Regulation when platforms are layered

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Abstract

In previous papers, Lehr & Sicker (2018a,b) argued that the changing character of our telecommunications infrastructure called for a new regulatory approach, with a new Communications Act to define the duties and authorities of a reconceptualized FCC (what we call *newFCC* in this paper).

Today's Internet ecosystem is comprised of multiple digital network platforms organized into a multi-layer architecture. Lower layer IP platforms provided by access and backbone ISPs collectively support the Internet, on which complementors can build higher-layer platforms, such as the platforms provided by powerful firms such as Google, Microsoft, Amazon, Facebook and Apple. These firms control and operate multiple platforms within the larger Internet ecosystem. When dominant platform providers pursue multi-platform strategies in an effort to capture or control a market, such strategies confound current methods for defining markets and assessing market power.

This paper draws on the layered platform nature of the Internet ecosystem, as described in Claffy & Clark (2014), to illustrate how this layered character of today's Internet ecosystem calls for new regulatory authority. This paper draws on the layered platform model to scope the duties for an agency (or agencies) with sector-specific expertise.

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1. Introduction

Numerous authors have pointed out the inadequacies in legacy telecommunications regulatory frameworks and called for new policy approaches to address the challenges confronting today's Internet environment.[2] Lehr & Sicker (2018a,b) proposed a model for how to reform U.S. communications policy. They posited two regulatory titles central to a proposed new law that would replace the existing Communications Act of 1934: a new Title II that would authorize a reconceptualized FCC (our *newFCC,* a sector-specific regulator) to employ strong public-utility-style tools (including the option to mandate strong remedies such as structural separation) in contexts where bottleneck facilities pose a barrier to the operation of one or more important market(s); and a new Title III that would apply where more light-handed, market-based regulatory frameworks were more appropriate. In neither paper did they address the platform nature of the Internet ecosystem and consider precisely what tools could address harms that might be associated with the digital platforms that firms like Google, Amazon, Facebook, Apple, or Comcast might be understood to provide at multiple levels of the Internet ecosystem) nor how both Titles might jointly apply to the same firm(s) in different market contexts.

Claffy & Clark (2014) pointed out that today's broadband Internet ecosystem comprises a complex matrix of layered platforms. Large firms in the ecosystem often operate multiple platforms, and when dominant platform providers pursue multi-platform strategies in an effort to capture or control a market, such strategies confound current methods for defining markets and assessing market power. Any framework for coherent regulatory policy for the Internet ecosystem ought to take into account how this layered platform structure impacts policy options. The current paper uses case studies exploring different consequences of the layered platform ecosystem to further motivate the need for a new law giving new or existing regulatory authorities the scope and tools necessary to navigate policy challenges arising in the evolving Internet ecosystem

Section 2 reviews the earlier work that provides a foundation for the current paper. Section 3 discusses the nature of platforms, and discusses the ambiguity in the definition of the term. It also introduces the distinction between an *internal* and an *external* platform. Section 4 discusses the implications of the external platform; section 5 discusses the internal platform. Section 6 discusses examples of public interest goals—the role of the regulator in shaping our communications infrastructure. Section 7 discusses the need for a sector-specific expert agency, and section 8 provides a few concluding thoughts.

2. Review of Earlier Work

In this section, we briefly review the major themes from our earlier papers that provide a foundation for the current work.

[2] For example, see Lehr & Sicker (2018a, b), Claffy & Clark (2014), Khan (2017), Noam (2018), Feld (2019), and Whitt (2018), to name a few.

2.1. Model for a *newFCC*

Lehr & Sicker (2018a) proposed a structure for a new Communications Act to replace the 1934 legacy legislation. The approach was high-level, sketching out the basic titles to frame a reform agenda. A key goal of the paper was to argue for the continuing need for a sector-specific, independent, national regulatory authority, which we refer to in this paper as the *newFCC*.[3] Of greatest relevance to this paper is the proposal in Lehr & Sicker (2018a) for new Titles II and III. The new Title II provides the authority to ensure access to a bottleneck facility, in the case that access to that bottleneck is deemed a necessity for a competitive market using that bottleneck, and there is a compelling public interest in sustaining that competitive market. The new Title II authorizes the use of regulatory tools traditionally associated with Public Utility-style regulation, which range from full-government ownership of a communications infrastructure utility (e.g., similar to the PTTs that prevailed in many countries or the local, municipally-owned telecommunication providers being built in some markets in the U.S.) to less-constrained versions of public utility oversight (e.g., associated with price cap-style rules). The scope of their Title II is limited to regulation of bottlenecks, because establishing, managing, and sustaining any such regulatory intervention imposes significant costs.[4] In making the case for the same sort of strong public utility authority that exists under today's current Title II, Lehr & Sicker (2018b) explicitly argued against framing Title II as common carriage, tying it more directly to a public utility framework focused on shared access to a bottleneck (or public) infrastructure. The obligations of common carriage do not derive from any determination of market power.[5]

Lehr & Sicker's proposed Title III deals with cases where there is a need to shape market behavior. The scope is broader than their Title II, and the tools are more limited: a market-based, light-handed regulatory model. Under their Title III, the regulator would promulgate general principals as ex ante, rules-of-the-road that may include specific requirements, e.g., a non-discrimination rule. These principles would provide guidance on acceptable market behavior to help steer or manage the market toward desired outcomes, as well signal behaviors that may elicit a regulatory response, e.g., injunction, penalty or structural remedy.[6] Lehr & Sicker intended that Title III rely less on

[3] Herein, we will use "*newFCC*" to refer to the sector-specific regulatory agency authorized by a new Communications Act. We do not mean to imply that there would literally be an abolition of the current FCC, but that the substantial changes in scope and authority proposed by Lehr and Sicker define a very different regulatory agency.

[4] The costs are both direct and indirect. Direct costs include the costs of regulatory oversight and compliance incurred by the regulatory and regulated firms. The indirect costs include the adverse spillover effects of the regulation that may distort prices and investment incentives in the market and adjacent markets. Typically, the indirect costs are larger but also harder to estimate.

[5] See Cherry (2012).

[6] A structural remedy is a strong type of regulatory remedy. Under the proposed Title II, some form of structural remedies are almost always necessary to effectively target the strong regulatory interventions under the new Title II and limit their adverse spillover effects to adjacent markets. Under Title III, the ability to implement a strong intervention such as a structural remedy ordering divestiture of certain assets or precluding participation in selected markets is part of the necessary toolset, but is intended to be used very sparingly and only in special contexts subject to strong justification.

detailed ex-ante rules and more on targeted, ex post enforcement actions to counter market-failure problems such as abuses of market power or coordination problems.[7] Title III also provides authority and tools to address market failures such as gaps in universal service (e.g., where private investment returns are inadequate to ensure appropriate levels of service).

Table 1 provides a summary of the various regulatory tools that Lehr & Sicker (2018a,b) argued should be in their *newFCC*'s arsenal.

[7] Much of the regulatory policy directed at competition issues has focused on addressing abuses of market power, but market failures may also arise in effectively competitive markets. These may include coordination problems like Lemons Problems (inability of firms to signal higher quality resulting in low quality pooling equilibria), interoperability problems (failure of firms to coordinate on standards), or failure to sustain pricing equilibria that are sufficient to recover long run costs (a problem that may arise in the presence of significant shared, fixed or sunk costs).

Table 1: *newFCC* Regulatory Toolset

Title II: Public Utility Regulation
• Bottleneck Access Rules: authority to impose mandatory sharing rules for bottleneck facility, including setting terms and pricing for access. • Associated PUC style regulatory oversight, with authority to set prices, terms, product selection, investment priorities, etc.
Title III: Light-Handed Regulation
• (a) Information sharing: transparency & disclosure, measurement, investigations, convening workshops, PR. • (b) Subsidies (e.g., universal service). • (c) Adjudication of Disputes, Inquiries, and Enforcement Actions: expert agency able to respond to complaints about violation of market behavior guidelines (e.g., Powell's Principles) and take enforcement actions (e.g., fines, injunctions). May include NOI leading to new (d) or (e) rules. • (d) Industry mandates: standards, requirements (e.g., minimum QoS). • (e) Special actions or rules: may include non-discrimination rules, data handling rules directed either at all market participants or potentially, asymmetrically, applied to dominant firms, and potentially, even strong tools (applied sparingly) such as structural remedies.

Lehr & Sicker (2018a,b) sketched out how a newly enfranchised FCC might apply its authority to lower layer network resources like conduit and outside structures, and the communications services built on top of them—most obviously the Internet itself. They did not elaborate the extent to which their framework was applicable to the regulation of higher-level digital network platforms, such as those provided by powerful firms such as Google, Amazon, Facebook, or Apple.

2.2. Internet ecosystem as a complex of layered platforms

Claffy & Clark (2014) noted that the broadband Internet ecosystem is best viewed as a layered collection of platforms that may combine and interact with each other in complex ways that are relevant to understand if the goal is to identify or address policy challenges. Figure 1 illustrates one example of the layered ecosystem.

Figure 1: The Internet Ecosystem – an example of a complex of layered platforms
From Claffy & Clark (2014)

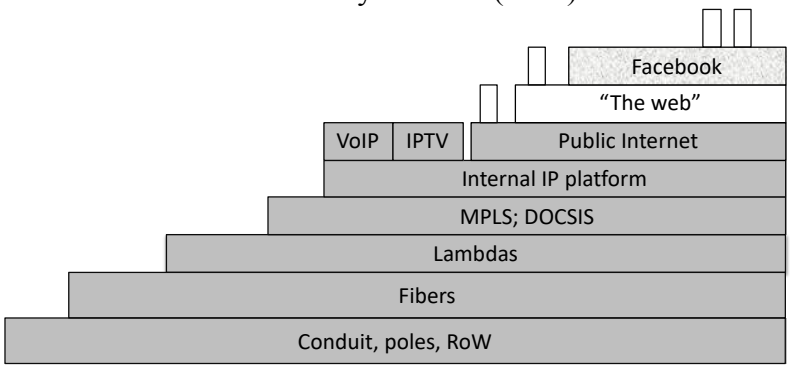

Figure 1 illustrates an example of layering. Lower layer infrastructures like fiber optic cables that may be owned by an access ISP like Verizon or Comcast may be used to support a capacity sharing layer such as DOCSIS on which the owner would implement a layer based on the Internet Protocol (IP) that could be sliced into multiple managed IP networks. That IP network could be used by the owner of the underlying fiber to provide higher-level services like IPTV or broadband Internet access. Multiple firms interconnect their IP networks to create the multi-firm global Internet, and firms such as Facebook then layer still higher-layer platforms on top of those underlying IP networks. Clark & Claffy's focus was on developing a model for talking about regulatory issues that accurately reflects the reality of today's Internet ecosystem comprised of multiple, layered platforms.[8] We explore here how the layered platform nature of the Internet ecosystem raises new issues from a regulatory perspective, or more generally, from the perspective of possible government intervention to remedy some harm. As a secondary matter, we consider whether the *newFCC* of Lehr & Sicker or some other regulatory agency (sector/issue-specific or otherwise) or tool may offer the best option for addressing those issues.

There are several ways in which the layered platform character of the ecosystem may change the reasoning about regulation. First, the platform structure leads to interactions among the actors at different layers, which in some cases may disadvantage certain actors. We want to understand the nature of those interactions, as a starting point to asking whether any of them might rise to the level that would warrant regulatory intervention. Second, if regulators find that intervention is justified, the layered structure may provide more than one option for how to intervene. We need some method to reason about where the most effective intervention might be directed and what agency or regulatory tools may be best suited to address the challenge. Third, a platform operator, especially one that operates multiple platforms, potentially at multiple layers, may be able to exploit the operator's expansive power for market surveillance to create and exploit information asymmetry that harms the public interest.

2.3. Normative goals for the Internet Ecosystem

A common theme in both strands of the authors' earlier work is the notion that communications policy is not and should not be limited solely to the goal of promoting effective competition and the smooth functioning of markets. Communications policy rightly embraces normative goals that include preferences for particular types of market outcomes. It includes aspirational goals that are intended to ensure that the U.S. has the communications infrastructure and supports the sorts of market outcomes that are socially and economically desirable, rather than just accepting whatever competitive markets may deliver.

Lehr, Clark et al. (2019) and Clark & Claffy (2015) highlighted aspirations for important features or outcomes that would characterize the sort of broadband Internet ecosystem we believe regulatory policy should promote. Those include promoting a broadband Internet that is (1) subject to no more government intervention than is necessary, but one that (2) facilitates affordable

[8] Herein, we use *ecosystem* to refer to the collection of firms, their users, the markets and their environment, which includes the institutions, regulations, rules, standards, and norms, that shape the interactions of firms and users. When we speak of the Internet ecosystem, we are including the firms, services, and users that contribute to creating, sustaining, and making use of the Internet.

universal access to (3) high quality infrastructure that provides (4) global connectivity to a (5) diverse range of applications and services to suit the diverse tastes and requirements of Internet and broadband users, is (6) (reasonably) efficient (cost-effective), is (7) trustworthy, is (8) evolvable, (9) enables permissionless innovation (of the sort the Internet has supported), and a host of other desirable attributes.

3. The nature of platforms

Discussions of platforms are often confusing (or confused) because there are actually two alternative definitions of the term currently in use.

1. The *industry* platform: An industry platform provides technology: a set of functions or capabilities on top of which further products and services can be developed, including higher-layer platforms. This version of platform is usually characterized by a degree of generality, which allows a range of higher-level services to be created on top of it. The developers of services on top of an industry platform are called *complementors.*
2. The *multi-sided* platform: A multi-sided platform allows multiple classes of interdependent users to interact. It is the mutual dependency that makes the platform multi-sided. There is no requirement that this form of platform be in any way general-purpose—intended to support a range of services. This sort of platform may support exactly one service, which is intrinsic to the platform. Since this sort of platform does not support the development of higher-level services, the term *complementors* is not applicable; this sort of platform has *users*, or *participants*, or for some platforms, *customers.*

The second definition—the multi-sided platform—is prevalent in recent literature.[9] However, if there is no generality to the function provided by the platform—if it provides a fixed service defined by its designer for the multiple classes of users for which the service is intended, the term *platform* is confusing to a technologist. In early literature, these sorts of platforms were called multi-sided *markets*.[10] The classic example of a two-sided market is the singles bar, where the two classes of participants are men and women. The operator of a singles bar may try pricing experiments such as a "lady's night", with free drinks for the women, in order to attract more women in order to attract more men. To us, there is nothing about this example that makes it a *platform* in the sense of an industry platform. There is no generality provided by the operator of the bar that is intended to allow others to build new services on top of it. It is just a two-sided *market.* The men and women (the two classes of users) interact, and the operator of the bar contrives to profit from this interaction (e.g., by selling drinks and food.) Although the operator jointly considers the demand of both types of customers in the design and pricing of the services offered, the customers play no direct role in determining what services are offered.

Hovenkamp (2019) has proposed to divide multi-sided platforms (or markets) into two sub-classes. One is the *transaction platform*, where a market-maker has created a market or exchange where buyers and sellers can find each other and potentially complete a transaction. This sort of marketplace is, of course, much older than the digital markets of the Internet. His other class of

[9] See OECD (2019), Graef (2016).

[10] There is a large and growing literature on multi-sided markets. For a review of this literature, see Evans & Schmalensee (2013), OECD (2009), or Rochet & Tirole (2004).

multi-sided platform he calls a *media platform*, but we would prefer the more general term *selling platform* or *product platform*. In this case, a seller of some product (e.g., media) adopts a two-sided approach to structure his selling strategy. A content provider might charge a fee when users access its content, or it might take a two-sided approach and give the content away but make money by selling ads as a part of the service. The owner of a bar might try to improve his sales of drinks by setting up his bar as a singles bar, but he could equally try the approach of a low-price bar, a sports bar, a hip bar, and so on. The multi-sided approach is not necessary as a way to structure a selling platform, but it is necessary if the purpose of the platform is to facilitate (and benefit from) multi-party transactions.

In Claffy & Clark (2014), the layers were called *platforms* because all but the highest layers were industry platforms. Many of them were not multi-sided. The concerns we raise in the following sections about potential abuse by a platform operator do not necessarily depend on the platform being multi-sided. Some platforms can be both industry platforms and multi-sided platforms, but this is not always true. We might have preferred the term *multi-sided markets*, but in this paper, we bend to the current usage. We use the term platform to talk about both kinds of platforms listed above, so our use of the term also includes industry platforms, whether or not they are multi-sided. It is therefore broader than the definition in papers such as (Feld 2019) or (Hovenkamp 2019).

In general, we will talk about the *users* of a platform, but when we talk specifically about industry platforms, we will use the term *complementors* of the platform.

3.1. The industry platform

Following Gawer & Cusamano (2014) and Claffy and Clark (2014), some industry platforms are created with the intention that they be used by the firm or firms that created them (*internal* platforms), while others are used by a larger set of actors (*external* platforms), perhaps totally open (as with the Internet) or open to a limited set of other firms. Furthermore, some platforms may be created by a single firm, and some by the collective effort of multiple firms. Figure 2 illustrates these options.

		Construction: One firm	Construction: Several firms
Use: EXTERNAL (to other firms)		Single firm external platform (iOS, Android, Microsoft Windows, Facebook)	Multi-firm external platform (Internet, Web)
Use: INTERNAL (To the creators		Internal single-firm platform (DOCSIS, IP-based platform: TV over DOCSIS, IPTV over IP)	Internal multi-firm platform (Connected IP platforms: VoIP)

Figure 2: Options for construction and use of platforms, with examples of platforms and uses of those platforms. From Claffy & Clark (2014)

A broadband platform provider like Comcast operates an internal DOCSIS platform, on top of which it operates a higher-level internal IP platform. In turn, on that platform Comcast builds a variety of further platforms and end-user services. It might offer digital TV over the DOCSIS platform, or IPTV over its internal IP platform. It might connect its internal IP platform with those of other providers to make a multi-firm internal IP platform, over which it offers telephony (VoIP).[11] Finally, it might interconnect with other providers to be a part of the Internet, which is an external, fully open platform provided by multiple firms.

As another example, Apple's iOS is an external platform that is built on top of Apple's internal hardware platform. Apple's iOS platform is used by application developers. Apple operates a multi-sided platform, the application store, to facilitate the marketing, distribution and sales of apps. The app store is an example of an offering we would prefer to call a *market*, rather than a *platform*.[12] It is multi-sided, serving app developers and iPhone users, but it is not an industry

[11] In the U.S., the FCC's 2015 Open Internet Order (FCC, 2015) defined a new Title II service, Broadband Internet Access Service (BIAS), that was the Internet access service that access ISPs provide to retail customers to enable them to access the Internet. BIAS is provided over the broadband platform operated by the access ISP, who may also provide other services such as IP telephony or television services using the same platform, but over logically separate and separately managed IP networks. Those other services are called "specialized services" and are not considered Internet services, although they may be interconnected with the Internet.

[12] In calling the Apple app store a market instead of a platform here, we are trying to clarify our use of terminology in this paper, recognizing that other authors with other concerns and classification schema may

platform: there is no way to build higher layer services on top of it. The features of the app store (like the features of a singles bar) are determined by Apple, its creator.

The distinction between internal and external platforms provides one way to understand the difference between Title II and Title III in the law proposed by Lehr & Sicker. Title II is concerned with public utility-style regulation. One use is to mandate sharing of a bottleneck: an internal industry platform intended by its creator only for the creator's use.[13] Title III targets potentially unreasonable terms for the use of an external platform.

In the following sections, we separately look at the implications of external and internal platforms.

3.2. The multi-sided platform

A multi-sided platform, as described above, is definitionally an external platform. It is characterized by multiple classes of users, the dependencies among them, and possible strategies (e.g., pricing strategies) for the platform operator to benefit from those users. The idea of an internal, multi-sided platform makes no sense. Some industry platforms, as we noted above, are multi-sided, which implies that they are external platforms.

An example of a multi-sided external industry platform is the Internet itself, specifically the region of the Internet operated by a broadband access provider like Comcast. In the past, there was one class of directly connected users to the network of an access provider: the retail end-users. Content coming from a provider would enter the access network via a path through a transit provider, which provided general interconnectivity to the regions of the Internet. However, a recent trend is the direct interconnection of large content providers such as Netflix or Youtube to the access networks. The large flows of content are no longer primarily routed over a transit network, but come over these direct connections. These direct connections create a direct business relationship between the content providers and the access providers, so the access providers now have direct relationships with two classes: retail users and content providers. The content providers and the retail users are inter-dependent (each needs the other), which makes the access network a multi-sided platform, and creates an opportunity for the access provider to adjust the pricing that each sees. There have been disputes as to whether content providers should be allowed to connect to the access network for free (since the users benefit from that content and pay for access) or whether the content providers should pay as well.[14]

differ (see, for example, page 218 in Cusamano, Yoffie, and Gawer (2019), in which in there schema they characterize the Apple App store as an "innovation platform" to distinquish it from a "transaction platform").

[13] Their Title II also covers the case where a platform is created by the government or through a government franchise, which then serves as an external platform shaped by public utility regulation.

[14] For further discussion of how interconnection in the Internet has evolved, see Clark, Lehr & Bauer (2016) and Faratin *et al.* (2008).

4. Dominance and the external platform

The operator of a platform may establish a dominant position in the market for the services provided by the platform: *platform dominance.* An actor that has achieved platform dominance has mostly driven from the market rivals who would provide a competing platform. That is, they have achieved horizontal dominance. Platform dominance can give the platform operator the power to engage in anticompetitive behavior. Such behavior might be addressed by a cross-sector agency charged with antitrust enforcement, but the layered platform character of the ecosystem raises new considerations both with respect to the nature of the potential abuse, as well as the options for remedy.

Platform dominance by itself is not anticompetitive. The concerns arising from platform dominance center on the relationship between the platform operator and those who use the platform, the complementors or users. A traditional behavior of a dominant firm would be to expand vertically into the space of the users. Indeed, such expansions happen. However, it is not usually the goal of the platform operator to displace the users and turn the external platform into an internal platform.[15] An external platform allows the operator to benefit from it use by others. The platform operator does not view the users as rivals, but as generators of value, which the platform operator may then seek to capture. This goal expands the range of potentially anticompetitive actions.

- The operator of the platform may establish prices for the use of the platform that resemble monopoly pricing.
- The operator may exploit features of the platform to observe what the users are doing, thus giving the operator a panoptic view of the ecosystem that it created, which it can exploit in unreasonable ways.
- The operator may selectively block certain users from the platform.

With respect to the first risk–monopoly pricing, classic antitrust policy recognizes that one of the benefits of becoming a successful monopolist is the privilege of charging higher prices. Moreover, if the platform operator sets fees at a level that discourages users of the platform, such behavior will be to some extent self-destructive, since external platforms cannot succeed without users. In this respect, pricing of an external platform should be at least partially self-correcting. From a regulatory perspective, there seems to be little appetite in the U.S. these days for direct price

[15] While a monopolist provider of an external platform would not seek to drive all users of the platform from the market, it may very well seek to drive some and become the sole user for that subset of markets. Amazon can let sellers on its platform take risk to explore new product areas and then pick successful products it sells itself.

regulation, even if the prices seem excessive.[16] However, in the EU, there is more willingness to rein in excessive prices.[17]

The second potential problem that may arise is associated with the surveillance of the users: the fact that the operator of the platform can observe what the users are doing. The information thus gained can potentially be used by the platform operator to disadvantage the users. For example, the platform operator may use the market intelligence they can gather as a basis to decide whether to develop an offering that competes with a user, or to manipulate the fees charged to different users.[18]

The third problem that may arise is associated with the potential for the dominant platform provider to block or exclude certain users from the platform, perhaps because they compete with an offering provided by the platform operator or as part of a negotiation over business terms. For example, Apple provides applications that compete with third-party applications on the app store, and Amazon offers products via its eCommerce platform that compete directly with the products offered by third-party vendors on its platform. If the platform providers' behavior is harmful to the process of competition (rather than to a particular competitor), it may constitute an antitrust violation. There have been strong concerns about blocking (or throttling) the activity of certain

[16] The U.S. resistance to price regulation reflects the numerous challenges it raises for policymakers. In setting regulated prices, policymakers have to ensure that prices are set high enough to allow the firm to cover its costs, including a reasonable opportunity to earn a risk-adjusted return on its invested capital. Setting prices that deny such a return threatens the economic viability of the firm and deters investment in the platform. In the face of significant shared and common costs, changing technologies and market conditions, and the risks inherent in engaging in platform competition, regulators confront numerous imperfect information and consistency challenges.

[17] Article 102 of the Treaty on the Functioning of the European Union (TFEU) states:

> "Any abuse by one or more undertakings of a dominant position within the internal market or in a substantial part of it shall be prohibited as incompatible with the internal market in so far as it may affect trade between Member States. Such abuse may, in particular, consist in: (a) directly or indirectly imposing unfair purchase or selling prices or other unfair trading conditions; (b) limiting production, markets or technical development to the prejudice of consumers; (c) applying dissimilar conditions to equivalent transactions with other trading parties, thereby placing them at a competitive disadvantage; (d) making the conclusion of contracts subject to acceptance by the other parties of supplementary obligations which, by their nature or according to commercial usage, have no connection with the subject of such contracts."

Subsection (a) directly addresses the question of excessive pricing.

[18] Moreover, the superior market intelligence (e.g., regarding the character of demand for customers in any multi-sided markets served via the platform, the technologies, costs or plans of complementors, etc.) may provide the platform operator with such a significant strategic advantage that it effectively forecloses competition either for the platform market itself or in the markets served via the platform. This informational asymmetry created by virtue of the platform operator's unique position may comprise a new type of entry barrier. To address this challenge, policymakers may need to identify how to level-the-playing field by either limiting the ability of the platform operator to benefit from the superior information or make the information more readily accessible to other market participants.

users by several of these platform providers. In another example, the FCC attempted to impose "network neutrality" rules to prevent operators of the Internet access platforms from discriminating against or blocking certain content or applications provided by so-called "edge providers".[19] Feld (2019) has proposed a measure of market dominance he calls the "cost of exclusion", or CoE. He argues that if the cost of being blocked or excluded from a platform is sufficiently high, then regulators should determine that that platform is dominant and is a candidate for targeted regulation.

Finally, even if a dominant platform operator is not engaging in anticompetitive behavior threatening competition in any single market, the fact that the platform operator may have acquired an excessive concentration of privately-held economic power by virtue of its platform dominance may raise regulatory concerns. One obvious risk is that the firm may choose to engage in anticompetitive behavior in the future. Another is that the private decision-making by the firm may deviate from the decisions that society would like to see made, implying that there is a public interest that may require regulatory intervention.[20]

4.1. The added complexity of multiple platforms within the firm

The above discussion painted an over-simplified picture, since it suggested that platform firms would operate only one platform. Firms today have availed themselves of multi-platform strategies to establish and cement their economic power in the Internet ecosystem. For example:

- Apple's ecosystem is a layered series of platforms comprising Apple's various devices, iOS, application store, and related services (e.g., Apple music). Subscribers to Apple's ecosystem benefit from common interfaces, easier interoperability among parts of the Apple ecosystem, familiar "look and feel," and from the scope and scale economies that Apple realizes from integrating the platform layers.
- Amazon offers its independent sellers a suite of product delivery and fulfillment services with scale and scope economies that are hard to match by standalone vendors, while offering consumers a suite of Amazon services supported by its array of platforms, for searching for products and negotiating purchase transactions (for new and used goods), for accessing a range of on-line media, and other sundry services. Both vendors and consumers of Amazon's eCommerce platform benefit from Amazon's integration across multiple layers of functionality and across most types of retail goods.
- Google offers its users a range of services from email to VoIP to search to cloud services across its global assortment of digital network platforms. Those include access networks (e.g., FTTH in certain communities in the U.S.), multimedia content, Android mobile broadband OS, Google Cloud Services, Internet search functionality, mapping services, Google's range of end-user messaging and document management services, its Chrome browser platform, its YouTube platform, et cetera.

[19] See FCC (2015).

[20] It is important to note that not all regulatory concerns may be traced to competitive failures. See Footnote 7 *supra*.

- Similarly, Microsoft offers its users a range of services including email, teleconferencing (Skype), social networking (LinkedIn), the Windows operating system, the Office suite of applications, and (for the firm) cloud services.
- Facebook started out as a social network, but has added messaging, document sharing, content access and a range of other applications to its platform. Its acquisition of WhatsApp expanded Facebook's role in messaging apps, and it is building a payment platform.[21]

While the benefits to users of these multi-platform operators are substantial, they also pose potential risks with respect to competition. The users of one platform may also become direct competitors of the firm when a platform operator exploits other aspects of its multi-platform strategy. There is a mutual dependency: the users need the platform, and the platform is of no value without users. In the case of an industry platform, both the platform and the complementors building on top of it are usually profit-seeking entities and may be contending for the same pool of revenues. However, there is usually no symmetry in the power of the two actors—except in special cases no single user has the power to influence the platform operator. [22]

The source of a multi-platform operator's economic power may stem from their control and integration of multiple markets. When dominant platform providers pursue multi-layer, multi-platform strategies in an effort to capture or control a market, such strategies confound current methods for defining markets and assessing market power. A platform provider that is competing to capture a dominant position in a global market may pursue a long-term strategy (which might, for example, involve low prices to consumers to capture market share). Such a firm (and its investors) may be willing to sacrifice profits over a longer horizon in the hopes of securing a much bigger future pie of monopoly profits. Current empirical methods for assessing market power focus on shorter-term behaviors and outcomes that may not capture the strategy of the firm, and its long-term implications. See the discussion in section 7.1 on the need to expand the scope of antitrust enforcement.

4.2. The scope of the platform ecosystem

The tools for development of Internet applications have greatly evolved in the last decade or so. In the early days of the Internet, the end-nodes on the computer were time-sharing systems supporting collections of users. In the 1980's the personal computer emerged as another class of end-node. But these were the only platforms that were available to the application developer. An application developer could purchase and operate a large computer server as part of the application, but the application developer had to include this cost and effort as part of the development.

[21] "Facebook building cryptocurrency-based payment system," Wall Street Journal, May 2, 2019, see https://www.wsj.com/articles/facebook-building-cryptocurrency-based-payments-system-11556837547.

[22] In some cases, a complementor may have a degree of market power, if it plays an important (or dominant) role at the next layer of the ecosystem. In this case, their tussle is part of how market competition ought to play out. A regulatory intervention that over-constrains the bargaining power of one side may strengthen the bargaining power of the other, resulting in a potentially worse outcome for consumers. In asymmetrically constraining the market power of a dominant platform player at one layer, regulatory policy may accentuate the market power of a dominant player at another layer, resulting in a less competitive ecosystem overall.

This situation has changed with the emergence of new platform elements that facilitate application development by lowering the initial investment costs and making it more scalable. These platform elements include:

- So-called *cloud* external platforms: Cloud platforms provide massive storage and computing on demand. Applications can build on top of these, and since cloud platforms can provide as much capacity as the application demands at it grows, applications can now scale almost without effort.
- *Content delivery networks* (CDNs): Applications that need to position content (or other service elements) close to the users can exploit CDNs, which again can provide capacity on demand. CDNs provide a highly decentralized platform element without the application designer having to invest any effort in the development of that capability. Since the development of a highly decentralized delivery platform would be an impractical effort for a newly minted application, CDNs allow new sorts of applications to be designed and launched. CDNs and cloud facilitate experimentation and innovation in app development since they lower the investment risk (an entry barrier) for app development. Applications that are highly successful (consider, for example, Netflix) can migrate from the third-party CDN platforms to their own distributed servers when their scale justifies it, but the third-party platforms provide a means to get started.[23]
- *App stores*: The app store is a way for developers and potential users to find each other. App stores are a classic example of a *multi-sided platform*, where the different classes of participants can meet and transact.
- *Software Development Kits* (SDKs) are collections of tools that facilitate the development of applications. They enrich the basic capabilities of the underlying platform (e.g., an operating system) with libraries of useful software development tools. As applications themselves become platforms for other applications, those applications often provide an application-specific SDK to facilitate the development on top of that platform. Thus, Facebook provides an SDK specific to Facebook to allow the development of new services that run on top of Facebook. The Facebook SDK facilitates such actions as analytics, login, message sending, ad placement, and utilization of user data. SDKs greatly reduce the effort of developing a new application.

Application developers today depend on platforms such as these, a range of service elements that are much richer than the actual Internet, even if they think of their application as an "Internet app". This reality raises an important question about the scope of authority for a regulator. Application developers depend on these assets to build Internet applications. These platforms can raise the same potential concerns as the platform layers of the Internet itself: extraction of excessive revenues from higher layers, exclusion of certain applications, and surveillance of the activities of the application and its user positioned on top of the platform. The importance of these platforms suggests that monitoring and potentially regulating these services is important to the overall health of the Internet ecosystem, even though they are not themselves communications infrastructure.

[23] For a discussion of the ecosystem of CDN options and how they have evolved, see Stocker et al. (2017).

4.3. The dynamics of digital platforms

Some characteristics of the digital ecosystem facilitate rapid evolution. Cloud platforms let a service provider scale up their offering with comparatively little cost, since the provider can requisition computing and storage resources from the cloud platform on demand. This ability allows successful offerings to grow quickly. Similarly, a CDN platform allows a service to expand as necessary. The global reach of the Internet means that an offering can reach a large market almost instantly.[24] The rapidity with which digital network platforms may grow and scale can result in significant disruption costs that in themselves may pose a significant policy challenge.

Digital network platforms that evince extreme returns to scale and network effects are prone to tipping, or *winner-take-all*, competition. This effect may accelerate the trend toward increased concentration and eventual monopolization as a dominant winner emerges. In the case of the largest digital platform providers that are active across multiple platforms, many of which are multi-sided, it is often quite challenging to dislodge dominant incumbents once they are established. This is because such platforms benefit from direct and indirect network effects and scale/scope economies across multiple markets and user groups; and because there may be significant switching costs for users that lock users into continued use of the platform. Of course, the same factors that enabled the digital platforms to grow so large so fast in the first place may be exploitable to replace the incumbents in relatively short order. Whether or not switching costs are high and how easy it would be for a new competitor for the market to challenge or replace the dominant incumbent is context-dependent, not uniform across platforms.

4.4. Example: the Apple app store

Apple helped jumpstart the smartphone revolution and the mass adoption of mobile broadband with the launch of its iconic iPhone in the summer of 2007. Since then, Apple has grown to be perhaps the largest and most valuable platform provider in the world. Applications for iPhones are provided via an *app store*, the marketplace (a two-sided market) where app providers and users meet.[25] Apple requires that apps for their mobile devices be made available *only* through the Apple app store. The application developer is dependent on this platform, but has no *right* to sell in the Apple app store; selling is a privilege controlled by Apple. Apple's control of the iOS ecosystem

[24] For a service to achieve global reach, it will have to be localized to the languages and regulations of the various parts of the globe. One of the advantages to developers that first bring a service to market in the U.S. or China is that the size of the domestic market allows for large growth without the need for localization to other markets.

[25] The two-sided characterization of the app store is a useful simplifying construct. However, one might view the app store as being a many-sided market that links multiple classes of distinct users: app sellers and iPhone users, that may themselves be segmented into distinct user classes. Different classes of applications make use of (are allowed to make use of by Apple) the Apple iOS and app store platform in distinctly different ways. For some analytic purposes these differences may not be important, but treating apps as differentiated goods in a homogenous app store "market" is likely to be misleading in other contexts. Consider for example the differences between VoIP, mapping, privacy, gaming, or business utility applications – each of these has its own, sector or class-specific features that interact across classes on both sides of the market (e.g., road warrior professional versus consumer, communications versus utilities).

with its control over the iPhone and other iOS devices and its application store gives Apple significant market power over a large number of users in the broadband Internet ecosystem.[26]

Since 2007, the ecosystem of Android has emerged to offer strong competition to iOS, with a much larger global share of end-users relying on the Android ecosystem (over which Google has significant economic and technical power). Although there are other marginal mobile broadband OS ecosystems (such as those developed by Blackberry and Microsoft) providing consumers and application providers with choices, Apple is in a somewhat unique position with market power over mobile application providers that it can exercise through Apple's policies regarding what applications to allow on its platform.[27]

One criticism of Apple in this context is they charge a fee of 30% for all purchases in the app store, a fee that has been criticized as excessive, given that Apple need not purchase at wholesale, pay significant costs to stock inventory, and so on. As discussed earlier, there seems to be little appetite in the U.S. to regulate pricing, even by a monopolist, but the situation in the E.U. is different, where regulation explicitly finds excessive pricing grounds for intervention.

Another aspect of the Apple app store is that Apple does not accept every app that requests to be listed. Apple curates the applications that are provided in its store and iPhone users appreciate that applications are likely to be free of malware and malicious behavior. However, Apple makes the decision as to whether to block an app; as the operator of the platform they have sole control of what is listed.

Apple has blocked some apps for reasons that have nothing to do with security. In May 2018, Apple rejected an application from STEAM, a provider of a multi-player gaming platform that would have allowed users who had purchased games that ran on other platforms to use those games on iOS devices.[28] In effect, the STEAM platform is an overlay platform on the iPhone. Speculation on the Web was that Apple blocked STEAM because it is possible to purchase games (and make in-game purchases) inside the STEAM platform, and Apple would not receive their 30% cut for those purchases.[29] (In May 2019, the STEAM app was accepted onto the Apple app store.)[30]

As another example, Apple briefly blocked the Google Map app in 2012 when Apple released its own map app. This decision was quickly reversed, however, amid murky speculation.[31]

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[26] Having adopted one OS platform, users confront non-trivial switching costs to switch to another OS.

[27] Bresnahan & Greenstein (2014) contrasted the Apple and Android ecosystems. Whereas Android enables third-party firms to participate on both the device and application sides of the OS platform, Apple only allows such competition on the application side. The Apple iOS is a one-sided platform and the Android operating system platform is two-sided.

[28] See https://www.reddit.com/r/apple/comments/8lwzv6/steam_link_app_for_ios_rejected_by_apple/,

[29] https://www.cultofmac.com/550533/silly-app-store-bans-have-gone-too-far-with-steam-link/

[30] https://www.engadget.com/2019/05/15/ios-steam-link-app/

[31] Christina Bonnington, *Ignore That Report About Apple Blocking the Google Maps App.* Wired, November 2012, https://www.wired.com/2012/11/report-google-maps-app-trouble/

Were Apple a physical retailer, the natural limits to the capacity of physical distribution channels (e.g., like the shelf space in a grocery store) might provide a valid economic rationale for excluding applications from the store. In the case of digital platforms, however, such limits on application choice do not readily apply. Should a regulator have a scope of authority that extends to platforms such as an app store? Feld (2019) argues that platforms such as this are within scope for a sector-specific agency, and uses his metric of cost of exclusion CoE as a way of characterizing the degree of market power and the justification for targeted intervention.

If a regulator determined that some behavior of the Apple app store (e.g., blocking or pricing) required intervention, the layered ecosystem provides more than one option to structure a remedy. One possible remedy would be to require that Apple allow competitive app stores for Apple apps. Another option is to regulate directly the behavior of the app store.

A regulator might hope that by forcing the app store space to be more competitive, unreasonable behavior would be resolved. However, in this case it is not clear that outcome would follow. If there were multiple app stores, each would want to make money. It is possible that app developers would discover that users did not search all app stores but looked only in their customary store for new apps. In this case, an app would need to be listed in *all* the app stores, and the app developer would have to bargain with each of them separately. Even though there are competitive app stores for the Android platform, the Google Play store also charges a 30% transaction fee. Competition might not drive down the cost to the app developer and consumer; it might increase it. At the same time, the quality of curation of the apps might go down, leading to an overall less trustworthy experience.

As an alternative to mandating competition and hoping that the right outcome follows, a better approach might be to accept that Apple has market power over their app store, and impose obligations on it to limit behavior that is determined to be abusive: for example, not discriminate among qualified applications, and make public the criteria by which applications are evaluated.

The two choices described here are not unique to this particular market. The forces in the Internet ecosystem that lead to rapid growth and "winner-take-all" outcomes suggests that dominant players are going to emerge in multiple contexts. A regulatory approach that tries to undo this outcome by attempting to create competition where natural competition has failed to thrive may be fruitless. The better approach may be to accept that a winner has achieved market dominance, and impose behavioral obligations on it to limit abuse of that power.

The app store is an example of a platform that does not fit neatly into one of the two classes proposed by Hovenkamp (2019). Superficially, the app store is a *transaction* platform, where makers and buyers of apps search, meet and transact. However, a potentially more important goal of the app store is to increase sales of iPhones. The easy access to lots of appealing apps and the curation of the apps to make the experience more trustworthy combine to make the overall Apple ecosystem more appealing. Apple could decide to make no profits from the app store, and still make money selling iPhones. Through this lens, the app store is a *selling* or *product* platform.

4.5. Example: Amazon eCommerce platform.

Products on Amazon show up in two ways. The original model for Amazon (i.e., books) mimicked traditional merchandizing: Amazon bought wholesale and sold at retail. However, the Amazon seller program provides a different way for sellers to reach Amazon purchasers. Amazon provides a set of tools for a seller to list their product on the Amazon web site, and charges a fee (typically between 8 and 15%) when an item is sold. As well, for additional fees, Amazon will stock the product in their fulfillment centers and deal with product delivery. This model has many interesting implications. First, Amazon need not make a decision about whether a product is going to generate enough sales that they should use their capital to purchase and stock the product. Sellers of low-volume niche products can list their product on the Amazon web site, relying on the search tools provided by Amazon to let customers find their products, and fulfill the purchases themselves. Amazon will deal with the payment process, which makes the process painless for the seller. As well, the seller has access to Amazon-provided features that allow purchasers to post reviews, ask questions about the product, and so on. As a result, users of the Amazon web site can find "almost anything," since it is so easy for a seller to market their products through Amazon.

However, sellers are totally dependent on the features of the Amazon seller platform, and if issues arise, the seller may not have recourse to the means to resolve them. If "purchasers" post critical reviews, Amazon may demand that the seller resolve the issue, even if the seller considers the reviews to be unjustified. Amazon defines the rules of the market, and the seller must use the program on a take it or leave it basis. Selling in the Amazon market is a privilege, not a right, and Amazon can suspend that privilege at their discretion.

Another risk to sellers on the Amazon platform is that Amazon, by necessity, can track all the transactions of every seller (and every buyer). Amazon might use this information for purposes other than the completion of the transaction. They might detect that a given product (or class of product) was proving very popular, and introduce their own product to compete with the products from the unaffiliated sellers that use the Amazon platform. This is an example of the risk that the platform operator can observe what the users are doing on the platform, and potentially use that information to the detriment of the users. Perhaps a platform operator like Amazon should be prohibited from using information it gathers as part of completing a sales transaction in any other context.

4.6. Example: Google Search and EU intervention

Google is one of the most powerful actors in the Internet ecosystem. They have developed and operate a number of platforms, including the Android operating system (a platform for mobile app developers), their search capability (a platform for advertising as well as search), broadband Internet access in certain cities, a map/geolocation platform, a platform for ad placement on third-party web sites, email, document preparation tools. The Google platforms are individually powerful, and Google's control of all of them gives them the ability to exploit synergies among them. As with Amazon, Facebook, and Apple discussed earlier, Google operates multiple platforms at multiple layers that comprise an ecosystem of complementary platforms with significant influence over the overall Internet ecosystem to which they belong.

The harms that might arise with these platforms fit into the patterns we described earlier where a platform operator has the power to exercise unreasonable control or constraint over the users of Google's various platforms. The European Commission has ruled in three different cases that Google was in violation of antitrust law in their control over their platforms; these cases illustrate the range of issues that can arise, all of which fit into this same pattern.

- In 2017 the EU fined Google 2.4B Euros for manipulating shopping search results, where they favored their preferred results over those of rivals.
- In 2018, the EU fined Google 4.3B Euros for abusing market dominance in mobile, where they had bundled their own browser with their Android operating system. They were required to allow users to install rival browsers and search engines on their smart phones.
- In March 2019, EU fined Google 1.5B euros for requiring publishers of ads using their AdSense business to agree not to accept advertising from rival search engines. The EU antitrust commission found that this restraint prohibited firms from competing in this space.

In total, the EU has fined Google $9.3B for antitrust violations.[32] These cases illustrate the power of a platform operator to exploit its control over its platforms. They also illustrate a difference between the U.S. and E.U. conceptions of antitrust enforcement. In 2013, the FTC closed its antitrust investigation of Google without taking action, although recently, it was announced that the U.S. Department of Justice (DoJ) would be initiating an investigation.[33]

Consumers presumably do not want their search queries to be manipulated in ways that may conflict with their interests (e.g., to facilitate first-degree price discrimination by directing users to sponsored sites that match the interests of the sponsor rather than the consumer). Users do not want the prices for airline tickets or other products that they are quoted to be higher than they would have been if the sellers knew less about them or if the users had a differently biased search engine. A valid antitrust concern arises because of Google's inherent capability to bias or manipulate search results to promote affiliate interests or harm rivals, and to extract additional surplus from end-users.

5. The internal platform

Not all platforms are intended to be used by other parties. The developer of a platform may intend to use the platform internally as a basis to develop and provide its own higher-level offerings. This arrangement, of course, has the consequence that competitors cannot enter the market and offer competing higher-level services without developing their own alternative to that platform.

[32] See https://www.theverge.com/2019/3/20/18270891/google-eu-antitrust-fine-adsense-advertising

[33] See Kendall, B. and J. McKinnon (2019), "Justice Department Is Preparing Antitrust Investigation of Google," Wall Street Journal, June 1, 2019, available at https://www.wsj.com/articles/justice-department-is-preparing-antitrust-investigation-of-google-11559348795. The authors quote an FTC staff memo from 2012: "evidence paints a complex portrait of a company working toward an overall goal of maintaining its market share by providing the best user experience, while simultaneously engaging in tactics that resulted in harm to many vertical competitors, and likely helped to entrench Google's monopoly power over search and search advertising."

Internal platforms exist at any level in the ecosystem. However, a part of the ecosystem where internal platforms are common includes the telecommunications infrastructure that provides the basic electronic transmission networks that support digital platforms built on top. The last-mile access providers need to install a range of facilities to support their networks. They often install conduits intended for their sole use, even while taking advantage of public rights of way for the placement of their conduit.[34] Broadband providers that install wireline connections to the home (copper pairs, fiber optics or HFC cable systems) typically do not intend to share those physical facilities directly with other firms, but intend to use them as inputs to their various services, including higher-level internal and external platforms. There are, of course, also external platforms in this part of the layered ecosystem. Independent operators install cell towers today to be leased to various cell providers. Fibers (or lambdas) in fiber optic cable are often leased to third parties, and conduit and other outside structures (poles) may be jointly owned or shared with other providers and users.

In most cases, these lower layer platforms are not providing service to the end user at that layer.[35] Major firms both build and use these platforms. This distinguishes these platforms from, for example, the Internet, an external platform where an end-user can directly send packets over that platform.

Since internal platforms do not provide any opportunity for competitors to use that platform, a firm that wants to compete at the higher layer would have to replicate the service provided to the first firm by that internal platform. However, in some cases building a second platform may not be feasible. The platform may constitute a natural monopoly (e.g., FTTH in most local markets) such that having a single platform provider offers the minimum cost solution, or indeed the only economically viable one.

If replication of the internal platform is either not efficient or impractical, and the government concludes that competition at the layer above is important to the overall ecosystem, the platform may be deemed a bottleneck resource (i.e., a resource that higher-level services require access to), and regulators may intervene to require that the owner of the internal platform make it external—share it with potential competitors. The decision to mandate such shared access need not depend on any evidence that the dominant platform provider was excluding other users in pursuit of some anticompetitive purpose, but rather that sharing the platform was sufficiently in the public interest. This case is perhaps most compelling when there is consensus that the platform is a natural monopoly, but that is not necessary.

[34] The use of public rights of way or other publicly-owned resources like spectrum may be used to assert a public interest in how the conduit is used, including whether it is shared with other parties, including potential competitors.

[35] For example, although Comcast may own the coaxial cable that connects a customer's home to Comcast's network, Comcast needs to add a bunch of other stuff in order to use that cable to provide the customer with services such as broadband Internet access, television services, or telephone service (VoIP). Those other components are associated with higher layer platforms as illustrated in Figure 1.

5.1. Regulation of last-mile Access

A long-standing regulatory concern centers on last-mile access, which may be characterized by monopoly power in many markets. Last-mile access is essential for a range of critical services (telephony, entertainment television delivery, *and* Internet access), The owner of monopoly last mile facilities could manage them so as to extract monopoly rents, limit choice (or quality), and harm innovation (e.g., foreclose competition). The historic remedy was to regulate the last-mile as a public utility, but recently the trend has been to deregulate these facilities, in the hope that facilities-based competition will replace the monopoly operator.

We mention this case here, because it provides a relatively well-understood and accepted justification for legacy FCC regulation and was the principal focus of the analysis in Lehr & Sicker (2018a,b). However, the layered nature of access technology (and industry structure) renders the analysis of last-mile access regulation more complex. Assume for the moment that the preferred remedy is to mandate sharing of the access platform. At what layer should this requirement be imposed?

Mandating sharing at a given layer creates the potential for competitive services at the next layer of the platform stack. For any proposed intervention (i.e., mandated sharing of a platform layer thereby making the internal platform external), the regulator must be able to defend the argument that the anticipated competition at the next layer thus created or protected (e.g., a market) is viable, and sufficiently serves the public interest that the mandate is justified. This reasoning will be different at different layers.

- (a) Conduit/Outside Structures: Lehr & Sicker (2018a,b) argued that ensuring shared access to conduit and outside structures might prove sufficient to create facilities-based competition in wireline access, which could in turn support a wide range of services. These assets are perhaps the easiest to understand as natural monopoly facilities. Investment in these is long-lived and sunk, and the technologies for provisioning these assets is relatively stable (at least compared to networking hardware and software). Moreover, there is a long tradition in regulated sharing of these resources among utilities. However, the landscape of outside structures is highly heterogeneous (most decisions about conduit and outside plant are local in scope), and major costs would remain for the potential market entrant. The regulator would have to argue that the remedy would provide sufficient scope for an entrant to be successful, and that the return on investment (presumably in competition with some incumbent), would attract a competitor.

- (b) Unbundled Network Elements (UNEs): The Telecommunications Act of 1996 mandated that an incumbent telephone provider unbundle the different network components that make up their network. The UNEs included copper loops, switch ports, and other elements. However, this conception of sharing is technology-dependent. More modern access technologies, such as the hybrid fiber/coax of the cable industry, or fiber to the home, use physical circuits that are shared among a number of residences. With such hybrid fiber/coax architectures, there is no easy way to unbundle a physical network element corresponding to the path to a single residence, so there is no way a new entrant could attempt to attract individual customers. A new mode of sharing would have to be defined to allow the sharing of such local distribution networks.

- (c) In the case of fiber optic access links, under some circumstances it might be possible for multiple competitors to share the fiber infrastructure, perhaps by using different optical wavelengths of the fiber, or different fiber strands in a bundle. If such sharing were possible, it would greatly reduce the cost of competitive provision of higher-level services. If the fiber were owned by the community or some other third-party, then such access might easily enable competition at the next layer. On the other hand, it would be easy for an incumbent to deploy a fiber system such that this mode of sharing was not practical. Alternatively, if sharing was mandated, based on a particular fiber system, that technology lock-in might prevent migration to a more advanced fiber system in the future.[36]

- (d) As an alternative to sharing of physical access technology, a regulator could mandate shared access at a higher layer. Almost all access technologies include a layer that breaks the transport capacity into logical transmission units such as packets, frames or cells. The regulator could mandate that capacity be shared at this layer, an approach sometimes called *bit-stream* access. This approach has several benefits. First, it is likely to be a more stable approach, since it is more technology-independent. Second, the regulator could mandate that the bit-stream sharing reach not just across the access link itself, but further into the network of the incumbent, to a point of interconnection with the competitor. This further reduces the cost of entry for the competitor. However, as the competitor uses more of the incumbent's network, it is constrained by the features of this network, which may limit the ability of the competitor to innovate new services. In the limit, the competitor may be restricted by the technology of the incumbent to offering services that are essentially copies of what is offered by the incumbent, which may prove a barrier to market entry by competitive providers of service, since there is little way for them to distinguish their offering.

As one moves up the layers, the costs of launching a competing last-mile network service is reduced, lowering the barriers to competitive entry. However, the range of services and type of competition that higher-layer resellers may offer is constrained by the nature and mechanism for managing sharing of the lower-layer resource. Today's facilities-based incumbents offer a triple play of video, telephone, and broadband Internet access services. The policy maker must decide whether, for a competitor to survive, it must be able to offer all these services, and whether there is a compelling public interest in creating competition in all these markets. Today, video and telephony are available as "over the top" (OTT) offerings over the Internet. Telephone service can also be provided using cellular technology. So perhaps it is sufficient, both to serve the public interest and to create a successful variant of competition, that a form of sharing be mandated that only creates competition in retail Internet access. Or perhaps, to serve the public interest in ensuring adequate broadband Internet access, it may be sufficient to regulate the incumbent provider to prevent blocking of higher-level services (e.g., regulation such as network neutrality), rather than trying to create by intervention a degree of competition.

[36] This is a problem that has bedeviled DSL sharing of copper wired plant. To the extent DSL sharing is successful, it may deliver competitive choices in retail ISP access among firms sharing the incumbent exchange carrier's copper plant, but at the expense of making it more difficult for the incumbent to retire copper plant and migrate to a next-generation fiber network.

This discussion illustrates how the layered nature of services and platforms in the Internet ecosystem complicates regulatory policy even when applied to legacy issues such as last-mile access platforms. Further, new technology or investment strategies might render obsolete a decision to mandate that an internal platform layer be opened up to competition. Lehr & Sicker pointed to spectrum policy reform that would expand opportunities for wireless competitors and to other reforms that remove regulatory barriers to new business models for providing last-mile access. These latter may include municipal or community networking or other models for edge-based, end-user self-provisioning alternatives to traditional, service-provider last-mile access services. In cases where private investment incentives are inadequate to justify investment in appropriate infrastructure, it may even be desirable for government to promote public utility investment in the broadband platform.

5.2. Universal Access

A further issue related to last-mile access is how to make broadband access universally available. This issue is also rendered more complex by the layered character of the technology.

Ensuring that all citizens have access to essential basic infrastructure is a fundamental responsibility for government policy. Under existing communications policy, the FCC oversees subsidy programs that total $8.7 B per year to support universal access to advanced communications services.[37] Historically, the focus was on ensuring universal access to telephony services, which were originally limited to fixed-line, voice POTS;[38] today, it includes promoting access to both fixed and mobile broadband Internet access services that provide access to a broader range of communication and information capabilities;[39] and tomorrow, the range of digital communication and computing services that society determines should be included in the universal access policy mandate may expand still further.

The multi-layer platform character of communications infrastructure has made planning of policy alternatives much more complex than in the era of telephone service, where it was clear what the service was (i.e., basic telephone service), what the technology was (i.e., copper pairs to the home), and in many cases who the provider would be (i.e., the incumbent telephone provider, who could be burdened with a duty to serve).

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[37] In 2016, total Universal Service Fund disbursements were $8.7 B, spread over the four programs: High-Cost Support ($4.5B), Low-income Support ($1.5B), Rural Health Care ($0.3B) and Schools & Libraries ($2.4B) (see Table 1.10 Universal Service Monitoring Report: 2017, prepared by Federal-State Joint Board on Universal Service, available at https://www.fcc.gov/sites/default/files/2017_universal_service_monitoring_report.pdf).

[38] POTS is Plain Old Telephone Service, and is a commonly used acronym to refer to basic, voice telephony service, to distinguish it from more advanced telephony services such as voice conferencing, voice-mail, and other messaging services.

[39] Internet access expands significantly the options for electronic communications to include telephony, multimedia messaging, chats, email, et cetera. These may be used simultaneously as substitute alternatives or complements to augment and enrich communication modalities. Moreover, the any-to-any communications facilitated may include machines as well as humans on either end.

Today, a policy maker must determine what service or services is actually critical for universal access. Modern cable systems and fiber to the home can support a range of services, including modern cable television and telephone offerings as well as broadband Internet access. Should the universal service aspiration apply to a platform layer that can offer these (and other) services, or should it apply more narrowly to the broadband Internet layer, which itself may be able to offer variants of these and other services. This decision will then shape what sorts of technology options are acceptable as a platform for universal access. Would construction of middle-mile fiber access, or open-access cell towers, be enough to attract private sector investment in fiber optic facilities in target communities lacking such facilities? Or, must the public sector support the construction of all the service layers necessary to bring connectivity to the home? How important is it that subscribers have choices in mobile and fixed broadband providers? All these decisions interact in complex ways that are fundamentally interdisciplinary, requiring substantial understanding of technology as well as economic and social factors.

6. Shaping the character of the ecosystem

As we stated in the introduction, the scope of regulatory authority should go beyond preserving competitive markets. Communications policy rightly embraces normative goals that include preferences for particular types of market outcomes. It includes aspirational goals that are intended to ensure that the U.S. has the communications infrastructure and supports the sorts of market outcomes that we desire for society and the economy, rather than just accepting whatever competitive markets may deliver.

We discuss three examples here that again illustrate the interplay between the layered character of the ecosystem and how goals might be achieved. Some societal goals span layers, so an approach to achieving these goals will require sector expertise that spans layers.

6.1.1. Privacy

Every layer in the ecosystem that can observe what a user is doing can potentially collect that information and can potentially use that information in ways that are inimical to privacy.[40]

One way to deal with this concern is to establish regulation that imposes uniform regulation on any platform layer that has visibility of personal information. Alternatively, there may be justification to impose different restrictions on different platform layers. Many applications today support their service using advertisements and provide their service free to users. As part of this (perhaps implicit) bargain, they collect whatever information they can about the users. Restrictions may regulate both what they can collect (and with what permissions) and how that information can be used beyond the purpose of selecting targeted ads to deliver. On the other hand, services such as broadband access (typically provided by Internet Service Providers or ISPs) typically offer their

[40] Note, in addition to arising at any layer in the ecosystem, the privacy concerns may arise in one-sided as well as multi-sided markets. When the privacy threats are arising from a firm active across multiple layers and across multiple markets, many of which may be multi-sided, the combination of those perspectives may allow the firm to pose an even greater and harder to untangle or diagnose threat to privacy than the threat posed by a less complex firm. Although the rise of digital platforms did not create privacy concerns, they certainly have the potential to amplify the risks of privacy harms.

service on the basis for payment. Should they be governed by the exact same rules? Should providers of cloud services (with which most users have no explicit relationship) be governed by the same rules.

The actual situation may be more complex than this summary suggests: since many firms operate multiple platforms, should there be any restrictions on how personal information gathered on one platform can be shared and utilized on other platforms of that firm?

We are not answering these questions; we pose them to illustrate how specific concerns such as privacy interact with different platform layers.

6.1.2. Reliability of critical digital network infrastructures

In the days of simple telephone service, the concept of reliability was relatively easy to define. The service that had to work was the ability to make a phone call, in particular to critical services such as 911. Since this service was delivered over the copper pairs of the telephone companies, the copper pairs needed to meet certain expectations of reliability.

Today, the concept of reliability is much more complex. If a high-level goal is the ability to call 911 in an emergency, how can that need be fulfilled? A user might use a traditional land-line phone, or a cell phone, or perhaps in the not too distant future, "There's an app for that." (Now an Apple trademark.) So what parts of the infrastructure need to be reliable to make critical services are reliable? Which platform layers actually matter, looking across the broad range of services that citizens, business and government depend on today? Every sector of the economy is becoming increasingly dependent on digital network platforms for basic communications and other computing capabilities, which increases the dependency of society and the economy on having access to robust and reliable digital network infrastructures.

One of the complexities in this space is that higher-level services can be designed to compensate for some failures of the lower layers. So the designers of the different layers are to some extent passing between each other the costs and obligations of reliability. A situation like this is likely to result in inefficiencies and non-optimal outcomes due to information asymmetries and network externalities. Should the regulator assume that the market can sufficiently resolve all of these issues, or is some form of intervention justified based on the societal need for reliable service? On the other hand, if the regulator decides to intervene, what sort of expertise and authority will be required to promote a better outcome?

6.1.3. Cybersecurity

Cybersecurity is a growing problem across the entire globe and across all sectors, and is not amenable to being solved by any single regulatory authority. Security problems, like other problems of reliability and robustness, arise at many layers. There is no single actor (platform layer) to whom a regulator could turn to improve the overall state of security. A regulator could assign to a given layer the responsibility for detecting and mitigating all the security problems that might arise at that layer, but this responsibility may be hard to implement. Some security problems may arise at one layer but only be detectable at higher layers. In some cases, the best approach may be to impose an obligation on a higher layer to implement mechanisms to deal with security

problems that actually originate at a lower layer. Therefore, it may take cross-layer coordination, which in turn may imply coordination among actors whose interests are not always aligned to improve cybersecurity.

Any attempt to impose regulatory obligations to improve cybersecurity will require an agency with deep technical expertise. The cybersecurity challenge needs to be broken down into actionable parts, and the responsibility for each part needs to be assigned to the set of actors best positioned to deal with it. In some cases, several classes of actors may need to take action, so there are serious coordination problems to be addressed, as well as externalities. Further, because many (although not all) cybersecurity problems are global, this agency cannot be framed as totally domestic and inward looking. In contrast to some of the other issues discussed here, such as universal access, which can be addressed internal to a given country, improvement of cybersecurity will require cooperation among policy-setting and regulatory bodies across the globe, which implies an international role for the sector-specific agency.

7. Scoping the authority of sector regulation

The goal of the previous sections has been to show by example that the layered platform character of the Internet ecosystem (or more generally the current ecosystem for communications) is technically complex, and that the issues that arise will benefit from technically informed regulatory decision-making. At a high-level, the decision that will face the lawmakers, if they move to provide new regulatory authority in this area, is which issues can be dealt with by an agency with broad scope, such as the DoJ or the FTC, and which will benefit from a sector-specific agency with capabilities and skills specific to the digital ecosystem, like the *newFCC* or potentially some other wholly new sector-specific agency.

7.1. The role of antitrust

We identified in this paper a number of behaviors that might be considered anticompetitive, and which thus might be addressed through the lens of antitrust. This approach raises two questions. First, can current antitrust enforcement practices deal with these behaviors, and second, will an agency that is not sector-specific have the skills and understanding to design and implement effective remedies?

Many of these behaviors we identified may not fit within the scope of current antitrust enforcement practices, which focus on short-term harms to the consumer as the principle justification for intervention. This view of current antitrust regulation has led for calls to rethink the scope of enforcement. Khan (2017) argued that antitrust policy has drifted too far from its activist origins in adopting the Chicago School's attack on traditional antitrust enforcement, most notably with respect to predatory pricing and vertical foreclosure. Khan criticized the ability of current antitrust policies to adequately evaluate the impact of large Internet mega-platform providers like Amazon that are active across a range of Internet-related markets. She concluded that a short-term consumer welfare standard fails to address adequately longer-term welfare interests in innovation, quality, and structural properties like the allocation of economic power. Wu (2018) argues that the rise of Amazon and other platforms represents a "new gilded age" and that antitrust policymakers have given the large platform players a pass in allowing them to acquire economic power through mergers and acquisitions that faced inadequate review, arguing that "Innovation and dynamic

effects, being harder to measure, do not get due consideration... and we might also consider a return to structural presumptions, such as a simple but per se ban on mergers that reduce the number of major firms to less than four" (Wu, pages 128-129, Kindle Edition).

Proponents of this perspective have labeled this movement neo-Brandeisian in honor of Justice Louis Brandeis, who served on the Supreme Court from 1916 to 1939, and is viewed as a champion of America's Madisonian traditions, which aim at a democratic distribution of power and opportunity in the political economy" (Khan, 2018, page 131). The neo-Brandeisian movement has attracted numerous detractors who have pejoratively branded it as "Hipster Antitrust," and criticize it on historical (mis-reading the legal history), empirical (failing to adequately account for market concentration trends), methodological (mischaracterizing the consumer welfare standard), and practical (threatening to render antitrust more political and less objective) grounds.[41] The debate over the need for reforms to antitrust policy and its enforcement due to the rise of the large Internet platforms continues to rage and is unlikely to be settled soon.[42]

7.2. The need for a sector-specific agency

With respect to the choice between a general competition authority such as the DoJ or FTC vs. a sector-specific expert agency like a *newFCC* to deal with antitrust concerns, this is a space of opinion, but we observe that the highly complex and technical character of the platform system, and its potential for rapid evolution, signal the value of an expert agency in crafting solutions. As well, if solutions are devised that require ongoing monitoring, an expert agency is better positioned than a general competition authority to carry out that role.

Remedies to address anticompetitive behavior can include strategies to promote platform or ecosystem characteristics that will render competition at that platform layer more contestable. That includes efforts such as more stringent M&A review to limit the ability of dominant platform providers from harming potential entrants by either taking them off the table prematurely (acquiring nascent competition) or further raising entry barriers (e.g., by raising the ante for acquiring user data and market intelligence). It also includes promoting policies that facilitate interoperability and interconnection to allow entrants and platform competitors to potentially share in network effects and reduce user switching costs. Policies that make it easier for users to multi-home and facilitate data portability also may help in rendering anticompetitive threats less worrisome. Enabling data portability will also be important for addressing the privacy and market intelligence concerns raised by platforms, and their implementation/application will likely require detailed understanding of the technical architectures and operations of the digital network providers. A sector-specific regulator with greater authority and scope for imposing industry behavior norms (standards, best practice mandates, minimum quality standards, and open access/non-discrimination obligations) that are closely tailored to the technical and market realities of the digital platforms would be in a better position to implement such policies.

An important role for a sector-specific expert agency is to keep abreast of technical developments in the ecosystem. A sector-specific agency should be a repository of knowledge about technology

[41] For example, see Yoo (2018) or Sacher & Yoo (2019).

[42] For further discussion of the issues, see FTC (2018).

and industry structure. Its preferred methods to shape the ecosystem should include information and discourse generating debate (via its bully pulpit or transparency and disclosure authority), rather than stronger interventions.

Lehr and Sicker are not the only ones to call for a new law. Harold Feld (2019) and Morton (2019) call for an expert agency to address concerns with digital network platforms. Feld focuses on digital, multi-sided services, accessed via the Internet, where one of the user classes is the public. He raises a number of concerns about how a platform operator can behave in ways that are harmful to the layer above, and calls for a new law to cover these layers of the ecosystem, the Digital Platform Act, and concludes that a sector-specific expert agency will be required to implement it. He contrasts the pros and cons of giving this responsibility to a vastly expanded FCC, or some new agency.

The discussion of a new Communications Act in Lehr & Sicker (2018a,b) included two relevant sections of the proposed law: Title II and Title III. Title II was concerned with bottlenecks and provided remedies that included public utility style regulation. Title II would apply to *internal* platforms, where the goal is to open up (make external) such a platform on the basis of a compelling public interest. Title III would apply to *external* platforms, where the goal is to regulate the potentially anticompetitive management of a platform that was intended for use by other firms, or where the goal is to shape the nature of that platform to meet other public interest goals.

However, Lehr and Sicker do not elaborate on whether the issues at higher layers of the ecosystem (such as the issues that Feld discusses, or more generally the issues with higher-level external platforms we discuss here) are within the scope of their Title III. It is not yet clear whether a revision of antitrust enforcement practices and a law such as the one proposed by Lehr & Sicker address the full range of issues, or whether there is a need for further lawmaking to give a *newFCC* the necessary authority to deal with the full range of public interest issues that arise at the upper layers of the ecosystem.

Lehr and Sicker argue that a sufficient reason to create a *newFCC* is to deal effectively with the layered platforms that comprise key lower-layer elements of our traditional last-mile access networks, where a presumption that a bottleneck facility exists remains a reasonable (if debatable) presumption. Applying those same tools and regulatory authority to address potential harms associated with what the FCC has previously designated as edge providers, and includes application and content providers like Google (YouTube), Amazon (Prime video), Facebook, and Apple raises a host of additional problems. If those firms are adversely impacting *newFCC* policies intended to protect the lower layer platforms they have historically been concerned with (e.g., adversely impacting consumer choices and use of their BIAS), then the *newFCC* ought to be able to act to enjoin those firms from engaging in the offensive behavior. However, when those higher-layer platform providers are using their digital platforms in other markets or giving rise to new harms, it is unclear that the *newFCC* may be the best agency or regulatory instrument to address those issues. With respect to its Title III toolset, a *newFCC*, if involved, may choose to rely more on its ability to convene industry stakeholder discussions and promote information gathering and sharing rather than on its authority to impose structural or behavioral rules.

As a practical matter, different issues in the digital ecosystem will almost certainly be addressed by different agencies. Cybersecurity issues might be addressed by DHS, and privacy issues might be addressed by the FTC. These issues span multiple layers, as do the issues of resilience and reliability, so it may not be effective to assign the responsibilities of a specific agency to specific platform layers or industry sectors, but by *behaviors*; harmful behaviors, no matter at what layer they occur, should bring the issue within scope of the relevant agency. Similarly, the range of tools a sector-specific agency is authorized to use would derive from specific market outcomes or behaviors (or classes of harms) and not the position of a firm in the digital ecosystem. We believe that this approach would provide an agency with the flexibility to deal with the ecosystem as it evolves, while preventing an open-ended mandate for regulation.

8. Summing up and Lessons Learned

Today's broadband Internet ecosystem comprises a complex matrix of layered digital platforms. Any framework for coherent regulatory policy for the Internet ecosystem ought to take into account how this layered platform structure impacts policy options.

We believe that the Internet ecosystem will benefit from (and indeed require) a sector-specific expert agency. It would function under new law that gives it a different scope and a different authority. Because the Internet and its ecosystem has become critical infrastructure for society, society needs a voice in the shape and character of that ecosystem. The scope of the regulator must not be limited to enforcement of antitrust harms and ensuring a functioning marketplace. There are issues that rise to the level of public interest which do not derive from concerns regarding market power. At a high level, a primary justification for a sector-specific agency is that an expert agency will be required as a focal point for decision-making to shape the ecosystem so that the public interest is served.

9. References

1. Asadullah, A., I. Faik, and A. Kankanhalli (2018), "Digital Platforms: A Review and Future Directions," *PACIS Proceedings*, pp.1-14, available at http://bit.ly/2Mr19Sy.

2. Baumol, W. (1982), "Contestable Markets: An Uprising in the Theory of Industry Structure," *The American Economic Review, 72*(1), 1-15. doi:10.2307/1808571.

3. Bresnahan, T., & Greenstein, S. (2014), "Mobile Computing: The Next Platform Rivalry," *American Economic Review, 104*(5), 475-480. doi:doi: 10.1257/aer.104.5.475

4. Brynjolfsson, E., & Smith, M. D. (2000). "Frictionless commerce? A comparison of Internet and conventional retailers," *Management Science*, 563-585

5. Cave, M. (2014), "The ladder of investment in Europe, in retrospect and prospect," *Telecommunications Policy, 38*(8-9), 674-683.

6. Cherry, B. (2012), "Challenges of Institutional Governance for Network Infrastructures: Reinstitution and Expansion of Legal Innovations," in Regulation and the Performance of

Communication and Information Networks, edited by G. Faulhaber, G. Madden and J. Petchey, Edward Elgar Publishing, 2012.

7. Clark, D. (2018), Designing an Internet, MIT Press: Cambridge, MA, 2018.

8. Clark, D. and kc Claffy (2015), "An Inventory of Aspirations for the Internet's future," Technical report, Center for Applied Internet Data Analysis (CAIDA), available at https://www.caida.org/publications/papers/2015/inventory_aspirations_internets_future/inventory_aspirations_internets_future.pdf.

9. Clark, D., W. Lehr, and S. Bauer (2016), "Interconnection in the Internet: peering, interoperability, and content delivery," Chapter 16 in J. Bauer and M. Latzer (eds) Handbook on the Economics of the Internet, Edward Elgar: Northampton MA, 2016.

10. Clark, D., W. Lehr and S. Bauer (2009), "Comments of David Clark, William Lehr, and Steven Bauer," In the Matter of Preserving the Open Internet (GN Docket No. 09-91) and Broadband Industry Practices (WC Docket No. 07-52), Before the Federal Communications Commission, January 2009, available at: http://apps.fcc.gov/ecfs/document/view?id=7020373725

11. Claffy, kc & D. Clark (2014), "Platform models for sustainable Internet regulation," *Journal of Information Policy, 4*, 463-488, doi: 10.5325/jinfopoli.4.2014.0463.

12. Clay, K., Krishnan, R., & Wolff, E. (2001). Prices and price dispersion on the web: evidence from the online book industry. *The Journal of Industrial Economics, 49*(4), 521-539

13. Cremer, J., Y. de Montjoye, and H. Schweitzer (2019), "Competition policy for the Digital Era: A report for the European Commission," European Commission, April 2019, available at http://ec.europa.eu/competition/publications/reports/kd0419345enn.pdf

14. Cusumano, M., D. Yoffie and A. Gawer (2019), *The Business of Platforms: Strategy in the Age of Digital Competition, Innovation, and Power*, HarperCollins Publishers: New York, 2019.

15. Ellison, S.F., 2016. 12 Price search and obfuscation: an overview of the theory and empirics. *Handbook on the Economics of Retailing and Distribution*, p.287.

16. Evans, D. and R. Schmalensee (2018), "Ignoring Two-Sided Business Reality Can Also Hurt Plaintiffs," in *Hipster Antitrust*, Antitrust Chronicle, April Volume 1, Spring 2018, published by Competition Policy International, available at https://www.competitionpolicyinternational.com/wp-content/uploads/2018/05/AC_APRIL.pdf

17. Evans, D. and R. Schmalensee (2013), "The Antitrust Analysis of Multi-Sided Platform Businesses," Institute for Law and Economics Working Paper No. 623, National Bureau of Economic Research, available at https://www.nber.org/papers/w18783.

18. Faratin, P., D. Clark, S. Bauer, W. Lehr, P. Gilmore, and A. Berger (2008),"The Growing Complexity of Internet Interconnection," *Communications & Strategies*, No. 72, 4th Quarter 2008, pages 1-21, available at https://ssrn.com/abstract=1374285

19. FCC (2015), "Report and Order on Remand, Declaratory Ruling, and Order," In the Matter of Protecting and Promoting the Open Internet, Federal Communications Commission, GN Docket No. 14-28, Adopted February 26, 2015, available at https://apps.fcc.gov/edocs_public/attachmatch/FCC-15-24A1_Rcd.pdf.

20. FCC (2010) "Connecting America: The National Broadband Plan," Federal Communications Commission, Washington, DC, March 2010 (available at: http://www.broadband.gov/).

21. Feld, H. (2019), The Case for the Digital Platform Act: Market Structure and Regulation of Digital Platforms, eBook, Roosevelt Institute Public Knowledge, May 2019, available at http://bit.ly/2QEexkR

22. Frischmann, B. (2004), "An economic theory of infrastructure and commons management." *Minn. L. Rev.* 89 (2004): 917.

23. FTC (2018), Hearings on Competition and Consumer Protection in the 21st Century, slides and video, October 15-17, 2018, available at https://www.ftc.gov/news-events/events-calendar/2018/10/ftc-hearing-3-competition-consumer-protection-21st-century

24. Furman, J. (2019), "Unlocking Digital Competition: Report of the Digital Competition Expert Panel," Chair of Expert Panel for report to UK Chancellor of the Exchequer, March 2019, available at http://bit.ly/2WJOLhl

25. Graef, I. (2016), EU competition law, data protection and online platforms: Data as essential facility, International Competition Law Series, Vol. 68, Kluwer, Law International, 2016.

26. Hagiu, A., & J. Wright (2015), "Multi-sided platforms," *International Journal of Industrial Organization, 43*, 162-174.

27. Hovenkamp, E. (2019), "Platform Antitrust," *Journal of Corporation Law*, forthcoming, available at https://ssrn.com/abstract=3219396.

28. Katz, M. (2019). Platform economics and antitrust enforcement: A little knowledge is a dangerous thing. Journal of Economics & Management Strategy, 28(1).

29. Katz, M., and J. Sallet (2018), "Multisided platforms and antitrust enforcement," *Yale Law Journal*, 127, 2142

30. Khan, L. (2018), "The New Brandeis Movement: America's Antimonopoly Debate," *Journal of European Competition Law & Practice, 9*(3), 131-132. doi:10.1093/jeclap/lpy020.

31. Khan, L. (2017), "Amazon's antitrust paradox," *Yale Law Journal, 126*(3), 710-805.

32. Lehr, W. (2019), "5G and the Future of Broadband," in G. Kneips & V. Stocker (eds.), The Future of the Internet - Innovation, Integration, and Sustainability, Baden-Baden: Nomos, 2019 (forthcoming)

33. Lehr, W. and D. Sicker (2018a), "Telecom Déjà Vu: A Model for Sharing in Broadband Access," TPRC46: The 46th Research Conference on Communication, Information, and Internet Policy 2018, available at https://ssrn.com/abstract=3142172.

34. Lehr, W. and D. Sicker (2018b), "Communications Act 2021," Journal of High Technology Law, Volume 18, Number 2 (2018) 270-330, available at https://sites.suffolk.edu/jhtl/home/publications/volume-xviii-number-2/.

35. Lehr, W. and D. Sicker (2017), "Would you like your Internet with or without video?" with D. Sicker, Journal of Law, Technology & Policy, vol 2017 (Issue 1 Spring), available at http://illinoisjltp.com/journal/wp-content/uploads/2017/05/Lehr.pdf.

36. Lehr, W., D. Clark, S. Bauer, A. Berger and P. Richter (2019), "Whither the Public Internet?," Journal of Information Policy 9 (2019): 1-42. doi:10.5325/jinfopoli.9.2019.0001.

37. Morton, F. (committee chair) (2019), "Understanding the Digital Advertising Ecosystem and the Impact of Data Privacy and Competition Policy," Senate Committee on the Judiciary, U.S. Congress, May 21, 2019, available at http://bit.ly/2EHruFQ.

38. Noam, E. M. (2018), "Old-style Utility Regulation for New-style Cloud-TV?", Paper presented at the TPRC46: The 46th Research Conference on Communication, Information, and Internet Policy 2018, available at: https://ssrn.com/abstract=2944382.

39. OECD (2019), *An Introduction to Online Platforms and Their Role in the Digital Transformation*, OECD Publishing, Paris, https://doi.org/10.1787/53e5f593-en.

40. OECD (2009), *Two-Sided Markets*, DAF/COMP(2009)20, available at http://www.oecd.org/daf/competition/44445730.pdf.

41. Pan, X., Ratchford, B.T. and Shankar, V., 2004. "Price dispersion on the internet: a review and directions for future research," *Journal of Interactive Marketing*, *18*(4), pp.116-135

42. Parker, G., M. Van Alstyne, and S. Choudary (2016), *Platform Revolution*, Norton: New York, 2016

43. Powell, M. (2004), "Remarks of Michael K. Powell, Preserving Internet Freedom: Guiding Principles for Industry," prepared for Silicon Flatirons Symposium, Boulder CO, February 8, 2004, available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-243556A1.pdf.

44. Rochet, J. and J. Tirole (2004), "Two-Sided Markets: An Overview, " IDEI Toulouse, France, available at https://web.mit.edu/14.271/www/rochet_tirole.pdf.

45. Sacher, S. and J. Yun (2019), "Twelve Fallacies of the 'Neo-Antitrust' Movement," *George Mason Law Review, Forthcoming*, pp.19-12.

46. Srinivasan, D. (2019), "The Antitrust Case Against Facebook: A Monopolist's Journey Towards Pervasive Surveillance in Spite of Consumers' Preference for Privacy," *Berkeley Business Law Journal*, *16*(1), p.39.

47. Stigler, G.J. (1961), 'The economics of information', Journal of Political Economy, 69 (3), 213–25

48. Stocker, V., G. Smaragdakis, W. Lehr, and S. Bauer (2017), "The Growing Complexity of Content Delivery Networks: Challenges and Implications for the Internet Ecosystem," Telecommunications Policy, Vol 41 (10) 1003-1016, https://doi.org/10.1016/j.telpol.017.02.004

49. Wheeler, T. (2019), *From Gutenberg to Google: The History of Our Future*, Brookings Institution Press, Washington DC, 2019.

50. Whitt, R. (2018), "Hiding in the Open (Part II): How Tech Network Policies Can Inform' Openness by Design' (and Vice Versa)," TPRC46: The 46th Research Conference on Communication, Information, and Internet Policy 2018, available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3135512.

51. Wu, T. (2018), *The curse of bigness: Antitrust in the new gilded age*, New York: Columbia Global Reports, 2018.

52. Yoo, C. (2018), "Hipster Antitrust: New Bottles, Same Old W(h)ine?" in *Hipster Antitrust*, Antitrust Chronicle, April Volume 1, Spring 2018, published by Competition Policy International, available at https://www.competitionpolicyinternational.com/wp-content/uploads/2018/05/AC_APRIL.pdf

53. Zuboff, S. (2019). The age of surveillance capitalism: the fight for the future at the new frontier of power, Hatchette Book Group: New York, 2019