability to the differing needs and institutional capacities of local governments.

To do so, the FAA should offer local governments two options for how to award licenses to drone delivery companies at the local level, subject to FAA approval: (1) a *contracting* model, in which firms compete on pricing schedules in exchange for an exclusive, fixed-term contract to provide the service subject to strict terms; or (2) a true *public utility* model, within which market participation is limited to a single private firm coupled with cost-of-service rate regulation. Localities that want drone delivery service should submit a detailed plan under one of these models to the FAA for approval. Once approved, local governments would grant exclusive licenses to providers under the terms of their proposal. Importantly, no drone delivery service would be able to operate without receiving both federal licenses and a local license in its area of operation: Local governments would thus have to affirmatively opt in to drone delivery service, putting them in at the forefront of decisions about their system of last-mile delivery.

1. Contracting model. Under a contracting model, a governmental entity possesses exclusive authority over the provision of a service and contracts with a firm to operate that service through a competitive bidding process.¹⁹¹ What results is not simply a *regulatory* relationship, but an *outsourcing* or *procurement* relationship, wherein the government outsources the provision of a service to a private entity via contract, contingent on strict terms to serve in the public interest. Similar dynamics and regulatory regimes occur commonly in infrastructural sectors, including in money and banking,¹⁹² electricity and other energy utilities,¹⁹³ and sanitation.¹⁹⁴ Given the

¹⁹¹ See George L. Priest, *The Origins of Utility Regulation and the "Theories of Regulation" Debate*, 36 J. L. ECON. 289, 304 (1993). For the classic theoretical exposition of the contracting model, traditionally also known as a "franchise bidding" model, see Harold Demsetz, *Why Regulate Utilities?*, 11 J. L. ECON. 55 (1968).

¹⁹² See Morgan Ricks and Lev Menand, *Rebuilding Banking Law: Banks as Public Utilities*, YALE J. REG. (forthcoming 2024); Morgan Ricks, *Money as Infrastructure*, 2018 COLUM. BUS. L. REV. 757, 801 (2018) ("Commercial banks' monetary function is . . . understood as an outsourcing or franchise arrangement.").

¹⁹³ Shelley Welton, *Public Energy*, 92 N.Y.U. L. REV. 267 (2017).

¹⁹⁴ Sheila R. Foster, *Collective Action and the Urban Commons*, 87 NOTRE DAME L. REV. 57, 114-115 (2011) (naming sanitation as among the services over which a local government has "sovereignty" and whose provision it "outsources"); see also RICKS *et al.*, *supra* note xx, at 32.

infrastructural nature of drone delivery, a contracting model through competitive bidding would carry significant benefits for both the industry and the public interest: restricting entry into the drone delivery market (thereby avoiding the problems of congestion and nuisance), maintaining a degree of competition through the procurement process, and allowing different terms and conditions of service that fit best with the preferences of people in different localities. This balance may make the contracting model an ideal regulatory framework for drone delivery at a time when its technology and business model is rapidly developing.

Under this approach, local governments would submit plans to the FAA for approval. After FAA review to ensure the plans meet licensing requirements, the local government would be able to solicit bids from drone delivery companies for an exclusive contract to provide the service in the area under the local government's jurisdiction, for a limited term of predetermined duration. While the companies would be required to submit detailed plans about their business models, costs, and technology, they would compete primarily on pricing schedules—how much they would charge for different tiers of service based on factors including package weight, product value, and distance from origin to destination. Once approved, the winning company's pricing schedule would be fixed for the entire term of their contract. Theoretically, with multiple companies competing for bids, pricing schedules would be bid down to marginal cost, thereby preventing the charging of monopoly or supracompetitive prices. But it is critical that policymakers do not automatically assume the existence of a competitive marketplace for these contracts. To maximize the actual likelihood of competitive marginal-cost pricing, it would be the responsibility of both local governments and the FAA to promote a competitive ecosystem in drone delivery overall. They can do so through provisions in procurement contracts like nondiscrimination rules that would prohibit powerful firms from distorting competition in the drone delivery market, and thereby in the market for public drone delivery contracts.¹⁹⁵

There are several problems inherent in the contracting model that its policy design should address. For example, what mechanism would discipline firms into maintaining their service quality and pricing schedules over time, if not competition or ongoing

¹⁹⁵ For an example of how to apply such rules through the procurement process in another sector, see Ramsay Eyre, *Promoting Competition in Federal AI Procurement*, VAND. POL'Y ACCELERATOR (2024).

utility-style rate regulation?¹⁹⁶ To address this issue, franchise contracts would not be indefinite or permanent: contracts would time out after a period of specified duration, and another bidding process would commence, ensuring regular intervals of competition on price and service quality.

A second potential problem with contracting is that incumbents have an advantage during the contract renewal process.¹⁹⁷ Having served an area for five years, or however long a contract term might last, a drone delivery company would likely possess a great deal of competitively sensitive information about how best to serve that area—both formally logged data and informal operating experience. Such information might provide a critical advantage in the bidding process, or it might make it more difficult for a competitor who wins the new bid on price to provide service of a similar quality. To remedy this issue, the data collected and used by drone delivery companies within the areas they serve—including operating plans, knowledge management practices, manuals, and handbooks—should be considered public property, in accordance with the strict privacy protections outlined earlier in this Part. They would not be shared with competitors during the performance of a contract, but they would be provided to subsequent providers who win bids, to ensure interoperability and thereby reduce switching costs. Winning a bid to be the exclusive private provider of drone delivery services within a particular locality is a powerful privilege. Making critical information available to the public would be a concomitant obligation—and it would enable local governments to ensure that another company could just as well take over should it be able to provide the service better, or at lower cost.

A third potential problem involves the risks inherent in outsourcing critical public functions to private actors. This author has written elsewhere on the risks of outsourcing public capacity in new technologies—risks which may also be present in outsourcing drone delivery.¹⁹⁸ These risks include higher costs, lower quality, depleted

¹⁹⁶ Of course, deviations from the winning pricing schedule would be contractual violations. Remedying such violations, however, would involve resolution or judicial intervention after the fact, rather than the prevention of the violation before it occurs.

¹⁹⁷ See Oliver Williamson, *Franchise Bidding for Natural Monopolies—In General and With Respect to CATV*, 7 BELL J. ECON. 73, 80 (1976) (“[B]idding parity between the incumbent and prospective rivals at the contract renewal interval is unlikely to be realized.”).

¹⁹⁸ See generally Ganesh Sitaraman and Ramsay Eyre, *Building Public Capacity on Artificial Intelligence*, VAND. POL’Y ACCELERATOR (Oct. 10, 2023), <https://cdn.vanderbilt.edu/vu-URL/wp-content/uploads/sites/412/2023/10/09151836/VPA-AI-Capacity.10.9.23.pdf>.

institutional expertise, and a lack of accountability relative to public actors.¹⁹⁹ It is also possible that firms competing for bids may attempt to unduly influence local governments, making corruption a relevant concern. It is partly for these reasons this paper recommends the exploration of a public drone delivery network operated by the U.S. Postal Service.²⁰⁰ But with a fixed pricing schedule, publicly owned operating information, consistent oversight, periodic contract bids, and various anti-corruption measures, it is possible that the likelihood and severity of these risks may be at least mitigated for private providers under a contract bidding model. Indeed, these are challenges that governments at every level face in procurement decisions. A whole literature spanning law, economics, and political science discusses the theoretical and practical problems inherent in government procurement, the lessons of which might well apply to a contract model of drone delivery regulation.²⁰¹ While outsourcing may always lead to a principal-agent problem wherein the contractor's interests differ from the government's or where the agent's actions are not in the public interest, the government still outsources the building of battleships, the collection of trash, and the augmentation of the money supply, among many other products and services.²⁰² Seen through this frame, drone delivery may benefit from regulation through competitive contract bidding, especially when compared to the challenges posed by unrestricted market entry.

A contract bid may be a good model for regulating private drone delivery operations while the industry undergoes its initial stage of development and proves its concept in American communities. But as the industry and the underlying technology changes, so too may the ideal regulatory regime. The FAA should periodically consider whether franchise bidding remains an effective model for governing drone delivery at the local level. If the problems identified in Part II remain, it should consider moving away from franchise bidding and to other frameworks, including full public utility regulation or purely public provisioning.

¹⁹⁹ Id. at 15-17.

²⁰⁰ See *infra* Part IV.2.

²⁰¹ See, e.g., Victor Goldberg, *Regulation and Administered Contracts*, 7 BELL J. ECON. 426 (1976); Oliver E. Williamson, *Transaction-Cost Economics: The Governance of Contractual Relations*, 22 J. L. ECON. 233 (1979); JEAN-JACQUES LAFFONT AND JEAN TIROLE, *A THEORY OF INCENTIVES IN PROCUREMENT AND REGULATION* (1993); Christopher R. Yukins, *A Versatile Prism: Assessing Procurement Law Through The Principal-Agent Problem*, 40 PUB. CONT. L.J. 63 (2010), THE VOLCKER ALLIANCE, *DOING THE PEOPLE'S BUSINESS: KEY COMPETENCIES FOR EFFECTIVE PUBLIC PROCUREMENT* (2016); Adam Graycar, *Corrupt procurement: rethinking the roles of principals and agents*, 5 POL'Y DESIGN & PRAC. 276 (2022).

²⁰² For more on the outsourcing relationship in money creation, see Ricks, *Money as Infrastructure*, *supra* note xx.

2. Public utility model. In the absence of a framework which ensures a modicum of competition between providers, such as the contracting model, localities should adopt a comprehensive suite of regulations to govern drone delivery as a public utility. In addition to the neutrality mandates and/or structural separations between drone operators and retailers that would be required under either model, local public utility regulation should include cost-of-service rate regulation—the defining feature of utility governance in industries such as electricity.

Under a public utility model, like in franchise bidding, licenses function as genuine *entry restrictions*, whereby entry into the market is limited to a certain number of players even though others might meet the requirements. But rather than franchises or procurement contracts, public utility entry restrictions often take the form of certificates of “public convenience and necessity,” or PCNs, which similarly allow for selective allocation.²⁰³ Importantly, PCN certification regimes serve interests not limited to ensuring licensed entities have the requisite expertise or meet safety standards: They address problems inherent in a market-based approach to infrastructural industries, including destructive competition and “cream-skimming,” or the siphoning off of the most profitable areas or customers.²⁰⁴ To put it more affirmatively, public utility entry restrictions can promote fair competition and innovation, ensure broad geographic access, protect national security, prevent exorbitant prices or unfair terms, and ensure reliability and consistent service for other businesses, customers, and the public at large.²⁰⁵

Rather than approving all license applicants who meet certain requirements, as in the FAA’s existing proposals, local governments would grant a limited number of PCN certificates in each geographic area, perhaps only one. Under this model, in which there is little if any competition between multiple private providers—like in electricity—it is critical to condition the license on cost-of-service rate regulation.²⁰⁶ Rate setting is

²⁰³ See RICKS *et al.*, *supra* note xx, at 86-87; William K. Jones, *Origins of the Certificate of Public Convenience and Necessity: Developments in the States, 1870-1920*, 79 COLUM. L. REV. 426 (1979).

²⁰⁴ RICKS *et al.*, *supra* note xx, at 29-30.

²⁰⁵ See *generally id.* at 11-21. It may strike some readers as counterintuitive that restricted entry could serve to stimulate innovation, rather than hinder it. *But see* JON GERTNER, *THE IDEA FACTORY: BELL LABS AND THE GREAT ERA OF AMERICAN INNOVATION* (2012) (on the remarkable innovations of the Bell System, the regulated monopoly of 20th-century telecommunications that was governed by public utility regulations, including entry restrictions).

²⁰⁶ RICKS *et al.*, *supra* note xx, at 30 (“To prevent entry restriction from bestowing supracompetitive profits on incumbents, it can be coupled with rate setting or profit sharing.”).

important to prevent the regulated entity from charging monopoly prices or lowering their output, while ensuring a fair rate of return on invested capital.²⁰⁷ It could be performed either by existing local or regional public utility commissions, or by new authorities appointed specifically to govern drone delivery. A key challenge with rate regulation, as in any public utility industry, is determining exactly what the cost of service and a fair rate of return is.²⁰⁸ No process to evaluate these metrics is perfect. But to maximize the accuracy of the rate-setting authority, the licensed drone delivery operator should be required to submit detailed cost accounting information, including proposed executive compensation. Rates would be publicly posted and may also be subject to competition from a public option provider, such as the USPS public network proposed below.

The public utility model could accommodate PCN certificates for multiple actors within the same geographic area, but doing so would require greater administrative capacity from local governments than certifying a single provider. To prevent nuisance and overcrowding and ensure safe operations through effective coordination, a local regulator would need to allocate routes and times for different providers to serve specific areas. This may be possible, but it would place extra burdens on local governments.

Importantly, licensing plans submitted to the FAA under both the contract model and the public utility model should include a geographical analysis of the locality, along with an upper limit on the number of drones or individual deliveries permitted within the area. Simply limiting the number of entities licensed to offer drone delivery does not necessarily limit their utilization to prevent congestion and nuisance. A cap on the number of drones or the number of flights they may take within a specified period, determined based both on geography and public input, can help avoid those issues.

B. USPS Drone Delivery

Another approach to address many of the concerns with expanded drone delivery—including nuisance, surveillance, and abuses of power—would be for the United States Postal Service to operate a public drone delivery service, just as it does for regular

²⁰⁷ *Id.* at 25.

²⁰⁸ *Id.* at 34.

package delivery. A public drone delivery network could either be the sole provider of drone delivery services in the areas where drone delivery makes sense or compete with private providers in the areas which elect to have them under one of the licensing models described above. Public provisioning can be a cost-effective and efficient way to shape the drone delivery market towards public-minded ends. As shown in other industries, from healthcare and education to banking and package delivery, public options can also have a disciplining effect on private firms by competing with them on price, quality, safety, and other features.²⁰⁹

The USPS is well-positioned to operate a public drone delivery service. It possesses a fully scaled logistics network that it uses to make more than 23 million deliveries every day, nationwide.²¹⁰ It already operates nearly 35,000 physical locations—namely, post offices and mail processing facilities—that could function as storage hubs from where drones make deliveries, supplementing other modes of postal delivery.²¹¹ The ubiquity of its infrastructure, coupled with its constitutional pedigree, empower it to serve nearly the entire American population.²¹² And it is affordable and well-liked: It charges rates that are typically lower than its private competitors, and in public polling, it consistently ranks as the government agency with the highest levels of popular support.²¹³

USPS has explored opening a drone delivery service before: In 2019, it issued a Request for Information (RFI) to consider the viability of a drone delivery network

²⁰⁹ See generally GANESH SITARAMAN AND ANNE ALSTOTT, *THE PUBLIC OPTION: HOW TO EXPAND FREEDOM, INCREASE OPPORTUNITY, AND PROMOTE EQUALITY* (2019).

²¹⁰ *One Day In The Postal Service*, U.S. POST. SERV., <https://facts.usps.com/one-day/> (last visited June 14, 2024).

²¹¹ *United States Postal Service's total number of post offices from FY 2015 to FY 2021*, STATISTA, <https://www.statista.com/statistics/943334/usps-number-of-post-offices/> (last accessed June 14, 2024) (recording 34,223 post offices in fiscal year 2021).

²¹² U.S. CONST. art. 1, §8, cl. 7; Tyler Powell & David Wessel, *How is the U.S. Postal Service Governed and Funded?*, BROOKINGS (Aug. 26, 2020), <https://www.brookings.edu/articles/how-is-the-u-s-postal-service-governed-and-funded/> (detailing how USPS's postal offices and distribution centers serve a significant portion of the American population, in fulfillment of its constitutional mandate).

²¹³ See *U.S. Postal Service Announces New Competitive Prices for 2023*, U.S. Post. Serv (Nov. 10, 2022), <https://about.usps.com/newsroom/national-releases/2022/1110-usps-announces-new-competitive-prices-for-2023.htm> ("USPS offers some of the lowest shipping rates in the mailing industry[.]"); Drew Desilver & Katherine Schaeffer, *The State of the U.S. Postal Service in 8 Charts*, PEW RSCH. CTR. (May 14, 2020), <https://www.pewresearch.org/short-reads/2020/05/14/the-state-of-the-u-s-postal-service-in-8-charts/>.

operated by the postal system.²¹⁴ But it did not follow up its RFI with a pilot program. Given renewed interest and action in drone delivery policy, it should put out a new RFI to reevaluate a public drone delivery option, which should include an examination of the ways in which drone delivery technology may have advanced in the last five years. Congress should also consider line-item appropriations to pilot public drone delivery at USPS, and should the pilot prove successful, consider funding it permanently.

In setting up a public drone delivery network and thereby expanding the capacity of the postal system, many important decisions will have to be made, of which two are worth highlighting. The first deals with personnel capacity: USPS will have to rapidly hire personnel able to competently operate drone delivery on a systemic level and implement a training program to enable postal workers to operate drone delivery out of local post offices. In this effort, it should make full use of the tools available to hire personnel with expertise in scaling delivery networks, including personnel from private companies who may wish to contribute to USPS's public service mission.²¹⁵ And it should strive wherever possible to design and implement using in-house expertise, rather than outsourcing to consultants, who would no doubt seek highly compensated contracts but often provide service of questionable value.²¹⁶

The second concerns procurement: Opening a drone delivery network will require either the construction of thousands of drones by publicly operated manufacturers, or else the procurement of these drones from private companies. In either situation, large procurement contracts will be required—either for component parts, like batteries or electronic chips, or for fully-built drones. Given the trends toward concentration already evident within the network model of drone delivery,²¹⁷ USPS may find it challenging to procure innovative technology over the long term at fair prices and terms. Procurement officials should consider conditioning contracts on interoperability rules, which could apply to drone manufacturers as well as network

²¹⁴ *USPS Joins the Drone Delivery Domain with RFI for Services*, CROWELL (Oct. 3, 2019), <https://www.crowell.com/en/insights/client-alerts/usps-joins-the-drone-delivery-domain-with-rfi-for-services>.

²¹⁵ For an overview of the mechanisms available to policymakers to build personnel capacity and their application in a different type of technology, see generally Sitaraman and Eyre, *supra* note xx.

²¹⁶ See generally MARIANNA MAZZUCATO AND ROSIE COLLINGTON, *THE BIG CON: HOW THE CONSULTING INDUSTRY WEAKENS OUR BUSINESSES, INFANTILIZES OUR GOVERNMENTS AND WARPS OUR ECONOMIES* (2023).

²¹⁷ See *supra* Part I.2.

operators. These and potentially other conditions may help ensure that the government gets a good deal and promote equal access for other businesses.²¹⁸

However, a public drone delivery network will also have to address issues that might also apply to private drone delivery services. While it might not pose the same risks of market power abuse (due to its ability as a public institution to price at cost), it should be sensitive to other risks—including congestion and nuisance as well as surveillance, labor, and environmental risks.²¹⁹ Thus, public drone delivery should be an option of last-mile delivery when local communities opt in to it, no less than in the case of private drone delivery services.

C. Report on Last-Mile Delivery

Drone delivery can be thought of as forming one component of a larger intermodal system of last-mile delivery, which also includes postal delivery, trucking, and mobile delivery platforms. Conceiving of drone delivery in this way can help policymakers cognize the disruptive effects that introducing drone delivery may have on both businesses and workers engaged in these other modes of delivery.

To consider these effects, the President or the Secretary of Transportation could create an independent commission of experts on last-mile delivery and charge it with writing a report on how different modes of last-mile delivery interact and what effect the introduction of drone delivery might have across this intermodal system. The commission could also be empowered to make policy recommendations to the Surface Transportation Board, the Department of Labor, the U.S. Postal Service, and other relevant agencies, to promote innovation while mitigating drone delivery's disruptive effects on labor, the environment, and our transportation system. One such recommendation could be to require localities to calibrate the number of drones or deliveries it permits to maintain the viability of less disruptive delivery methods, thereby promoting innovation and efficiency while mitigating the drawbacks of technological disruption for existing businesses and their workers. If not a new commission, the President and the Secretary could commission a similar report by a pre-existing expert group or body.

²¹⁸ For an overview of the tools available to promote competition and innovation in federal procurement and their application to a different sector, see generally Eyre, *supra* note xx.

²¹⁹ See *supra* Part II.

D. An Industrial Strategy for American Drone Production

As drone delivery scales, one issue that policymakers may face is the fact that many drones used in America are manufactured in foreign countries, including geopolitical rivals like China.²²⁰ This raises national security concerns: They could be used as tools of foreign surveillance, compounding the problems detailed in Part II concerning surveillance by private drone delivery operators.²²¹ In the case of an emergency, foreign-manufactured drones could be withheld from American purchasers, leaving America without drones. Foreign manufacturing may also have undesirable economic effects: Manufacturers might be prone to limit their supply or increase prices in response to shifting global demand, causing supply chain bottlenecks. In such a situation, foreign-dominated manufacturing might also pose problems for governing drone delivery's industrial structure: When faced with limited supply and high demand, manufacturers may furnish certain contracts with preferential terms or prices, and thereby distort competition in America's drone delivery industry. For these and potentially other reasons, it would be wise for policymakers to consider measures to promote domestic or allied drone production.

Given the urgency of the regulatory questions at play in governing drone delivery, enumerating the particular mechanisms of an industrial policy to stimulate domestic drone manufacturing is a task beyond the scope of this paper. But as drone delivery scales under a new regulatory structure, it is important that policymakers consider where these drones come from—and whether actions need to be taken to ensure resilient and secure supply chains for UAS and their essential components. Policymakers could look to the tools used in recent landmark industrial policy legislation to subsidize the domestic production of clean energy and semiconductor chips.²²² Such subsidies may also be accompanied by measures to limit the use of foreign-produced drone technology, given that restrictions on the foreign ownership

²²⁰ Noah Smith, *Three holes in the U.S.' economic strategy against China*, NOAHPINION (June 11, 2024), <https://www.noahpinion.blog/p/three-holes-in-the-us-economic-strategy>.

²²¹ The risks of foreign-manufactured drones may parallel those of foreign-manufactured electric vehicles (EVs), which are the subject of an investigation into the national security risks posed by their surveillance-enabling technology. See Jim Tankersley, *Biden Calls Chinese Electric Vehicles A Security Threat*, N.Y. TIMES (Feb. 29, 2024), <https://www.nytimes.com/2024/02/29/us/politics/biden-chinese-electric-vehicles.html>.

²²² See, e.g., Inflation Reduction Act, Pub. L. 117–169, 136 Stat. 1818 (2022); CHIPS and Science Act, Pub. L. 117–167, 136 Stat. 1366 (2022).

and production of critical infrastructure are common throughout American history.²²³ Indeed, the FAA Reauthorization Act of 2024 included a measure to limit the Department of Transportation’s procurement or use of foreign-produced drones.²²⁴ Importantly, any subsidies offered should also be accompanied by strict conditions on their use and on the business structures and practices of the entities receiving them. This would ensure that industrial policy, in the case of drone delivery, could be used to truly *discipline* capital and thereby promote open markets and the interests of consumers, workers, and the environment, rather than simply reward and entrench corporate power.²²⁵

Conclusion

Further along in its technological life cycle, drone delivery could prove to be an innovative and efficient method of delivering packages to consumers. But it is critical that policymakers do not overlook their obligations to promote the public interest and a healthy, fair system of last-mile delivery because of the attractiveness of such a possibility. The public interest, in the case of drone delivery, is not limited to safety or the potential benefits of its expansion: It also includes legitimate problems posed by drone delivery’s business model that policymakers should address. Should they be left unaddressed, they may hinder drone delivery’s acceptance and threaten the long-term viability of the industry itself—not to mention subjecting American communities to the downsides of unwanted technological interventions. Luckily, there are tools that policymakers can use to regulate drone delivery in the public interest. It is critical that they explore these options now, at this turning point in the future of aviation technology.

²²³ Ganesh Sitaraman, *The Regulation of Foreign Platforms*, 74 STAN. L. REV. 1073 (2022).

²²⁴ FAA Reauthorization Act of 2024, *supra* note xx, at § 936.

²²⁵ See Jeff Gordon, *Can Subsidies Discipline Capital?*, LPE BLOG (May 13, 2024), <https://lpeproject.org/blog/subsidies-discipline-derisking-capital/> (arguing that subsidies as a tool of industrial policy can shape, and not only reinforce, market behavior); *cf.* Daniela Gabor, *The (European) Derisking State* (2023), <https://doi.org/10.31235/osf.io/hpbj2> (“[D]erisking [including through subsidies] and capital discipline are fundamentally at odds because the former relies on private profitability to enlist private capital while the latter forces capital into pursuing the strategic objectives of the state even where these may be at odds with changing market conditions or profit calculations.”).