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Some Economics of Digital Ecosystems – Note by Marc Bourreau

Hearing on Competition Economics of Digital Ecosystems

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Some Economics of Digital Ecosystems[1]

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Introduction: from digital conglomerates to product ecosystems

1. Over the last years, large digital conglomerates have emerged, such as the so-called GAFAM (Google, Apple, Facebook, Amazon, and Microsoft). These big-tech firms have achieved high degrees of diversification in different ways. They expand directly into new markets by introducing new products and services.[2] Diversification also happens through the financing of start-ups.[3] Last but not least, the big-tech firms grow via mergers and acquisitions. Some of them have made headlines (e.g., the acquisition of WhatsApp by Facebook in 2014 or LinkedIn by Microsoft in 2016). However, acquisitions of start-ups occur regularly on a much larger scale. For example, from 2015 to 2017, the five digital giants acquired a total of 175 companies.[4]

2. Today, competition in the digital sector is shaped by the competition between these large digital conglomerates.[5] Big-tech players all keep a stronghold where they have been historically dominant. For example, Alphabet/Google is dominant in search, Facebook in social networks, electronic commerce is dominated by Amazon, and Apple and Microsoft hold strong positions in operating systems.[6] Besides, these firms operate in many other markets, some related to their primary market, others not. As their market footprint overlaps, the big-tech firms compete with one another in many areas where they also face the competition of specialist firms.

3. Their multimarket presence allows big-tech firms to offer *product ecosystems*, that is, lines of products and services linked through shared functionalities, which provide benefits to the consumers when used together. For example, Apple offers an ecosystem of digital devices (the iPhone, the iPad, the iWatch, etc.), and Google an ecosystem of digital services (Gmail, Maps, Youtube, Google Doc, etc.).

4. In this paper, I first propose some economics of product ecosystems: what is a relevant definition of ecosystems for competition analysis? Which characteristics of technology favor the development of product ecosystems? Then, I discuss how competition between and within ecosystems may work and potential competition concerns.

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[1] Part of this note is based on Bourreau, Marc and Alexandre de Streel (2019), "Digital conglomerates and EU competition policy," mimeo.

[2] In 2017, their overall R&D investments were over $71 billion. See, Gautier, Axel and Joe Lamesch (2020). "Mergers in the digital economy." *Information Economics and Policy*, forthcoming.

[3] E.g., Google Ventures for Alphabet, Microsoft Ventures for Microsoft, Facebook Investment Arm.

[4] Gautier and Lamesch (2020).

[5] See Bourreau and de Streel (2019).

[6] Google has a market share worldwide above 90% in search (http://gs.statcounter.com/search-engine-market-share), and Facebook a market share of over 70% for social networks (https://gs.statcounter.com/social-media-stats). Amazon controls about 50% of e-commerce in the US (https://techcrunch.com/2018/07/13/amazons-share-of-the-us-e-commerce-market-is-now-49-or-5-of-all-retail-spend/?guccounter=2).

1. Some economics of ecosystems

1.1. What are ecosystems?

5. The concept of "ecosystem" has been developed in the strategic management literature, where it designates, roughly speaking, a group of firms that interact and depend on each other's activity (see, e.g., Jacobides, Cennarmo and Gawer, 2018, for a comprehensive overview).[7] In the digital economy, ecosystems of firms have developed around multi-sided platforms. For example, Amazon operates an ecosystem of independent sellers through its marketplace. Here, the platform plays the role of a regulator or coordinator of its environment, giving access to its customer base to independent vendors, which contribute to the platform's value through complementary product sales.[8]

6. However, another distinct feature of the digital economy today is that the big-tech firms often offer access to their consumers to a line of products and services rather than a single product or service.[9] In this paper, I will call *product ecosystem* a line of products and services with a technological linkage increasing the complementarity between them. For example, Apple offers access to a product ecosystem composed of various devices and services linked together through shared functionalities (e.g., the ability to receive messages, share files, take notes, etc., on all devices), to the benefit of the consumer. Similarly, Google provides multiple services to the consumer (mail, office software, maps, cloud service, etc.) that are linked together because they share relevant data, allowing for a high degree of service personalization across all services.

1.2. What features of the digital economy facilitate the development of product ecosystems?

7. Two key characteristics of the digital economy facilitate and encourage the development of product ecosystems.

8. First, on the supply side, firms enjoy strong economies of scope in product development. Economies of scope occur when it is less costly to produce two or more goods together in a given firm than separately. In particular, this happens when there are sharable inputs in the production process (Panzar and Willig, 1981).[10]

9. Economies of scope can exist in the production process but also at the product development stage, particularly when products adopt a modular design. A modular design means that a product consists of independent building blocks, or modules, whose interactions are ruled by standardized interfaces. Contrary to an integrated design, a modular design allows using and re-using components across various products and services within the same firm. Thus, it gives rise to economies of scope in product development.

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[7] Jacobides, Michael, Cennarmo, Carmelo and Annabelle Gawer (2018). Towards a theory of ecosystems. *Strategic Management Journal*, 39(8): 2255-2276.

[8] Hagiu, Jullien and Wright (2019) suggest that a platform may even have an incentive to host rivals into its ecosystem. The idea is that hosting a rival leads to lower shopping costs for consumers, which allows the platform to raise its access fee (see Hagiu, Andrei, Jullien, Bruno and Julian Wright A(2019). "Creating Platforms by Hosting Rivals." *Management Science*, 66(7): 3234-3248).

[9] There are few exceptions, with big-tech players like Booking, Airbnb, or Netflix, focusing on specific markets.

[10] Panzar, John and Robert Willig (1981). Economies of Scope. *Bell Journal of Economics*, 71(2): 268-272.

10. Digital products and services typically involve a modular design, because they are composed mainly of hardware or software components, which can be mixed and matched in different products and services, due to strong levels of standardization and interoperability. For example, Apple uses and re-uses its in-house processors across its product lines for iPhone, iPad, and Mac, rather than developing a specific processor for each device. Similarly, the progress made in artificial intelligence and algorithms allows companies like Google or Facebook to improve a whole range of services.

11. Due to their modular design, digital product components can be shared across a product line, leading to substantial economies of scope in product development. Once the basic components have been developed, the development costs of new products and services are significantly lower. Therefore, economies of scope in product development reduce the costs for firms to expand into a multi-product entity and to create product ecosystems.

12. Data represent an important sharable modular input for digital firms. Recent empirical evidence suggests that there are significant economies of scale in data exploitation. For example, Schaefer, Sapi and Lorincz (2018) show that larger amounts of data allow providing more relevant search results for a search engine.[11] In the same vein, Bajari, Chernozhukov, Hortaçsu and Suzuki (2019) find that more data bring forth more precise demand forecasts in electronic commerce.[12] Data can also generate substantial economies of scope in product development as they can be used to create different products thanks to their general-purpose nature. For example, Facebook recently entered the dating market with Facebook Dating, a service that relies on the data collected from social network users to find relevant matches.

13. A second key feature of the digital economy that can incentivize firms to develop product ecosystems is that on the demand side, consumers may enjoy benefits from the consumption of products or services from the same ecosystem.

14. These benefits can be of different types. Consumers can value purchasing different products or services from the same provider (one-stop shopping), for example, due to lower transaction costs. Consumption synergies can also arise due to firms' efforts to create ties or linkages between their products, which increase the complementarity between them. For example, Apple has developed a number of "continuity" features allowing to use one device to improve the experience with another one (e.g., use an iPad to expand the workspace of a Mac).[13]

15. When a product ecosystem generates consumption synergies, a consumer will derive a higher utility from joining the product ecosystem than from consuming the same products from independent providers, everything else equal. Thus, the presence of demand-side synergies gives firms an incentive to expand their product lines and create product ecosystems.

16. There is some degree of analogy between demand-side synergies and economies of scope in product development. In both cases, synergies are obtained due to shared functionalities across products. Therefore, modularity and what it implies in terms of

[11] Shaefer, Maximilian, Sapi, Geza and Szabolcs Lorincz (2018). "The effect of Big Data on Recommendation Quality. The Example of Internet Search." DICE Discussion Paper No. 284.

[12] Bajari, Patrick, Chernozhukov, Victor, Hortaçsu, Ali and Juinichi Suzuki (2019). "The impact of Big data on Firm Performance: An Empirical Investigation." *AEA Papers and Proceedings*, 109: 33-37, 2019.

[13] https://www.apple.com/macos/continuity/

standardization and operability, appears to be a necessary condition for both supply-side and demand-side synergies to arise.

17. Consumption synergies can be related to the network effects that an ecosystem firm enjoys in its primary market. Think of the example of Facebook Dating above. By linking its new dating service to its social network, Facebook can ensure that users of the dating service have access to a huge network from the very beginning. Thus, there are substantial consumption synergies from consuming the dating service from Facebook ecosystem.

1.3. What is the business model underpinning the development of ecosystems?

18. The digital firms that offer product ecosystems have adopted various business models, usually related to the business model they embraced in their primary market. The business model details have implications on the firm's incentives to develop and expand its product ecosystem.

19. Some digital players have created *device-centric* ecosystems (Apple or Microsoft, for example). The modular design of their products and services allows the firms to expand their product lines at relatively low cost. Linkages between their different products and services generate consumption synergies on the demand side. The firm then derive revenues by charging prices for their devices or services.

20. Other players have developed *ad-centric* ecosystems, like Google or Facebook, for example. Their objective is to attract a large audience, retain its attention, and monetize this audience with advertising. Economies of scope in product development facilitate expansion into a multiple-product entity, and consumption synergies allow to keep the consumer into the ecosystem. To attract a large audience, the firm typically offers free services to the consumers. It then charges advertisers to access their audience, which represents their main source of revenue.

21. Caffarra, Etro, Latham and Scott-Morton (2020) argue that these two different business models have different implications on the incentives to invest in the ecosystem quality.[14] In a device-centric ecosystem, quality improvements can be monetized in a standard way, either by charging a higher price for the ecosystem's products and services or by expanding sales. In an ad-centric ecosystem, the firm cannot easily extract the surplus generated on the consumer side by the quality improvement since monetization occurs on the advertising side. For example, quality improvements that would hardly increase the number of users or their participation level will be of little value for the firm. Conversely, investments that increase consumers' stickiness to the ecosystem are of high value.

22. Casadesus-Masanell and Hervas-Drane (2015) show that the device-centric and ad-centric business models can emerge as an equilibrium outcome when two firms compete in business models.[15] More precisely, they study a model where two firms can derive revenues from consumers by charging them a fee for their product or service and/or from a data market (which can also be interpreted as an advertising market) by monetizing the data collected from their users. They show that competition leads the two firms to differentiate their business models. One firm adopts a device-centric business model, deriving revenues by charging consumers, with low data collection (or advertising) levels. In contrast, the

[14] Caffarra, Cristina, Etro, Federico, Latham, Oliver, and Fiona Scott Morton (2020). "Designing regulation for digital platforms: Why economists need to work on business models." VOX, CEPR Policy Portal, 4 June.

[15] Ramon Casadesus-Masanell and Andres Hervas-Drane (2015). "Competing with Privacy." *Management Science*, 61(1): 229-246.

other firm adopts an ad-centric business model, charging very low prices to consumers (possibly even negative in their model) and deriving revenues from the data/advertising side.

2. Competition between and within ecosystems

23. In markets with product ecosystems, we can distinguish the competition taking place between ecosystems and the competition occurring within them.

2.1. Competition between ecosystems

24. Competition between ecosystems can be described as the competition between generalist firms offering an ecosystem of products and services to the consumers, each ecosystem being incompatible with the rivals. When she adopts a given ecosystem, a consumer runs the risk of being locked in and exploited ex-post by the ecosystem firm. However, the economic literature on 'systems' suggests that the competition between ecosystems is particularly intense, compared to a situation where consumers would consume the same types of products and services from 'specialists' (e.g., see, Matutes and Regibeau, 1988[16]). Therefore, even though consumers may be locked in *ex-post* into an ecosystem, from an *ex-ante* perspective, the competition between ecosystems to attract consumers will be fierce.

25. However, recent contributions show that this may not always be true. Matutes and Regibeau (1988) obtain their finding that competition between incompatible systems is more intense than competition between compatible systems in a duopoly setting with symmetric firms. Hurkens, Jeon and Menicucci (2019) show that the assumption of symmetric firms is crucial. If one ecosystem strongly dominates the others (in the sense that consumers derive a higher stand-alone utility from its products than from the rivals' products), the competition between ecosystems is less intense than the competition between specialist firms.[17] However, in the digital sector, one may argue that no ecosystem strongly dominates the others.

26. Kim and Choi (2015) and Zhou (2017) further show that the competition between ecosystems can be softer than the competition between specialists (hence, Matutes and Regibeau's finding is reversed) if the number of competitors is above a given threshold, where this threshold can be relatively small (e.g., it corresponds to 4 firms in Kim and Choi's setting).[18] If this is the case, the formation of incompatible ecosystems tends to soften competition compared to a situation where consumers would be able to adopt products and services from specialists.

27. Chen and Rey (2018) highlight another mechanism, which suggests that competition between ecosystems may be soft.[19] The authors study a conglomerate merger

[16] Matutes, Carmen and Pierre Regibeau (1988). ""Mix and Match": product compatibility without network externalities." *RAND Journal of Economics*, 19(2): 221-234.

[17] Hurkens, Sjaak, Jeon, Doh-Shin and Domenico Menicucci (2019). "Dominance and Competitive Bundling." *American Economic Journal: Microeconomics*, 11(3): 1-33.

[18] See Kim, Sang-Hyun and Jay Pil Choi (2015). "Optimal compatibility in systems markets." *Games and Economic Behavior*, 90: 106-118; Zhou, Jidong (2017). "Competitive bundling." *Econometrica*, 85(1): 145-172.

[19] Chen, Zhijun and Patrick Rey (2018). "A Theory of Conglomerates Mergers." Mimeo.

in a model with two independent oligopolistic product markets and Bertrand competition in each market before the merger. When the merger occurs, it involves one firm from each market and the merged entity can thus offer the two products (hence, offer a product ecosystem). They consider that consumers derive consumption synergies if they consume the two products from the merged entity. The authors then show that the merger softens price competition by creating a (vertical) differentiation between the ecosystem firm and the specialist firms. The former is perceived as high-quality due to the consumption synergies, while the latter are perceived by comparison as low-quality.

28. More generally, when a multi-product firm faces specialists rather than generalists (ecosystem firms), she may have an incentive to bundle its products and offer a product ecosystem to soften competition.[20] This is because the specialist firms, which sell complementarity products, do not internalize the complementarity between their products, and therefore, tend to set too high prices compared to the prices a generalist firm would have chosen, to the benefit of the ecosystem firm.

29. Finally, when firms offer product ecosystems, consumers may imperfectly anticipate their future usage in the ecosystem. For example, consumers may be unable to foresee perfectly which types of products and services they will find useful in the ecosystem in the future. This may also limit the ability of competition between ecosystems to work properly.

30. When competition occurs mainly between ecosystems, a relevant question concerns the prospect of entry of a new competitor.

31. A concern is that dominant firms may have control over product components essential to derive economies of scope in product development or consumption synergies. If new entrants cannot replicate the essential component, they may find themselves at a competitive disadvantage when introducing their product ecosystem, or may only be able to enter as a specialist.

32. Data may constitute an essential component. For example, data on consumer behavior allows Amazon to predict the demand for new products in a way that potential competitors may find hard to match. If product innovation is data-driven, incumbent ecosystem firms may be protected from potential competition, and the market will not be contestable.

2.2. Competition within ecosystems

33. Firms offering product ecosystems compete with one another but also face competition from specialized firms (specialists). For example, Facebook faces competition from Twitter in the market for social networks, Apple competes with device manufacturers in the smartphone or laptop markets, like Samsung or Lenovo, and Amazon has various rivals in electronic commerce.

34. The literature on systems suggests that specialists are at a disadvantage against generalist firms. This competitive disadvantage comes in particular from the fact that specialists do not internalize the complementarity between their product and the other ecosystem products, and consequently, tend to set too high prices. Therefore, even without any anti-competitive behavior from the dominant ecosystem firms, competition within the ecosystem, between ecosystems and specialists, may fail to emerge.

[20] See, e.g., Hurkens et al. (2019).

35. Bundling and the development of product ecosystems may also affect negatively innovative entry for more strategic reasons. For example, Choi and Stefanidis (2001) show that bundling can deter innovative entry in system markets.[21] The idea of their model is that through bundling, an incumbent firm imposes to potential rivals to enter all product markets, which raises barriers to entry.

36. Platform envelopment (Eisenmann, Parker, Van Alstyne, 2001)[22] represents another type of strategy which may prevent competition from emerging. Platform envelopment occurs when a dominant platform enters a new market created by a new entrant, and forecloses the entrant. In Eiseinmann et al. (2001)'s framework, the dominant platform enjoys two kinds of competitive advantage. First, it can leverage its customer base and the associated network effects from its primary market to the new market, possibly overtaking the entrant in terms of network benefits to the consumers. Secondly, shared components between the two product markets generate economies of scope, which represent another source of competitive advantage for the incumbent. This theory suggests that if a specialist succeeds in creating a new product or service, it faces the risk of being imitated and "enveloped" (foreclosed) by a dominant ecosystem. Anticipating this risk, the firm may renounce entering the market.

37. In a similar vein, Prufer and Shottmüller (2017) show that a firm benefitting from data-driven indirect network effects may leverage its market power in its primary market to enter and dominate a new market.[23] This happens if the two markets are "connected", meaning that data collected in one market facilitates quality improvement in the other market. Therefore, when they enjoy data-driven network effects, firms have an incentive to expand into connected markets. Specialists in connected markets may be unable to compete successfully with ecosystem firms if it requires access to the data from the primary market.

38. This discussion suggests that access to key components may be a pre-requisite for competition within an ecosystem to emerge and be sustainable.

3. Conclusion

39. Product ecosystems are lines of products and services with a technological linkage increasing the complementarity between them.

40. Two key features of the digital economy can favor the development of product ecosystems: (i) large economies of scope in product development, due to the modular design of digital products and services, and (ii) consumption synergies due to technological linkage between ecosystem products, increasing the complementarity between them.

41. When they choose to enter an ecosystem, consumers face the risk of being locked-in and exploited *ex-post*. This risk has to be balanced with the fierce competition between ecosystems to attract consumers in the first place. However, competition between ecosystems is strong, compared to the competition between specialized firms, only if a few of them operate, and they are relatively symmetric. If one ecosystem dominates the market,

[21] Choi, Jay Pil and Christodoulos Stefanadis (2001). "Tying, Investment, and the Dynamic Leverage Theory." *RAND Journal of Economics*, 32(1), 52-71.

[22] Eisenmann, Thomas, Parker, Geoffrey, Van Alstyne, Marshall (2011). "Platform Envelopment." *Strategic Management Journal*, 32: 1270-1285.

[23] Prufer, Jens and Christoph Schottmüller (2017). "Competing with Big Data." Tilburg Law School Legal Studies Research Paper Series No. 06/2017.

or the number of ecosystems is not small, competition between ecosystems may be less intense than competition between specialized firms.

42. Ecosystem firms benefit from supply-side and demand-side synergies and can internalize the complementarities between their products and services. Thus, when entering a market where an ecosystem firm operates, a new innovative firm may find itself at a substantial disadvantage. The incumbent firm may also engage in various entry-deterring strategies (bundling, envelopment), limiting entry prospects. In sum, competition within ecosystems may fail to emerge and be sustainable.