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Internet infrastructure and competition in digital markets

Executive summary

The size of some technology companies, as well as their political and economic power, is a defining feature of the modern economy. Reigning in and regulating “big tech”, a catch-all for diverse companies known by acronyms such as GAMAM or BAT, is on the political agenda in China, the European Union (EU), and the United States (US). Some economists have explained the scale of technology firms through features that generate “winner-takes-all” markets: (indirect) network effects, platform economics, or the use of big data analytics. A less well-researched aspect of big tech market power is the role of proprietary Internet infrastructures. This paper seeks to fill this gap by proposing a theory of vertical integration in platform markets to study the effect of proprietary Internet infrastructure on competition in (digital) platform markets.

The ownership structure of the physical Internet (data centers, Internet exchanges, Internet backbone) has undergone drastic changes in the past decade. Traditional voice carriers, such as AT&T or MCI/Verizon in the US, have connected local networks, including campus and corporate intranets, or lower-tier Internet Service Providers (ISP) which handle “last-mile” connections to residential buildings. These carriers deliver data packages abiding by principles of net neutrality and best-effort. Smaller ISP typically pay the largest, Tier-1 ISP for access to a global network, while the Tier-1 ISP often interconnect free of payment, creating a global network of networks, the Internet.

Digital service providers, such as Google, Netflix or Meta, have increasingly complemented this so-called “public Internet" (albeit operated by private companies) with their own investments. These investments have created parallel, proprietary infrastructures.[1] These do not fall under net neutrality rules, so users can pay for higher quality or guaranteed reliability. This quality improvement enables innovative, quality- or latency-sensitive applications, such as cloud gaming, but also corporate and security-sensitive applications that require near 100% uptime.

Researchers and competition authorities are becoming increasingly aware of the role played by private Internet infrastructure but there is little knowledge about its policy implications. The EU's Digital Markets Act (DMA) recognizes that large platforms can steer and block access to certain infrastructures and calls for openness and free choice in its pursuit of “fairness" and “contestability" in digital markets.[2] The German competition authority in its report on “Competition 4.0" singles out content delivery networks (CDN) as one piece of Internet infrastructure which has been increasingly used by content firms.[3] However, neither text draws conclusions for the application of competition policy based on

[1] The most spectacular examples include ocean-crossing submarine cables, such as JUPITER, connecting the United States, Japan, and the Philippines, owned by a consortium including Amazon Web Services, Meta, NTT, PCCW, PLDT, and Softbank Corp (https://www.submarinecablemap.com/submarine-cable/jupiter). A transatlantic example, Havfrue/AEC-2 connects the United States, Ireland, Denmark and Norway and is owned by Aqua Comms, Bulk, Meta, and Google (https://www.submarinecablemap.com/submarine-cable/havfrueaec2). Both cables became ready for service in 2020.

[2] The DMA discusses network access in recitals 14 and 51 of the preamble. Article 6(1)(e) proposes an unspecified obligation for “gatekeeper" firms not to restrict choice of Internet access providers. However, it is not clear how the DMA will treat proprietary networks operated by gatekeepers. References are to the draft version of December 15, 2020, https://eur-lex.europa.eu/legal-content/de/TXT/?qid=1608116887159&uri=COM%3A2020%3A842%3AFIN.

[3] Bundeskartellamt (2016) Working Paper: Market power and platforms https://www.bundeskartellamt.de/SharedDocs/Publikation/DE/Berichte/Think-Tank-

economics principles. There is also uncertainty in how to weight this infrastructure in the analysis of market power by technology firms. This is relevant for authorities deciding whether to allow, for example, a firm such as Meta to acquire competitors such as WhatsApp, Instagram, or Giphy. Trade-offs arise between increased efficiency in serving the customers of the owners and users of private infrastructure and enabling competition policy objectives such as maintaining contestable markets.

Setup and preliminary, non-technical summary of results

We expand a standard model of competition for a competitive bottleneck by a vertical dimension. A pure upstream player, U, as well as a vertically integrated content platform (CP) invest in infrastructure. Infrastructure increases the total size of market demand downstream (for example, by lowering latency which results in greater demand for new services).

U bargains with the CP and a pure downstream fringe platform (FP) for access to its network. Downstream, the CP and FP compete for consumers and collect advertisement revenues. While both platforms compete neck-to-neck over a portion of a market equal in size to the infrastructure that they both can access, the CP will generally rely on larger infrastructure. This larger infrastructure translates into an additional portion of the downstream market over which it has market power. The ability to charge high prices to some consumers impacts the CP's outside option when bargaining with U.

Preliminary results show that in this setup, both U and the CP have larger investment incentives when the CP owns the larger network. We claim that imposing net neutrality or mandated network access both reduce consumer welfare in this market. Furthermore, capacity constraints of the FP can explain the side payments that have been observed between content firms, such as Netflix, and carriers.

In non-technical terms, the paper's preliminary propositions and conjectures can be described as follows:

1. Absent net neutrality, when a pure upstream player and a vertically integrated digital platform company have similar investment costs, the latter has the larger incentives to invest in its network. Both firms have higher investment incentives when in equilibrium, the digital platform company has the larger network.
2. Under net neutrality, U will set a price that extracts the whole surplus of the digital platform. It will find it generally profitable to exclude fringe players, i.e. smaller platforms.
3. When large platform companies have to offer access to their proprietary networks under conditions that would pass current antitrust standards, such as the as-efficient-competitor principle, the result may be more competition but higher prices for consumers because the large platform can raise its rival's costs.
4. If smaller platform companies are unable to compete for all services with larger platform companies, for example due to barriers to entry, the investments incentives of an Internet Service Provider and a large platform company can coincide. When the investment costs of the Internet Service Provider are lower than those of the large platform company, the latter might offer a conditional payment to subsidize network investment.

Bericht.pdf?__blob=publicationFile&v=2 [in German]. The authors mention that on-demand server and network services allow small scale entry, while many large firms invest additionally in CDN to reduce response times. The report does not contain conclusions for the competitive assessment of these CDN.

Furthermore, the proposed research offers several possible routes for expansion which I will discuss in the full paper, including the role of competition in upstream markets, platform differentiation, innovation and steering.

Motivation and literature

Large digital platform companies increasingly integrate vertically by building Internet infrastructure, such as edge computing facilities, content delivery networks, or submarine cables. These investments enable new services while changing their bargaining power towards the upstream supplier. I model competing investment incentives in Internet infrastructure between an upstream player (e.g., an Internet carrier) and a large downstream platform and its effects on competition with smaller downstream platforms without proprietary infrastructure.

I preliminarily find that investment incentives increase both upstream and downstream when the downstream platform has the larger network. With symmetric investment costs, the downstream platform will invest more than a pure upstream player. I discuss the model implications for net neutrality, network access regulation, and efficient side payments between platform and upstream industry.

The current paper relates closely to the emerging literature on the economics of Internet infrastructure (Greenstein, 2020). Wilson, Xiao, and Orazem (2021) analyze the investment decisions of Internet service providers (ISP) and find long-term effects of investment delays on infrastructure quality. Greenstein and Fang (2020) find that market entry for data centers is driven by demand- rather than supply factors. Chaturvedi, Dutta, and Kanjilal (2021) investigate ISP pricing, in the presence of complementarities with content providers.

Net neutrality, the principle of non-discrimination of data by carriers, sets this industry apart from other vertical relationships. Even though net neutrality is controversial and not uniformly enforced, it poses economic questions and trade-offs as described by Greenstein, Peitz, and Valletti (2016). Current net neutrality regulation is uneven, focusing on ISP while leaving open bypass opportunities and loopholes for cloud services and content providers (Stocker, Smaragdakis, and W. Lehr, 2020). This paper contributes to this literature by exploring the implications of vertical integration by downstream content platforms on competition between platform companies. We analyze how Internet infrastructure as an essential input to content services impacts platform competition in a two-sided market framework.

Researchers in digital economics and computer science have started to document a trend towards private and proprietary networks which has drastically changed the ecosystem of the Internet in the recent past. This paper is a first approach from an economic theory angle to analyze the effects of this drastic shift in ownership structure. Stocker, Knieps, and Dietzel (2021) document extensively the geographic and virtual dimension of private networks and describe their implications for firm costs, service quality, and innovation. Concurrently, the future of the public “best-effort” Internet and the functional disparities between services that rely on it versus services that are supported by proprietary networks and clouds has caught attention (Lehr et al., 2019; Balakrishnan et al., 2021). By analyzing the previously overlooked competitive effect of a novel aspect of competition in digital markets that is currently used predominantly by the largest digital firms, this paper contributes to the academic debate on regulation and antitrust towards large technology companies (see also Petit, 2020).

Key references

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