Coopetition and orchestration in demand-side inter-platform ecosystems: a quantitative analysis *

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Abstract

The increasing relevance of platform ecosystems has spurred a rich literature studying their value creation and value capture dynamics. These are shaped by coopetitive relations between a platform owner that acts as the only orchestrator and its complementors. However, little is known about these dynamics in the case of inter-platform ecosystems. In the latter, nongeneric complementarities between the agents making up the ecosystem are established between platforms, rather than within them. This article proposes an empirical analysis to study value creation, value capture and orchestration in demand-side inter-platform ecosystems. Using recent data from internet traffic between the major 246 European digital platforms, we develop a methodology to measure nongeneric complementarities in consumption between them and assess the nature of their competitive relationships. We corroborate that demand-side inter-platform ecosystems are a non-negligible phenomenon: 18% of these platforms show them. Moreover, we identify four types of such ecosystems defined by the coopetitive relationship linking their members: complementors, indirect competitors, direct competitiors and unrelated. Finally, we find evidence of some demand-side inter-platform ecosystems being co-orchestrated by multiple platforms and of one being user co-orchestrated.

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1 Introduction

Over the last few years, there has been a rising interest in understanding how firms create and capture value through ecosystems by balancing cooperative and competitive relations. In particular, management and antitrust scholars, as well as regulators, are paying increasing attention to these dynamics in the context of platform-based or "platform ecosystems", as platform organizational forms and related business models are ubiquitous in the digital age (Gawer, 2022; Parker & Alstyne, 2008) and ecosystems tend to be based on platforms (Jacobides et al., 2021).

The concept of "ecosystem" is built on the notion of nongeneric complementarities in production and consumption (Jacobides et al., 2018). The latter arise when firm A makes a specific investment (i.e. an investment that cannot be easily redeployed to function with another firm) to make its service complementary with legally-independent firm B's in such a way that it increases the value of firm B's service. For example, the flights metasearch engine Skyscanner offers a service that is tailored to facilitate the search and purchase of flight tickets. The features developed by this platform (e.g. price alerts, icons indicating conditions of purchase of the ticket such as whether it is flexible or not, etc.) make airline's websites more valuable: customers can find their preferred flight more easily, which increases airline's sales. On the contrary, while Google Search also makes virtually all websites more valuable for similar reasons, this search engine is not tailored to make any particular (type of) platform more valuable: it is a general-purpose technology analogous to electricity, which can power any electric device. Then, we can say that there are demand-side linkages between Skycanner and airline's platforms, but not between Google Search and the rest of the websites of the world wide web.

The ecosystems literature has provided a rich body of insights on how firms make strategic decisions within platform ecosystems. These insights build on a set of key intertwined features of platform ecosystems that underpin numerous theoretical contributions and case studies:

(i) **Intra-platform ecosystems**. Platform ecosystems are intra-platform in that nongeneric complementarities are only generated between the agents that compose it: the platform owner, complementors and end users. Hence, other platforms are either pure competitors or irrelevant to the platform owner, and they are therefore outside the boundaries of the ecosystem.

(ii) **Standard intra-platform coopetition**. Platform owners and complementors collaborate by generating nongeneric complementarities between their complementary products or services, but they also compete for value appropriation. Platform owners can, to a certain extent, compete with complementors by providing services that are substitutes to theirs.

(iii) **Single-firm orchestration**. Ecosystems have a single 'orchestrator'. In the case of a platform ecosystem, this is the platform owner.

These features are key to firms participating in a platform ecosystem in that they shape the boundaries and the nature of their competitive and value creation domains. Therefore, they have a major influence on how they form their strategy. Moreover, they are also essential to increasingly platform-ecosystems-aware antitrust authorities and regulators in their comprehension of platform ecosystems' competitive dynamics and boundaries. This interest is confirmed by the proliferation of high-profile pieces of legislation and studies dealing with competition issues in platform ecosystems such as the European Commission's Digital Markets Act[1], the recent United Kingdom's Competition Market's Authority market study of mobile ecosystems[2] or the new Greek competition bill[3], which contains specific provisions on digital ecosystems.

The platform strategy literature and anecdotal evidence suggest that these features might not describe all platform ecosystems. However, to the best of our knowledge, there has been no quantitative research that corroborates the existence and analyzes the nature of alternative types of platform ecosystems. This article proposes a contribution in that direction. Using a novel quantitative approach, we measure the boundaries and describe the nature of competitive relationships within inter-platform ecosystems. i.e., ecosystems created *between* platforms. In particular, we develop and test a methodology capable of capturing nongeneric complementarities in consumption ("demand-side linkages" hereafter) between the major 246 European platforms and assess the nature of their competitive relationships.

Building on this empirical methodology, we provide answers to three research questions and derive strategic implications. Are demand-side inter-platform ecosystems a prevalent phenomenon in the platform economy? If this is the case, firms with platform business models should not only consider the ecosystem they host within their platform (intra-platform ecosystems) as their competitive domain to form their

[1] See https://ec.europa.eu/competition-policy/sectors/ict/dma_en

[2] See https://www.gov.uk/cma-cases/mobile-ecosystems-market-study

[3] See https://www.lexology.com/library/detail.aspx?g=75527f4b-11fd-4922-9be0-cbee540b80bd

strategies, but also include the ecosystems they form with other platforms (inter-platform ecosystems). What is the nature of coopetitive dynamics (if any) within demand-side inter-platform ecosystem? If it is not the same as within intra-platform ecosystems, a promising research avenue to understand such a relevant phenomenom would open. Are demand-side inter-platform ecosystems always fully orchestrated by a single platform owner? If not, platform owners should consider the agency of other platform owners and end users when designing their competitive strategies.

Our three main results confirm that demand-side inter-platform ecosystems are a relevant phenomenon that presents significant differences (although also common aspects) with intra-platform ecosystems in terms of coopetitive dynamics and orchestration. First, we find demand-side linkages between 18% of the major 246 European platforms. Hence, it is not uncommon for a platform's boundaries of value creation and value capture to include another platform, even when both orchestrate their own ecosystems. Second, we find four types of demand-side inter-platform ecosystems distinguished by the coopetitive relationship linking their members: complementors, indirect competitors, direct competitors and unrelated. Although we find some commonalities with coopetitive dynamics in intra-platform ecosystems in that traditional envelopment strategies (envelopment of a weak substitute, unrelated or complement platform) are possible (Eisenmann et al., 2011), these strategies do not fully account for the existence and the nature of coopetitive relations in inter-platform ecosystems. Third, we find evidence of three types of orchestrations in demand-side inter-platform ecosystems : i) a 'traditional' one in which a single platform owner is the orchestrator, ii) co-orchestration between different platform owners and iii) co-orchestration between a platform owner and its users.

The rest of the article is structured as follows. Section 2 describes the dynamics of value creation and value capture in intra-platform ecosystems. Section 3 shows that the literature and some anecdotal evidence suggests the existence of (co-orchestrated) inter-platform ecosystems. Section 4 describes the data used and the transformations made to analyze it. Section 5 explains the methodology developed to measure demand-side linkages between platforms. Section 6 presents the main results and their implications. Section 7 concludes and indicates directions for further research.

2 Value creation, value capture and orchestration in intra-platform ecosystems

In this section we draw from the (platform) ecosystems literature to describe the main features of intra-platform ecosystems in terms of value capture, value creation and orchestration. In the following sections, we will empirically assess whether and to which extent they are present in inter-platform ecosystems and highlight the strategic relevance of our findings.

2.1 Defining platform ecosystems

Despite the multiplicity of definitions of the term "ecosystem" and related denominations that exist in the literature (Baldwin, 2020; Bogers et al., 2019; Jacobides et al., 2018; Kapoor, 2018; Moore, 2006; Adner, 2017), they all share the core idea of multilateral interdependence between legally independent firms that, on the basis of complementarities, (Hou & Shi, 2020)[4] jointly create value for customers. Following Jacobides et al. (2018, 2020), we define an ecosystem as "a set of actors with varying degrees of multilateral, nongeneric complementarities that are not fully hierarchically controlled" (Jacobides, Cennamo, & Gawer, 2018). Thus, ecosystems are distinct organizational forms from conglomerates (in which firms are not legally independent) and value chains. In the latter, contrary to in ecosystems, firms (be them legally independent or not) are vertically related, as they co-produce a final good. However, in ecosystems, firms are related through nongeneric complementarities between different goods and services. There can be complementarities in production (supply-side) or in consumption (demand-side) between two products or services. Two types of complementarities can be distinguished: unique (the value of A is maximized with B) and supermodular (more of A makes B more valuable). Moreover, they can be unidirectional (A is complementary with B but not viceversa) or bi-directional (A is complementary with B and viceversa).

A key aspect of Jacobides, Cennamo and Gawer's definition is that complementarities have to be nongeneric. For this to be the case, there have to be specific inter-organizational arrangements to enable value creation between two firms that are part of an ecosystem. For example, although tea and cups are complementary, none of the firms that produces them makes a specific investment for this complementarity to exist or to enhance it. Specific investments, in turn, are defined as non-fungible

[4] We exclude more restrictive uses of the term "ecosystem" that require complementary products to be sold by the same firm (Bourreau & De Streel, 2019) and, in some cases, to be sold as a bundle (Eben & Robertson, 2021; Crémer et al., 2019).

investments. Once a specific investment is made to generate complementarities with a firm, its output cannot be easily redeployed to create complementarities with another firm.[5] This is because for two platforms to make specific investment requires of each of them to "tailor, redesign or customize their products to the specificities of the other platform architecture in order for their products to offer value to customers" (Jacobides et al., 2020, p. 9).

Platform-based ecosystems, in turn, are a specific (yet pervasive) type of ecosystem in which complementarities are not only nongeneric (a necessary condition for ecosystems to exist), but also supermodular, the latter being a distinctive feature of platforms (Jacobides et al., 2021).

2.2 Value creation and value capture in intra-platform ecosystems

The platform ecosystems literature identifies three types of interdependent agents that constitute them: platform owners, complementors and end users (Cenamor, 2021; Cennamo, 2019; Eisenmann et al., 2006; Gawer, 2014; Thomas et al., 2014). By creating nongeneric complementarities with each other, they enhance two types of values to end users: stand-alone value (i.e. quality) and network value, which is linked to the installed user base (Davis, 1989; Katz & Shapiro, 1986).

Both the platform owner and its complementors can increase these values to end users through nongeneric complementarities. On the one hand, the number, variety and quality of complementors has a positive impact on the network value of the platform. High-quality complementary products have a disproportionate large effects on platform adoption, notably in early stages (Binken & Stremersch, 2009; Song et al., 2017). Complementary products with high network value also positively affect platform adoption, notably in late stages of the platform (Cenamor et al., 2013; Gallagher, 2012).

On the other hand, platforms' stand-alone and network values can be a source of competitive advantage for their complementors. In early stages, high-quality platforms offer the opportunity for complementors to differentiate their value proposition in order to satisfy early adopters' needs (Cennamo et al., 2018) and build a quality-based competitive advantage (Cenamor, 2021). Moreover, complementors can leverage the platform's network value, as it can be an important source of users. In late

[5]This notion of specific investments between platforms recalls the notion of "platform-specific investments" within platforms from Hagiu & Wright (2015).

stages in which the platform has a large user base and complementors find it harder to exploit network effects, the latter can encourage direct interaction and information exchange with end-users in order to enhance the complementary product's value (Marchand, 2016). Hence, the extent and the nature of nongeneric complementarities between complementors, the platform owner and the user base define the locus of value creation of a platform ecosystem.

In addition to being the basis of a platform ecosystem's value creation, nongeneric complementarities between its agents are also the ground on which complementors compete both with the platform owner and other complementors for value capture. Hence, (platform) ecosystems are characterized by a well-studied dynamic of coopetition, as firms belonging to the same ecosystem need to simultaneously cooperate through the creation of nongeneric complementarities in order to create value and compete for value capture (Panico & Cennamo, 2022; Zhu & Liu, 2018; Hannah & Eisenhardt, 2018; Ansari et al., 2016; Kapoor & Lee, 2013; Gawer & Henderson, 2007).

Platform owners can compete with complementors for value capture in multiple ways: raising fees, restricting access to resources, restricting access to the platform's user base and entering their market (Zhu & Liu, 2018). However, these actions have an impact on complementors' incentives to invest and behavior, and hence on their willingness to cooperate and create value (Gawer & Cusumano, 2014; Kapoor, 2014; Gawer & Henderson, 2007), although market entry can also "seed" the market with high-value complements (Kretschmer et al., 2022; Ozalp & Kretschmer, 2019; Pierce, 2009; Niedermayer, 2013). Complementors, in turn, compete with each other for end users within the platform. In certain platform ecosystems, complementors compete to be placed at the top of the platform rankings, which ensures more clients and hence more value capture (Boudreau & Jeppesen, 2015). Competition for end users can take many forms beyond pricing, such as copycatting (Xue et al., 2019), extending their portfolio to new product categories within same platform ecosystem (Barlow et al., 2019), doing complex innovation (Zhao et al., 2020) and differentiating their products to enter niche markets (Ozalp & Kretschmer, 2019). Then, competition between complementors, which is usually promoted by the platform owner, can increase the value of the platform to end users, as it can improve the variety and quality of output. In sum, coopetition is an inherent feature of (platform) ecosystems underpinning value creation and value capture. As a result, successful platform ecosystems have to balance competitive and cooperative tensions (Kretschmer et al., 2022).

Relationships between (platform) ecosystems' agents are neither based on formal bilateral contracts (as in supply chains) nor on hierarchical links (as in firms), but on voluntary cooperation for joint value creation between legally-independent firms. Then, the above-mentioned dynamics of value-creating cooperation (through the generation of nongeneric complementarities) and value capture each agent decides on on voluntary basis need to be 'orchestrated' in order for the platform ecosystem to produce a sustainable value proposition. It is outside of the scope of this article to review the multiple ways in which orchestration can take place [6]. For the purpose of this article, let us highlight that, according to the literature, orchestration[7] i) is always led by a firm, which in the case of platform ecosystems is the platform owner (Gawer et al., 2002; Gawer & Henderson, 2007) and, as highlighted by Teece (2010) and Jacobides, Sundararajan & Van Alstyne (2019) ii) implies for the orchestrator to "keep cospecialised assets in value-creating alignment, but also" iii) "to identify new cospecialised assets and divest or run down old cospecialised assets" (Hou & Shi, 2020). In other words, only the platform owner, in its role of the platform ecosystem orchestrator, can decide which agents may participate in the ecosystem (Eisenmann, 2008) to create nongeneric complementarities. Although "consumers have a say in the choice of complements", it is ultimately firms who "provide the contours of free choice" (Jacobides et al., 2020, p.24).

3 Towards (co-orchestrated) inter-platform ecosystems

As we showed in the previous section, the (platform) ecosystems literature studies ecosystems in which value creation and value capture take place through a platform and the only agents creating nongeneric complementarities are the platform owner, complementors and end users. The platform owner, in turn, plays the role of the orchestrator that decides, among other things, which agents can create nongeneric complementarities. In other words, the platform ecosystems literature focuses on intra-platform ecosystems.

However, none of the definitions of (platform) ecosystems cited above

[6]For a deeper analysis on the technological, institutional, economic and behavioral layers of ecosystem orchestration see Autio (2021).

[7]We employ the term 'orchestrator' as equivalent to several other terms that have been used to describe the same role, such as 'platform leader' (Cusumano & Gawer, 2002; Gawer & Cusumano, 2008), 'platform sponsor' (Eisenmann et al., 2011, 2008) or 'keystone organization' (Gueguen & Isckia, 2011; Iansiti & Levien, 2004)

requires nongeneric complementarities to exist only within the boundaries of a given platform. The distinctive features of platform ecosystems understood as an organizational form allow for the existence of both intra- and inter-platform ecosystems. Consistently, the platform strategy literature provides reasons to believe that platform ecosystems might extent beyond the boundaries of a single platform, and, moreover, that the platform owner might not always be the only orchestrator.

Karkhu and Ritala (2021) study the strategies through which entrant platforms can capture value without making upfront investments in value creation. One of these is "platform injection", a strategy through which "an entrant injects its own boundary resources into the incumbent's platform and ecosystem"(Karhu & Ritala, 2021), establishing so a competing platform inside the incumbent's ecosystem. Amazon used this strategy when it injected its Amazon Shopping app into Google Android's ecosystem by publishing it on Google Play. This app included digital content from Amazon Fire, a rival ecosystem to Google Play's. Similarly, Adobe tried to inject its Flash (the *de facto* interactive web apps developing standard by then) plug-in into Apple's iOS platform and Safari browser. When Apple prevented this on technical grounds, Adobe re-injected its platform by building a cross-code compiler enabling developers to compile their Flash as native iOS apps.

In a similar vein, Tiwana (2013) describes two types of envelopment strategies (Eisenmann et al., 2011) through which a platform can become a "nested platform" (i.e. a platform within a platform) in the context of apps ecosystems. The first one is "horizontal envelopment", where an app begins expanding its capabilities to provide value to other apps, eventually becoming an infrastructural component for other apps to build on. If it succeeds, the app might become the orchestrator of a new (nested) ecosystem. This has been the case of Google Chrome, which evolved from being simply an app within an ecosystem to an ecosystem with its own apps. The second one is "vertical envelopment", whereby an app starts to incorporate functionalities provided by a platform owner. If it succeeds, the app might evolve into an ecosystem of its own nested within the platform owner's.

Casadesus-Masanell & Campbell (2019) study the strategic interaction in the UK betting industry between the entrant platform Betfair and traditional bookmarkers. They find that although the two compete for clients, they also act as complementors to each other. Bookmarkers use Betfair as a channel to operate their business. The latter's transparent price policy allows bookmarkers to price their risk more accurately. Conversely, Betfair users benefit from bookmarkers' experience in setting initial prices for an event.

Kretschmer, Leiponen, Schilling & Vasudeva (2022) mention that "a platform ecosystem may also become embedded within another platform ecosystem with whom it hopes to sustain a synergistic relationship". The examples that they provide recall the notions of "platform injection", "horizontal envelopment" and "vertical envelopment" described above. One of them is the case popularly known as "Craiglist Hack", in which the then nascent Airbnb platform replied to accommodation listings in the classified platform Craiglist inviting users to migrate to Airbnb. Another example is that of Zynga Games (producer of the popular game Farmville), which used its role of a successful Facebook complementor (through which it provides its games) to build its own gaming ecosystem by leveraging on Facebook's user base. As these examples show, the relationship between these 'embedded ecosystems' "can be opportunistic, synergistic, or parasitic, and possibly all three" (OECD, 2019, p.86).

The common point to these contributions is that they highlight that there can be nongeneric complementarities *between* platforms if a platform acts as a complementor to another (often rival) platform.

Finally, we can question whether inter-platform ecosystems have an orchestrator and, if so, whether this role is necessarily (fully) played by a firm. Contrary to intra-platform ecosystems, in inter-platform ecosystems, nongeneric complementarities do not take place within a single platform controlled by a platform owner that becomes the 'natural' orchestrator. Then, which agent can play the role of orchestrator, if any? Could some or all the platforms linked through nongeneric complementarities be co-orchestrators? Moreover, the particularities of digital platforms provide reasons to believe that users could also be at the origin of nongeneric complementarities between platforms without that being envisioned by platform owners in the first place. End users can use a single feature of a platform in different manners and, in that way, generate unexpected nongeneric complementarities in consumption with another platform. In that case, users can be at the origin of the existence of (part of) an interplatform ecosystem.

Some anecdotal evidence supports this view. For example, the social media platform Twitter became popular among journalists and public figures. Although Twitter was not designed as a journalism-oriented platform, end users decided to use the resources that the platform provides in unexpected ways, such as inventing Twitter threads. These became complementary to newspapers in that they constitute specialized information sources. In response, Twitter made additional specific investments for its platform to have stronger generic complementarities with journalism-oriented users, such as fact-checking and account verification. In parallel, independent firms part of Twitter's ecosystem started offering thread-making tools. This example shows how unexpected uses of a platform by end users might trigger the extension of a platform ecosystem's boundaries in directions not foreseen by the platform owner. Another example is the popular photo- and video-based social media app Instagram, which, without the platform owner intending it, "is now a dating platform" (Safronova, 2017). For example, reacting to a user's photo post with a fire emoji became a user-generated code to signal romantic interest. Tinder users, in turn, would post their Instagram accounts in their profile in order to provide an alternative 'window' to themselves that could help them obtaining more and better matches on Tinder. Acknowledging this 'user diversion' of the resources provided by Instagram, the popular dating app Tinder added in 2015 a feature for users to be able to link their Tinder and Instagram accounts[8]. In other words, users sparked the generation of nongeneric complementarities between the two platforms.

In conclusion, as the literature and some anecdotal evidence suggest, platform ecosystems could be inter-platform and (user-)co-orchestrated. If this is the case, the strategic and regulatory implications would be major for several reasons. First, ecosystem boundaries define the confines of value creation between its participants. If several platforms are part of an inter-platform ecosystem, this implies that platform owners and complementors have to look beyond the intra-platform ecosystem they belong to in order to produce a strategy. Second, because coopetition is inherent to ecosystems, the existence of inter-platform ecosystems would expand value capture strategies beyond the platform and, by that token, affect value co-creation within the (inter-platform) ecosystem. This would be more the case if, as the literature suggests, inter-platform ecosystems are made of rival platforms. Third, (user-)co-orchestration of an ecosystem would add a degree of uncertainty to the platform owner in the building of its strategy, but also a set of new opportunities of value creation, as the examples of Twitter and Tinder show. Fourth, the existence of inter-platform ecosystems would modify the way regulators and antitrust authorities analyze platform ecosystems, a topic to which they are paying increasing attention. This interest is confirmed by the proliferation of high-profile pieces of legislation and studies dealing with competition issues in platform ecosystems such as the European Commission's Digital Markets Act[9], the recent United Kingdom's Competition Market's

[8] See https://www.thedrum.com/news/2015/04/15/tinder-integrates-instagram-provide-more-detailed-picture-swipers

[9] See https://ec.europa.eu/competition-policy/sectors/ict/dma_en

Authority market study of mobile ecosystems[10] or the new Greek competition bill[11], which contains specific provisions on digital ecosystems. Competition and regulatory analysis has incorporated the analysis of the interdependence between markets linked through indirect network effects within a platform (ecosystem) (Franck & Peitz, 2021; Evans & Noel, 2005; Filistrucchi et al., 2014). If inter-platform ecosystems are a relevant phenomenon, they should be incorporated to these analyses in a similar manner.

However, to the best of our knowledge, there has been no empirical research on the existence and the nature of (co-orchestrated) inter-platform ecosystems. Therefore, we have scant knowledge on the value creation, value capture and orchestration dynamics that underpin them, as we cannot assume that the insights derived from intra-platform ecosystems hold for inter-platform ecosystems.

This article proposes a contribution in that direction. Using a novel quantitative approach, we measure the boundaries and describe the nature of competitive relationships within inter-platform ecosystems. In particular, we develop and test a methodology capable of capturing nongeneric complementarities in consumption ("demand-side linkages") *between* the major 246 European platforms and assess the nature of their competitive relationships. We use that methodology to answer three research questions essential to the understanding of value creation, value capture and orchestration dynamics in inter-platform ecosystems. Are inter-platform ecosystems a prevalent phenomenon in the platform economy? If not, inter-platform ecosystems would be an intellectual curiosity without significant strategic and regulatory implications. What is the balance between and the nature of competition and cooperation between platforms within an inter-platform ecosystem? Are inter-platform ecosystems always fully orchestrated by a single firm? If not, platform owners should consider to a greater extent the agency of other agents such as other platform owners and end users when designing their value creation and competitive strategies.

In the following sections, we describe the data and the methodology used to design an empirical approach that allows us to answer these questions.

[10] See https://www.gov.uk/cma-cases/mobile-ecosystems-market-study
[11] See https://www.lexology.com/library/detail.aspx?g=75527f4b-11fd-4922-9be0-cbee540b80bd

4 Data

4.1 Source and structure of the raw data

We use data from SimilarWeb, one of the major web analytics companies. SimilarWeb provides information on website traffic volumes and rankings estimated using the data from internet service providers, web crawlers, and its user panel. The dataset downloaded ("original dataset" hereafter) captures all desktop traffic (measured in number of visits) between domains and the country of origin of the traffic for Europe and the United States. Each observation corresponds to traffic from an origin domain (e.g. www.google.com) and a destination domain (e.g. www.amazon.com). When traffic is direct (i.e. when traffic does not come from any other domain, such as when someone types the domain name in a web browser) the origin domain is referred to as "Direct". We selected only the traffic that included at least one domain belonging to one of the major 246 European digital platforms as the origin or the destination of the traffic in 2020. We narrowed the analysis to 20 European Member States in order to observe user behavior in the countries where these platforms are the most popular.[12] The original dataset contains 4 254 212 observations. This dataset gives us a comprehensive overview of cross-platform traffic for all the major European platforms. Thus, it is particularly suited to study inter-platform demand-side linkages. Table 1 below describes the variables of the original dataset. For a thorough description of the source types see Section 4.1.

[12]There is no information in SimilarWeb on Estonia, Cyprus, Latvia, Lithuania, Luxembourg, Malta and Slovenia.

Table 1: Description of the variables of the original database

Variable name	Description	Type of variable
domain	The domain that received traffic. For example, www.tripadvisor.com	string
in_referral	The domain that sent the traffic. For example, www.google.com	string
source_type	Type of traffic, divided into the following categories: "Search / Organic", "Search / Paid", "Direct", "Referral", "Email", "Social", "Display Ad" and "Other".	categorical string
visits	Number of visits from the domain sending the traffic to the domain receiving it for the period of analysis.	numeric
ctry	Country of origin of the traffic.	string

The major limitation of the original dataset is that it only captures desktop traffic. As a consequence, platforms such as food delivery platforms in which mobile app use is more relevant than desktop use are underrepresented. However, mobile apps rarely link to each other or to external websites. Consequently, demand-side linkages would be more difficult to find using mobile data. Moreover, the data does not allow us to distinguish business users from final users traffic. Hence, we cannot take the two-sideness of platforms (intra-platform demand-side linkages) into account in our analysis. Our focus is therefore on observing (less self-evident) inter-platform demand-side linkages.

4.2 Criteria of selection of the platforms and country coverage

The list of platforms selected captures the most frequently used platforms across the European Union's Member States following a methodology developed by the Observatory of the Platform Economy.[13] In order to assess how used platforms are, we used SimilarWeb's ranking. SimilarWeb displays the top-5 websites in each category and subcategory for each country. The ranking is based on a website traffic scoring method that calculates the number of monthly unique visitors together with the number of page views across desktop and mobile traffic. To implement the

[13] See https://platformobservatory.eu/

platform selection for each Member State, we selected platforms appearing among the top websites in the country, and additionally major platforms from each of the categories of websites provided by SimilarWeb (e.g. "social media", "search engines", "e-commerce marketplaces", etc.) that include platforms. The latter are conventionally defined as multisided markets in which at least two types of users benefit from positive indirect network effects.

We obtained a first list of 166 platforms[14] that we detailed in order to distinguish different platforms belonging to the same firm that were initially identified as one. For example, we distinguished Gmail from Google Search, two distinct services belonging to the same firm. The resulting list is made of 246 platforms. Although all traffic between these platforms and domains not belonging to any of them was analyzed and taken into account to build a proxy of the level of demand-side linkages (cf. Section 4.1 below), the results shown in Section 5 focus exclusively on the platforms identified as presenting demand-side linkages in the final list of 246 platforms on which this article focuses.

We carried out an analysis aggregating the 20 European countries of the sample in order to obtain a larger sample and capture cross-country traffic, as the raw data only provides information about the country of origin. Alternative analyses at the country level did not alter significantly the structure of the results in terms of cross-market linkages (cf. Figure 4 below); they simply reduced the number of platforms present.

4.3 Association of domains and platforms

In order to obtain platform-level data from the original dataset containing domain-level traffic, we created a dictionary matching platforms to domains. We built an initial dictionary by selecting the domains associated to the identified platforms (e.g. "blablacar.com" , "blablacar.fr", etc. for platform "BlaBlaCar") using a domain names search engine. We then eliminated the domains that were incorrectly assigned to a platform. For example, the domain "sapo.pl", a beauty products distribution company, was incorrectly associated to the news platform "sapo.pt". Inversely, we added domains corresponding to an identified platform that were not present in the initial list but appeared as sending traffic from/to one of the domains identified. For example, the domain "accounts.ebay.de" appeared as receiving traffic from the identified domain "ebay.com". Although it was not initially identified as one of Ebay's domains by the domain names

[14]The list of the 166 platforms can be found in Table 5 in the Appendix.

search engine, we included it as one of the domains associated to this platform in the final list.

The domains not associated to any platform but showing traffic from/to one were kept in the final sample and attributed the same identifier ("ND") in order to be treated as a single platform. This resulted in 3 068 domains linked to the 246 platforms analyzed, excluding the "ND" platform.

We then proceeded to eliminating platforms' self-traffic. For example, traffic from "allegro.pl" to "0.allegroimg.com", both belonging to the platform "Allegro", was treated as self-traffic and eliminated from the sample.

We associated each platform to a parent platform in order to distinguish traffic between platforms belonging to the same conglomerate from traffic between platforms not linked by ownership ties. For example, the platforms "Olx" and "Autovit" were associated to the parent platform "Olx", as they both belong to the OLX Group.

5 Methodology

There are empirical contributions to the ecosystems literature on which this article builds to tackle the issue of measuring the boundaries of an ecosystem. For example, Battistella et al. (2013) develop and test a methodology consisting in analyzing links that represent current tangible (monetary fluxes) and intangible (flows of knowledge and information) relationships, as well as possible future relationships between actors of an ecosystem (nodes). Similarly, Basole (2009) studies the mobile ecosystem by building a network of actors (nodes) linked through monetary and knowledge exchanges, but also commercial agreements (alliances, partnerships, etc.). Lee & Kim (2018) use network analysis to identify links between all the actors of the Korean ICT ecosystem across four layers, including a user layer that, contrary to previous studies, incorporates demand-side data. They measure how content (books, games, etc.) created by content providers flows from platform providers (IoS, Android, etc.) through network providers (e.g. AT&T) to personal devices manufactured by device providers.

In the same methodological vein, this article uses network analysis and clustering to detect relationships between firms in an ecosystem. However, it differs from this literature in three ways. First, while most of the existing empirical literature on ecosystems focuses on supply-side relationships (e.g. alliances, buyer/supplier relations, etc.) and, in rare cases, introduces a demand layer, our focus is exclusively on demand-side relationships. Second, to our knowledge, this article is the first one to use user traffic data to study demand-side complementarities in platform ecosystems. Finally, the empirical literature on ecosystems is mainly from technology-related fields and, for that reason, unlike this article, does not concentrate on the implications of these relationships in terms of regulatory and competition analysis. The rest of this article makes a contribution in that direction by measuring and analyzing demand-side linkages between the major legally-independent European digital platforms.

In the remaining of this section, we described the methodology employed.

5.1 Calculation of a proxy of demand-side nongeneric complementarities and choice of a threshold

In order to capture nongeneric complementarities, we exclude from the analysis traffic that does not fit the definition of this concept given in Section 2. This implies two methodological choices. First, as mentioned in the previous section, we only analyze referral traffic and not all the traffic between platforms that comes from other sources such as email or social media. SimilarWeb captures traffic that is classified into the following types of sources: “Direct”, “Mail”, “Referral”, “Social”, “Organic search”, “Paid search” and “Display ad”. “Direct” refers to traffic coming from users typing the URL of the website into a browser, using a link saved in a bookmark or coming from outside of the browser (e.g. a hyperlink in a Word file). In that regard, it does not entail any type of complementarity with another website. “Mail” and “Social” (the latter referring to traffic sent from social media platforms such as Facebook) traffic implies that individuals and organizations use a communication service nested in a platform to share links to another one. We do not consider this to imply that these actors are making a specific investment and hence does not imply that there are *nongeneric* complementarities between the two platforms. In an offline context, this would be analogous to using a telephone to order a pizza: neither the pizza shop nor the telephone company have done any specific investment to jointly create the value coming from combining their services. Like the telephone in this example, emails and social networks are general-purpose technologies that, although complementary to many other, do not require firms to do specific investments in order to generate these complementarities. Note in that respect that traffic originated in themed online communities such as the French-speaking videogame website and online forum “Jeux Vidéo” are not classified as “Social”. This is consistent with our identification of nongeneric complementarities in consumption. Indeed, platforms such as Jeux Vidéo do a specific investment to gather and entertain a specific type of user base that can only increase the value of certain other types of platforms with which the attention and input of this particular community is complementary.

“Organic search” and “Paid search”, in turn, imply that an individual clicked on a search result after doing a query in a search engine. Because the platforms classified as search engines are all generalistic search engines such as Google Search, we do not consider that links between them and other websites can reveal nongeneric complementarities. Again, in this case there is no specific investment behind cross-platform traffic. Indeed, Google uses an algorithm that can respond to any query and provide pertinent links to any website in the web. In contrast, traffic from specialized search engines such as Google Flights or Skyscanner to other websites (which are classified as referral traffic) do imply specific investments from the platform sending the traffic. Skyscanner tailors its data acquisition strategy to target airlines specifically and develops features to show users the options that are more relevant for them to chose a flight. These can be considered to be specific investments that cannot be redeployed to create value through complementarities with other firms besides airlines.

Finally, the “Display ad” category captures traffic generated by users clicking on a display or video ad via a known ad-serving platform. Given that the placement of these ads responds to the outcome of an auction to buy target advertisement space, we do not consider it to represent nongeneric complementarities. Platforms sending the traffic simply show the ad of the company that paid the most for the eyeballs of a particular type of user (e.g. a male 20 to 25 years old that likes motorbikes). This does not entail any type of specific investment from the platform sending or receiving the traffic.

The second methodological choice we made in order to exclude traffic not representing nongeneric complementarities consists in omitting traffic that is (mis)categorized as “referral traffic” coming from generalist search engines such as Google or from generalist social networks such as Facebook. In the latter case, referral traffic distinguishes clicks on links sent through these platforms’ messaging services as opposed to clicks appearing on a timeline. However, the same reasoning applies. Given that there is no specific investment from a platform such as Facebook for people to connect to other platforms through links sent on Messenger, we exclude this traffic from the sample.

Once we obtain a final dataset with only the traffic that can be considered to reveal nongeneric complementarities (i.e. corrected referral traffic), we calculate the share of total visits received by each platform from other platforms (246 in total) not belonging to the same conglomerate and the "ND" platform, which consolidates all other domains' traffic. The reason for excluding intra-conglomerate traffic from the numerator of this share is that, as the definition of "ecosystem" we follow and, more broadly, the literature specify, ecosystems are an organizational form between "a set of actors with varying degrees of multilateral, nongeneric complementarities *that are not fully hierarchically controlled*" (Jacobides, Cennamo, & Gawer, 2018).[15] Hence, we define the demand-side linkages from platorm A to platform B as

$$DSL_{A \to B} = \frac{RefTraf_{A \to B}}{\sum_{i=1}^{n} RefTraf_{i \to B}} \tag{1}$$

Where $RefTraf$ stands for "referral traffic", A and B are two legally independent platforms and n is the total number of platforms and non-platforms domains.

Equation 1 can be thus interpreted as the share of total inter-platform demand-side nongeneric complementarities traffic that goes from platform A to platform B, the two being legally independent.

We use this indicator as a proxy of demand-side complementarities: the higher the share of referral traffic platform A receives from platform B, the higher nongeneric complementarities in consumption from B to A are. The intuition behind this proxy can be interpreted both in terms of unique and supermodular complementarities in consumption. For example, since the hotel booking platform Hotels received 46% of its referral traffic from TripAdvisor, we can say that its value is maximized with the latter (unique nongeneric complementarity in consumption), as it allows consumers to find convenient hotels they might not have found otherwise. Alternatively, we can say that more of TripAdvisor makes Hotels more valuable (supermodular complementarity in consumption), as an increase in the use of TripAdvisor will generate more traffic to Hotels; this will raise its value because more users will review and book hotels from Hotels, which will allow the latter to offer a better service to its customers.

As this example illustrates, the classification of a certain share of total received referral traffic by platform A from platform B as nongeneric complementarities in consumption from B to A requires distinguishing

[15] Emphasis added.

incidental traffic from significant traffic. Only the latter should be considered to reveal nongeneric complementarities in consumption. A threshold of share of total received visits needs to be determined to make that distinction. It could be determined qualitatively on the basis of the analysis of traffic between platforms that are known to be complementary, similarly to market share thresholds indicating dominance in a market, which are established on the basis of past antitrust cases. We lack such information. Moreover, a qualitative approach would put a blind spot in demand-side linkages between platforms that could not be expected to be complementary. As our results show, these cases exist. Hence, we adopt an empirical approach.

In order to establish this threshold, we build a graph representing referral traffic (links) between the major European platforms (nodes). It should be noted that in order to capture all corrected referral traffic, we include platforms belonging to the same conglomerate in this graph. Links are directed to distinguish the platform sending and receiving the traffic and weighted with the number of visits. Table 2 presents the summary statistics of this graph. As the table shows, although referral traffic from/to a major European platform is not uncommon (each sends/receives traffic from about 29 other platforms in average, including the "ND" platform), it is in most cases negligible in terms of number of visits. Indeed, most of the traffic corresponds to very small shares of total received referral traffic (approximately zero in average). Consequently, the distribution of the weight of the links is rightly skewed and presents a high kurtosis coefficient.

Table 2: Summary statistics for the graph representing the directed loaded links between platforms represented by the variable "Share of received traffic" in 2020

Indicator	**Value**	**Description of the indicator**
N	244	Number of nodes (platforms)
K	3 506	Number of links (cross-traffic relations)
AvgDeg	28.63	Average degree of the network
MinW	≈0	Minimum weight of the links
MaxW	1	Maximum weight of the links
MeanW	0.06	Mean weight of the links
MedW	≈0	Median weight of the links
SDW	0.22	Standard deviation of the weight of the links
SkewW	3.70	Skewness coefficient of the weight of the links
KurtW	11.95	Kurtosis coefficient of the weight of the links

In order to exclude negligible traffic from our definition of demand-side linkages, we look for a threshold value at which the fall in the skewness and kurtosis coefficients stabilize when the threshold is increased. As Figures 5 to 7 in the Appendix show, this is the case for both indicators once a 10% threshold is reached. Moreover, at this point, the fall in the average degree the graph also stabilizes. In other words, with a threshold of 10% the noise of the sample consisting of sporadic low cross-traffic between platforms is eliminated. Hence, we adopt a 10% threshold of received referral traffic ("significant traffic" hereafter) in our analysis.[16] This threshold is also reasonable from a qualitative point of view, as we can consider that if platform A receives at least 10% of its referral traffic from platform B, there are nongeneric complementarities in consumption from B to A.

5.2 Classification of platforms and their competitive relations

In order to identify the markets in which platforms are active and the competitive dynamics that underpin their cross-traffic, we create our own classification of platforms in terms of the main (sub)topic they cover and the (sub)service they provide. For example, the fashion online retailer platform Boozt is classified under topic "Retail", subtopic "Fashion", service "Marketplace" and subservice "Vendors", the latter being distinct from subservice "Classifieds", which describes secondhand online marketplaces. The classification was made on the basis of a qualitative assessment of the platforms. When more than one (sub)service or (sub)topic existed, the main one was chosen based on the number of listings when pertinent (e.g. if there were more items listed as second hand than as new in an online marketplace, the former was chosen as the main subservice) or by detecting the most prominent one in the description of the platform in its website and app stores. For example, although Booking allows to search and book lodging, flights, rental cars, tourist attractions and taxis from/to airports, we classified it in the "lodging" subtopic category, as its main market is lodging, which is consistent with its self-description: its webpage and app stores header are "The best hotels & accomodations" and "Hotels & Vacation Rentals", respectively. However, platforms' multiple (sub)topics and (sub)services were taken into account when analyzing the competitive relations between those presenting significant traffic.

Drawing on this classification, we established 6 competitive relation categories described in Table 3 below.

[16] The results in terms of clusters of demand-linked markets (cf. Figure 4) are robust when higher thresholds are chosen. We tested for thresholds between 0.1 and 0.9 and obtained the same clusters from 0.1 to 0.5 with the exception of a 0.2 threshold, in which two clusters shown in the results were merged.

Table 3: Categories of competitive relations

Competitive relations category	Description	Example
Direct competitors high	Platforms that share the service and the subtopic	Booking & Airbnb
Direct competitors medium	Platforms that share the service and partially share the subtopic	TripAdvisor & Airbnb
Indirect competitors high	Platforms that share the service but not the subtopic	Google Search & Skyscanner
Complementors high	Platforms that do not share the service but share the subtopic	Trovaprezzi & Amazon
Complementors medium	Cross-traffic between platforms with subtopic "price comparison" and platforms with topic "retail"	Idealo & Otto
Unrelated	Platforms that share neither the service nor the subtopic	Jeuxvideo & Leboncoin

We consider the following subtopics to be partially similar: "women fashion" and "fashion", on one hand, and "tourism", "air travel" and "lodging", on the other hand. As a result, platforms sharing these subtopics are considered to be medium level (as opposed to high level) competitors or complementors depending on whether they share the main service or not, respectively.

Let us now develop on the examples that illustrate how we classified competitive relationships between platforms. Booking and Airbnb share the service ("search") and subtopic ("lodging"). Thus, they are direct competitors active in the same relevant market because they provide substitute services: finding and booking accommodation. TripAdvisor and Airbnb, in turn, share the service "search" but not the subtopic. The former's is "tourism" while the latter's "lodging". This is because, although TripAdvisor does allow to look for accomodation and book it, it also provides broader tourism-related services for which it is more known such as restaurant ratings, flight search and car rentals. Hence, TripAdvisor is a direct competitor of Airbnb to a lesser extent than Booking. Google Search and Skyscanner are good examples of indirect competitors. They share the service ("search") but not the subtopic. Google Search's is "search" while Skyscanner's is "air travel". This translates the fact that, although they both compete on the search engine market, they compete for customers only partially. Google is a generalist search engine and Skyscanner is a search engine specialized in flight tickets. For the same reason, they only compete partially for keyword and display advertising. Trovaprezzi, a generalist price comparison platform, is a high compelementor of Amazon, a generalist marketplace. They share the "retail" subtopic but they have different and complementary services: Amazon's is "marketplace" and Trovaprezzi's is "search". The case of Idealo, another generalist price comparison platform, and Otto, a fashion marketplace, is slightly different. For the same reasons as in the previous example, they are both considered to be complementors, but to a lesser extent than Amazon and Trovaprezzi. In the case of Idealo and Otto, the former is generalist and the latter specialized, so their level of complementarity is lower than if they were both generalist or both specialized in the same subtopic. Finally, Jeux Vidéo is a gaming forum and LeBoncoin a secondhand marketplace. They do not share neither the service nor the subtopic. Hence, they are considered to be unrelated.

5.3 Construction of a network and community structure detection

Using the subset of the final dataset that corresponds to cross-traffic between platforms representing at least a 10% of total received referral traffic by the receiving platform, we define two networks. In the first one (cf. Figure 1), each platform constitutes a node and the share of received referral traffic is represented by a weighted directed link from the platform sending the traffic to the platform receiving it. The weight of the links is equal to the share of received referral traffic by the receiving platform. Links are classified into the 6 categories corresponding to the types of competitive relationships they represent as detailed in Table 3. In the second network (cf. Figure 4), nodes correspond to markets, which are defined as unique combinations of platforms' main service and subtopic. Platforms sharing these characteristics and their traffic are aggregated and treated as a single entity represented by a node. Weighted direct links, in turn, represent cross-traffic between and within markets. Their weight is equal to the share of received referral traffic by the receiving market. Contrary to the first network, this network allows for loops and does not classify links into categories.

We applied the "cluster optimal" community detection algorithm developed by Brandes et al. (2007) to each network object (graph) in order to obtain subgraphs of nodes representing a series of platforms or markets related through demand-side linkages. This algorithm is based on maximizing the modularity measure over all possible partitions. The higher the modularity of nodes within a subgraph is, the denser connections between the nodes within it are. Conversely, this implies that connections between nodes in different subgraphs are sparser. Alternative community detection algorithms tested generated very similar communities.

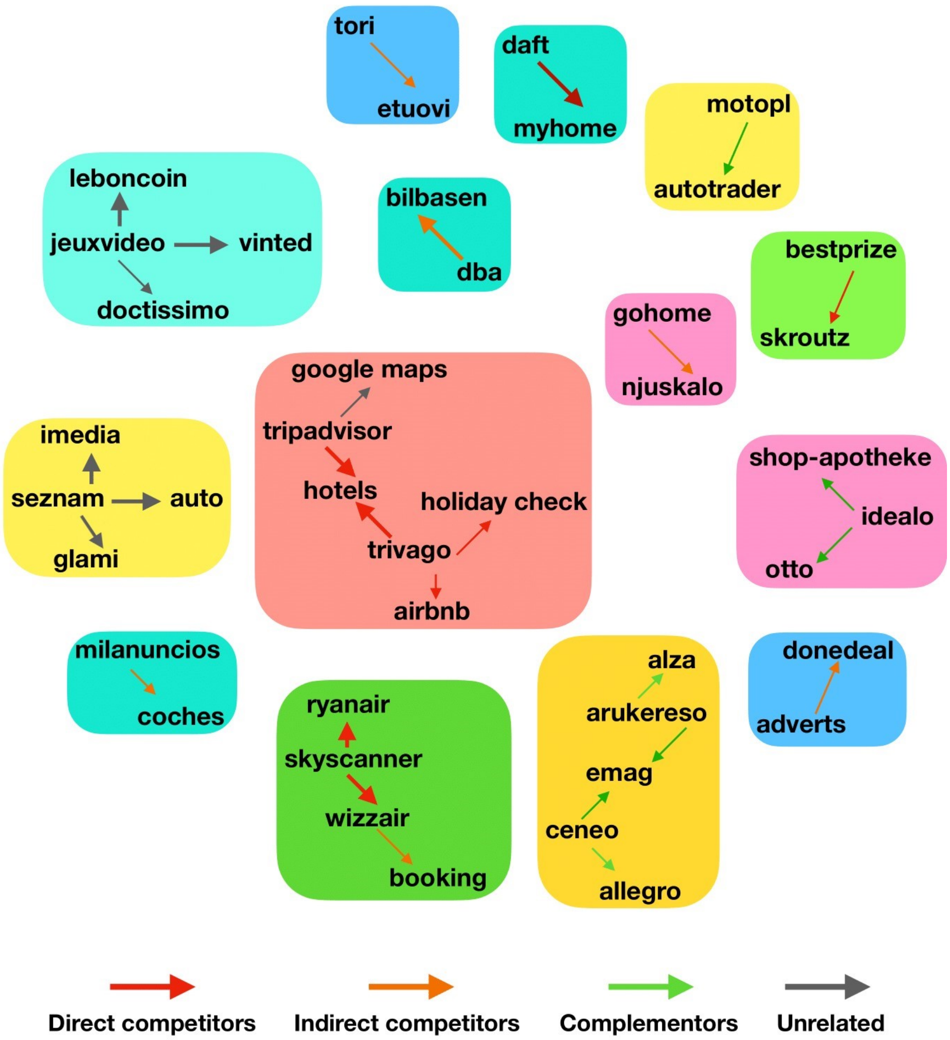
6 Results

The main goal of this article is to empirically analyze some constitutive features of inter-platform ecosystems and derive theoretical implications. In order to do so, we focus on three research questions. Are inter-platform ecosystems a prevalent phenomenon in the platform economy? What is the balance between and the nature of competition and cooperation between platforms within an inter-platform ecosystem? Are inter-platform ecosystems always fully orchestrated by a single firm? In this section we use the methodology described above to answer them.

6.1 Extent and intensity of demand-side linkages in inter-platform ecosystems

Figure 1 summarizes the main findings of the empirical analysis. The network represents the 44 platforms (nodes) that are connected through demand-side linkages out of the 246 platforms analyzed. The thickness of the links corresponds to the degree of demand-side linkages measured in terms of the share of significant referral traffic received. The nature of the competitive relationship between the firms linked through demand-side linkages is represented by the color of the link. Painted areas correspond to 15 subgraphs of firms connected to each other through demand-side linkages, which we can assimilate to demand-side inter-platform ecosystems. It is interesting to notice that these subgraphs are not connected to each other. This implies that no platform plays the role of bridging demand-side inter-platform ecosystems.

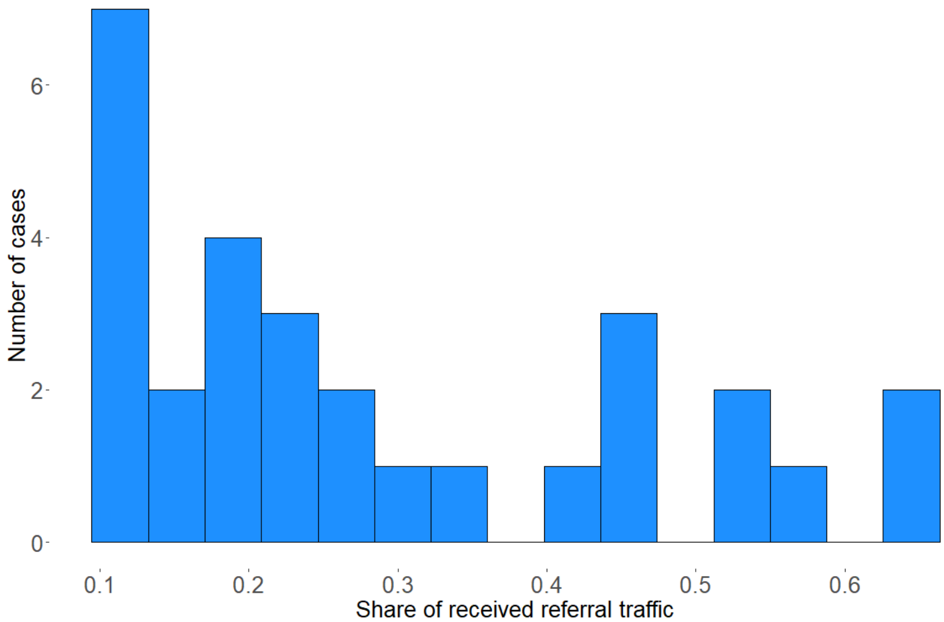
Figure 1: Significant desktop referral traffic between the major legally-independent European platforms in 2020



The thickness of the links is proportional to the share of total received referral traffic. Traffic below 10% of total received referral traffic, between platforms belonging to the same conglomerate and including non-platform domains excluded. Twenty European countries included. Painted areas correspond to the communities detected.

Using the results summarized in Figure 1, we shall now address our research questions. Regarding the prevalence of demand-side inter-platform ecosystems, we find demand-side linkages between 18% of the major 246 European platforms. As shown in Figure 2, the intensity of these linkages, measured as the share of received significant referral traffic, varies considerably across platforms. Demand-side linkages slightly over 10% (the threshold found to distinguish occasional from significant referral traffic) are the most common, although not the majority. For the rest of the cases, the intensity of demand-side linkages is rather evenly distributed and reaches a maximum level of 64%. The mean and median intensity of demand-side linkages are 29% and 22%, respectively.

Figure 2: Distribution of the level of demand-side linkages between the major legally-independent European platforms in 2020



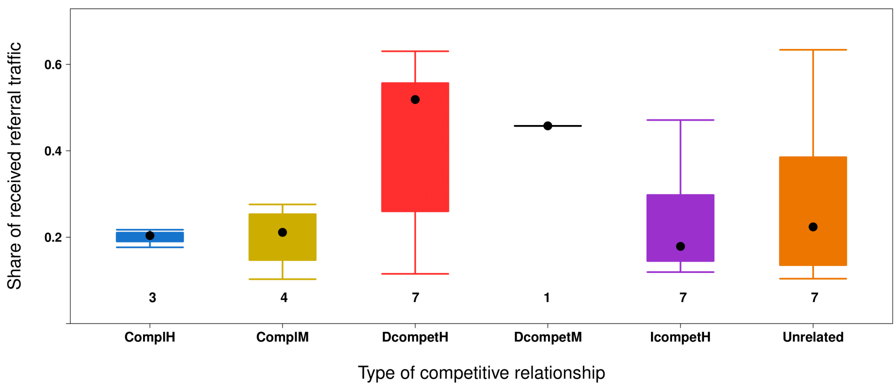
It should be noted that demand-side linkages between platforms with common ownership (e.g. Gmail and Google Search, both owned by Alphabet) are excluded from the results presented because the concept of ecosystems requires firms to be legally independent. However, as mentioned above, firms with common ownership are taken in to account when calculating the share of received referral traffic from/to legally-independent firms. Hence, given that the list of 246 platforms analyzed includes several platforms belonging to the same conglomerate, the maximum share of platforms that could potentially present demand-side linkages in this sample is not 100%. Alternatively, we could calculate the number of "parent platforms" (e.g. Alphabet) that have demand-side linkages with another parent platform. For example, if Gmail presented demand-side linkages with Yahoo Finance and with Yahoo Answers (two separate platforms owned by the parent platform Yahoo), this would be counted as two (and not three) *parent* platforms presenting demand-side linkages over a total of 143 parent platforms. Using this alternative calculation, we find demand-side linkages between 31% of the major parent platforms. Independently of the method chosen, the results show that, both in terms of the share of platforms presenting demand-side linkages and their mean/median intensity, nongeneric complementarities in consumption are a non-negligible phenomenon in the European platform economy. This confirms the empirical relevance of the concept of inter-platform ecosystems. However, in order to assess the implications of the existence of demand-side linkages in terms of value creation and capture dynamics, we need to analyze the coopetitive relations between platforms forming an inter-platform ecosystem. In the next subsection we turn to this.

6.2 Coopetition in demand-side inter-platform ecosystems

In order to study the balance between and the nature of competition and cooperation between platforms within inter-platform ecosystems, we analyze Figure 3 in the light of Figure 1. On this basis, we first provide a description of the four types of inter-platform ecosystems observed and then we analyze the coopetitive relations that characterize them.

Figure 3 shows the intensity of demand-side linkages (i.e. the level of cooperation through the creation of nongeneric complementarities in consumption) between platforms forming an inter-platform ecosystems by type of competitive relationship (complementors, indirect competitors, direct competitors or unrelated).

Figure 3: Distribution of significant desktop referral traffic between the major legally-independent European platforms according by type of competitive relationship in 2020



The numbers below the box plots correspond to the number of links between platforms detected for the category. Traffic below 10% of total received referral traffic, between platforms belonging to the same conglomerate and including non-platform domains excluded. Twenty European countries included.

The analysis of Figure 3 allows us to identify four types of inter-platform ecosystems in terms of their coopetitive dynamics, each representing roughly a quarter of the platforms involved in inter-platform ecosystems.

Complementors inter-platform ecosystems. These ecosystems are made of platforms providing complementary services. In particular, we find evidence of ecosystems in which demand-side linkages go from price comparison tools to marketplaces (cf. yellow cluster in the lower-right side of Figure 1) and from a specialized car news platform to a specialized cars marketplace (cf. yellow cluster in the upper-right side of Figure 1). These ecosystems represent 24% of the platforms participating in inter-platform ecosystems in the sample and have a standard median value of demand-side linkages close to 20%.

Indirect competitors inter-platform ecosystems. These ecosystems are made of platforms that provide services that partially overlap. The majority of the platforms taking part in these ecosystems are generalist classifieds marketplaces creating demand-side linkages with classified marketplaces specialized in products such as housing (Tori/Etuovi) or cars (Dba/Bilbasen; Milanuncios/Coches). In these cases, the generalist marketplace, which has higher traffic, creates demand-side linkages with a specialized platform that competes with it in one of the product categories it offers. An alternative yet minority pattern in which the most specialized platform sends traffic to the most generalist one can be found in two cases. The first one is represented by Wizzair (flight search and booking platform), which creates demand-side linkages with Booking (mainly lodging -but also flights- booking platform). In this case, the most specialized platform sends traffic to the most generalist one. The direction of demand-side linkages mimics the user's buying experience: first buying a flight, and then opting for an accommodation provided by another partially rival platform. The second one is represented by Gohome (a real estate marketplace) creating demand-side linkages with Njuskalo (a generalist classifieds marketplace). Indirect competitors inter-platform ecosystems gather 24% of the platforms participating in inter-platform ecosystems in the sample and have a standard median value of demand-side linkages close to 20%.

Direct competitors inter-platform ecosystems. These ecosystems are made of platforms for which their main markets fully overlap. We observe three main types of platforms creating demand-side linkages with direct competitors: flight search and booking (Skyscanner/Wizzair/Ryanair), lodging search and booking (TripAdvisor/Hotels/Trivago/Holiday Check/Airbnb) and real estate marketplaces (Daft/My Home). These inter-platform ecosystems represent slightly over a quarter (28%) of the platforms participating in inter-platform ecosystems in the sample. More interestingly, the intensity of demand-side linkages are considerably higher in direct competitors inter-platform ecosystems than in others: over 50%, as opposed to close to 20% for the rest of the types inter-platform ecosystems identified.

Industry-agnostic inter-platform ecosystems. These ecosystems are made of platforms that are seemingly unrelated in that they provide different services in heterogeneous domains. We observe two of such cases. The first one is constituted by the web portal Seznam, which creates demand-side linkages with Glami (a fashion price comparison platform), Imedia (a firm offering communication services) and Auto, a car news platform. The second one is constituted by the gaming forum and news platform Jeux Vidéo, which creates demand-side linkages with LebonCoin (a generalist classifieds platform), Vinted (a second hand clothing marketplace) and Doctissimo (a health news portal). In both cases, the rationale is that of a platform that attracts a user base interested in seemingly unrelated topics and creates demand-side linkages with other platforms specialized in those topics [17]. Finally, we find demand-side linkages between TripAdvisor and Google Maps, two platforms that are part of an inter-platform ecosystem in which demand-side linkages between direct competitors predominate. In this case, the rationale of the nongeneric complementarity is easy to interpret: TripAdvisor seeks to redirect users to GoogleMaps in order to provide a better understanding of the location of and routing to the sites it provides information on.

Note that, except for minor exceptions like the one just mentioned, the four types of inter-platform ecosystems are 'pure' in that the competitive relationships between the platforms that constitute them (complementors, indirect competitors, direct competitors or unrelated) are of the same nature. Moreover, regardless of the nature of their competitive relationships, the demand-side linkages created between platforms are always one-sided. Despite these commonalities, we find major differences between these four types of inter-platform ecosystems in terms of the type of coopetitive relations platforms establish within them.

Complementors types of inter-platform ecosystems' coopetitive relationships are characterized by medium levels of cooperation and low-medium levels of competition. In these inter-platform ecosystems, a platform (e.g. a price comparison tool) decides to generate demand-side linkages with another platform offering a complementary service located in an adjacent market (e.g. an online marketplace) in order to increase its

[17] We will come back to this point in greater detail in the next subsection.

value creation capacities. As in intra-platform ecosystems, both platforms can increase their user base through nongeneric complementarities in consumption. For example, the price conmparison platform becomes more useful to its users (i.e. it can increase its stand-alone value) by offering them a complementary service (the capacity to buy the products found), which in turn increases its network value. This, in turn, mechanically increases the network value of the other platform. While the platforms do not compete in the same market, there is a risk of envelopment of complements (Eisenmann et al., 2011) given that they are in adjacent markets. Hence, the level of competition is low-medium, as the platforms can compete for value capture without competing for customers. For example, they can compete in terms referral fees or by restricting referral traffic or access to the platform's information (e.g. by not providing APIs, making web scrapping more difficult, etc.).

Indirect competitors inter-platform ecosystems' coopetitive relationships are characterized by medium levels of cooperation and medium levels of competition. In these inter-platform ecosystems, a platform (e.g. a generalist marketplace) decides to create demand-side linkages with another platform (e.g. a specialized marketplace) despite it being a competitor in at least one of the markets it serves. In doing so, the platform creating the demand-side linkage expects to increase its value creation capacity. This will happen if this demand-side linkage increases its stand-alone value by facilitating access to another platform that provides either a service it does not provide or a higher-quality service it provides. Although this can entail a loss of sales in the overlapping market, the platform creating the demand-side linkage expects that this will be more than compensated by an increase in its network value stemming from the fact that the higher quality will translate into more users. Then, possible losses in the overlapping market would be more than compensated by higher sales in other markets. For the receiving platform, in turn, the relation created by the demand-side linkage is purely beneficial in the short run. However, in the longer run, the platform creating demand-side linkages might use them to envelop a weak substitute (Eisenmann et al., 2011). In this case, if it succeeds, the network value of the other platform would decrease. In these types of inter-platform ecosystems, competition for value capture takes place in terms of product competition. However, it can also take other forms referred to above (referral fees, restricting access to APIs, etc.).

In **direct competitors inter-platform ecosystems**, because the platforms' main markets overlap and the observed level of demand-side linkages is high (cf. Figure 3), coopetitive relations are characterized by high levels of cooperation and competition. In this type of inter-platform ecosystem, a platform (e.g. a lodging booking platform) decides to cooperate with a rival platform in order to increase its network value and ultimately drive out of the market the other platform. This "platform absortion" envelopment strategy can be thought of as the inverse of the "platform injection" (Karhu & Ritala, 2021) strategy. In the former, the target platform is absorbed if the platform generating the demand-side linkages manages to become the gateway to the users of the market in which they both compete. In order for this to happen, strong demand-side linkages with the absorbed platform are needed. If the strategy is effective, the absorbed platform should see its network value decrease in the long run and the share of users referred by the platform creating the complementarities increase. The platform creating demand-side linkages, in turn, will see its network value increase. Competition between these platform takes place both in terms of competition for customers in the same market and by the above-mentioned other means.

Finally, in **industry-agnostic inter-platform ecosystems**, the coopetitive dynamics are characterized by medium levels of cooperation and low levels of competition. In these inter-platform ecosystems, the platform creating demand-side linkages cooperates to increase its standalone value by offering an easy access to other platforms located in unrelated markets that share a user base. The platform creating the complementarities increases its standalone value by facilitating access to other platforms its user based is interested in. This, in turn, should increase its user base, and hence its network value. The other platform benefits from an increase in traffic, which boosts its network value. Given that the platforms are located in unrelated non-adjacent markets, although there is a risk of envelopment of unrelated platforms (Eisenmann et al., 2011), this risk is lower compared to the one faced by platforms in complementors' inter-platform ecosystem. The platforms can compete for value capture through other means than product competition.

Table 4 below provides a summary of the characteristics of the four types of inter-platform ecosystems in terms of their coopetitive relationships.

Table 4: Coopetitive relations in inter-platform ecosystems

		Relationship between the inter-platform ecosystem participants			
		Complementors	**Indirect competitors**	**Direct competitors**	**Unrelated**
Reason to start coopeting		Increasing value creation Possible envelopment of complements	Increasing value creation Possible envelopment of weak substitutes	Platform absortion	Increasing value creation Possible envelopment of unrelated platform
Cooperation intensity		Medium	Medium	High	Medium
Type of value creation	For the platform creating the DSL	Stand-alone and network value	Stand-alone and network value	Network value	Stand-alone and network value
	For the platform not creating the DSL	Network value	Network value	Network value (at least in the short-run)	Network value
Competition intensity		Low-medium	Medium	High	Low
Value capture mechanism	For the platform creating the DSL	Other	Product competition and other	Product competition and other	Other
	For the platform not creating the DSL	Other	Product competition and other	Product competition and other	Other

Although the existence of all of these inter-platform ecosystems could be explained by a type of envelopment strategy, traditional envelopment strategies (Eisenmann et al., 2011) cannot fully account for the existence of inter-platform ecosystems for two reasons. First, except for the case of direct competitors' inter-platform ecosystems, as shown above, value creation motives that do not necessarily imply envelopment can explain the existence of these ecosystems. Second, even when a traditional envelopment strategy (i.e. envelopment of weak substitute, unrelated or complement platforms) is at the origin of the inter-platform ecosystem, it does not take place through tying or bundling, but through the creation of nongeneric complementarities in consumption.

As a result, we observe coopetitive dynamics that are not characteristic of traditional platform envelopment strategies and differ from those of intra-platform ecosystems. Only the complementors and, to a lesser extent, indirect competitors types of ecosystems are characterized by coopetitive relations that resemble those of intra-platform ecosystems. In the former, like in intra-platform ecosystems, agents offer complementary services. In the latter, as it can be the case in intra-platform ecosystems when the platform owner enters the complementor's market, agents provide partially overlapping services. In the other two cases, contrary to what happens in intra-platform ecosystems, agents might decide to establish a coopetitive relation within an ecosystem even when the services they provide are unrelated or fully overlap. Moreover, in the four types inter-platform ecosystems identified, contrary to what happens in intra-platform ecosystems, some or all the agents can be orchestrators of their own intra-platform ecosystems. In the case of the main European platforms found to take part in inter-platform ecosystems, this is usually the case[18]. However, it is less clear which agent(s), if any, orchestrate(s) an inter-platform ecosystem. In the next subsection we provide some hypotheses on this on the basis of the results of the data analysis.

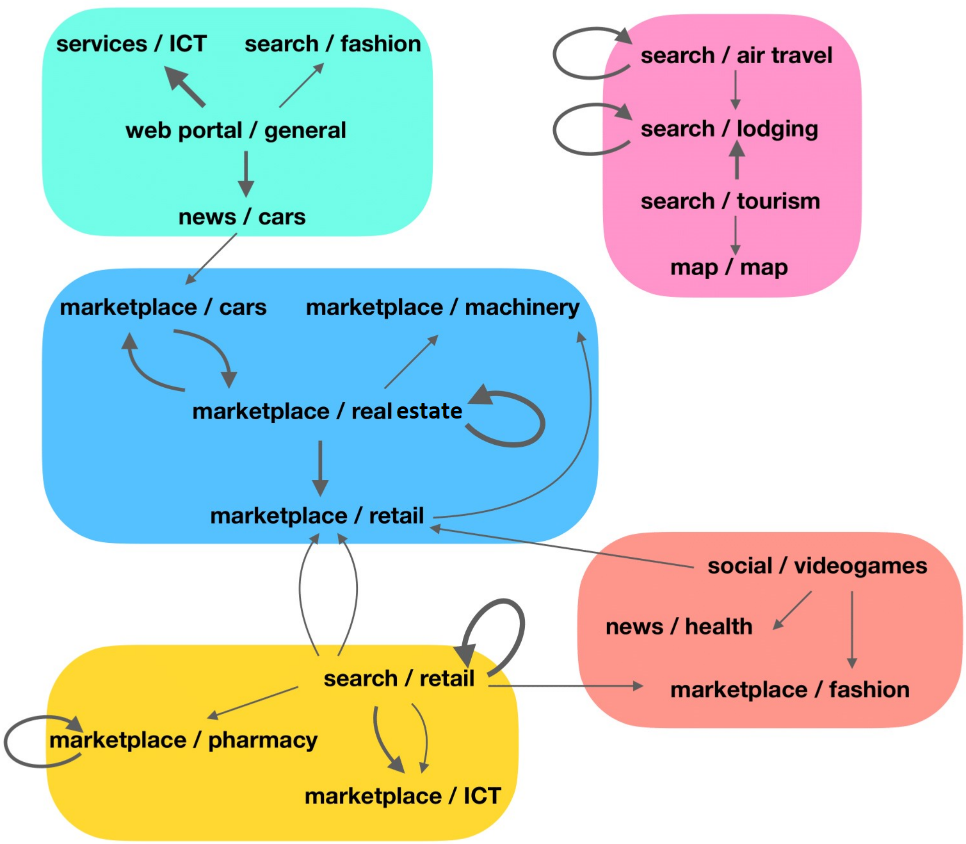
6.3 Orchestration in demand-side inter-platform ecosystems

In intra-platform ecosystems the platform owner is the orchestrator (Gawer et al., 2002; Gawer & Henderson, 2007) that decides which other agents can enter the ecosystem to take part in the creation of nongeneric complementarities. In the case of the demand-side inter-platform ecosytems analyzed in this article, each platform can unilaterally decide to create nongeneric complementarities in consumption with another one. This can result in two-agent ecosystems in which a single platform is the orchestrator, as in the case of Milanuncios and Coches' ecosystem (cf. lower-left side of Figure 1). More interestingly, as a result of a series of such unilateral decisions, in demand-side inter-platform ecosystems more than one platform could play the role of the orchestrator. For example, we see an ecosystem formed by Skyscanner, Ryanair, Wizzair and Booking (cf. green-circled platforms in the middle-lower part of Figure 1). While Skycanner decides to generate demand-side linkages with Ryanair and Wizzair by creating a platform tailored to be complementary to these two's, Wizzair also decides to establish demand-side linkages with Booking by offering its users the capacity to book an accommodation through Booking after purchasing a flight. As a result, Skyscanner is indirectly linked to Booking within the same inter-platform ecosystem through demand-side linkages it did not establish itself directly and, more importantly, that it cannot control. As this example illustrates, in inter-platform ecosystems, given that, as opposed to intra-platform ecosystems, there is not a single actor that can exclusively control the technical components underpinning the ecosystem (i.e. *the* platform owner), orchestration could be multi-polar. In other words, in demand-side inter-platform ecosystems, more than one agent can "keep cospecialised assets in value-creating alignment and "identify new cospecialised assets and divest or run down old cospecialised assets" (Hou & Shi, 2020).

However, in theory, we could think that certain platforms are, because of the nature of the service they offer, more prone to play the role of the only orchestrator of an ecosystem. In order to have an empirical intuition of which types of platforms could play this role, we turn now to Figure 4.

[18]See Table 5 in the Appendix for a full list of the platforms analyzed.

Figure 4: Significant desktop referral traffic between the main markets of the major European platforms in 2020



The thickness of the links is proportional to the share of total received referral traffic. Traffic below 10% of total received referral traffic, between platforms belonging to the same conglomerate and including non-platform domains excluded. Twenty European countries included. Painted areas correspond to the communities detected.

In Figure 4, we re-do the network of Figure 1 but, instead of considering each individual platform (e.g. Airbnb) as a node, we consider the type of platform, which is defined by its subtopic and service (e.g. topic "lodging" and service "search"), as detailed in Section 5.2.

Figure 4 shows that four types of platforms are central nodes structuring subgraphs by sending traffic to other platforms: retail search (mainly price comparison tools), real estate marketplaces, general web portals and videogames-related social networks. Although these types of platforms do not exhaust the entirety of platforms that could act as single orchestrators in inter-platform ecosystems, they provide some insights on what characteristics could make a platform play that role. The first one is providing a (price) comparison tool of services offered by other platforms. These types of platforms are 'natural' single orchestrators of the inter-platform ecosystem they create through their service. The second characteristic is being a high-traffic platform that serves multiple adjacent markets, or a single market related to other adjacent ones. In our sample, this is the case of real-estate-focused classifieds platforms. In addition to being high-traffic, these platforms focus on a market that has other adjacent ones they might serve themselves or not, such as cars or general retail. As shown in the previous subsection, these platforms have incentives to form demand-side inter-platform ecosystems with indirect competitors. Third, platforms that constitute and nurture a community of users that are also users of other platforms can act as single orchestrators of demand-side inter-platform ecosystems. In Figure 4, this is the case of a general web portal (Seznam) and a gaming forum and news platform (Jeux Vidéo). In the case of the former, offering a web portal service makes it the 'natural' single orchestrator of an ecosystem made of more specialized platforms that, although functionally unrelated, share a user base. This is because in web portals only the platform owner can decide with which other platforms to create referral traffic, as the decisions on content are exclusively made by the platform owner. However, this is not the case of specialized social networks such as Jeux Vidéo, where content production depends on users to a large extent.

We posit that, in the case of Jeux Vidéo, it is not the nature of the service provided by the platform but the agency of its users what makes the platform to play the role of the orchestrator of the demand-side inter-platform ecosystem it belongs to. However, we interpret this orchestration as being shared between two agents of the platform: the platform owner and end users.

The platform owner makes specific investments in creating content that attracts a particular user base centered on gaming. This allows it to create demand-side linkages with other platforms that are related to the gaming industry that did not appear as statistically significant in our sample but can be observed by browsing the website[19]. For example, the platform contains a section of reviews of gaming-related products (e.g. headsets, chairs, joysticks, etc.) written by its staff with direct links to Amazon Marketplace's listings of such products. In addition, this specific investment attracts a gaming community to its various forums. In the latter, users of this specialized social network also create content and demand-side linkages that cannot be fully controlled by the platform. Interestingly, the statistically-significant demand-side linkages of Jeux

[19] See www.jeuxvideo.com

Vidéo that we observe are with seemingly unrelated platforms: Le Bon Coin (classifieds marketplace), Vinted (second hand clothes marketplace) and Doctissimo (health news portal). Although the investments made by the platform owner are specific, users can divert their original purpose by finding ways of using the functionalities of the platform to generate demand-side linkages the platform owner might have not foreseen. This is because the common characteristics and tastes of a gaming community of users can exceed the gaming industry. Then, provided that the platform owner allows for sufficient agency, users can "keep cospecialised assets in value-creating alignment and "identify new cospecialised assets and divest or run down old cospecialised assets" (Hou & Shi, 2020) even if their intention is not to increase the ecosystems' value proposition. Hence, in that respect, we can consider users as co-orchestrators of the demand-side inter-platform ecosystem to which Jeux Vidéo belongs.

7 Conclusion and implications for further research

In this article we developed and tested a methodology capable of capturing nongeneric complementarities in consumption ("demand-side linkages") between the major 246 European platforms and assess the nature of their competitive relationships. Our main results confirm that demand-side inter-platform ecosystems are a relevant phenomenon that presents significant differences (although also common aspects) with intra-platform ecosystems in terms of coopetitive dynamics and orchestration.

The results of this article open four avenues of research. The first one relates to the nature of coopetition in "direct competitors" and "unrelated" inter-platform ecosystems. We have seen that these two types of inter-platform ecosystems are characterized by coopetitive dynamics that depart substantially from those described by the literature on intra-platform ecosystems. Although we have provided some preliminary interpretations on the reasons why platforms might engage in coopetitive relations with unrelated or directed competitors by forming an ecosystem with them, further research is needed to better understand this phenomenon. In particular, case studies could help discerning the motivations behind and the strategic interactions within these types of inter-platform ecosystems.

The second avenue of research refers to the phenomena of co-orchestration by multiple platforms and "user co-orchestrated ecosystems". Regarding the former, it would be particularly interesting to understand how co-orchestration might affect an inter-platform ecosystem's stability and innovation processes. Regarding the latter, our results show that in some cases (cf. Jeux Vidéo), although the platform sending the traffic makes a specific investment (e.g. designing and generating content to federate a French-speaking gamer community) to generate value with other firms (in this example firms in the gaming industry) through nongeneric complementarities, it cannot fully target ex-ante with which platform(s) these complementarities will be created. In some cases, (e.g. the health news platform Doctissimo), users simply use platforms' specific investments to generate value in ways that the latter cannot predict, creating so what we can label as "user-co-orchestrated ecosystems". In ecosystems, orchestration aims at keeping co-specialized assets in value-creating alignment and in dis(investing) new (old) ones (Teece, 2010). In cases such as Jeux Vidéo's, it seems like users are partially and perhaps unwittingly and unwillingly playing the role of orchestrators. This contrasts with the prevailing view in the (intra-) platform ecosystems literature according to which this activity is purposely carried out by the (only) platform owner. In this view, while "consumers have a say in the choice of complements", firms "provide the contours of free choice" (Jacobides et al., 2020, p.24). Are user-orchestrated ecosystems a different organizational form distinct from the "firm-orchestrated" ecosystems studied in the literature? Or are they rather user-generated complementarities that firms have not (yet) orchestrated within the boundaries of an ecosystem?

This leads to a third avenue of research related to firms' responses to user-orchestrated ecosystems. If platform owners adapt ex-post to demand-side complementarities that other (likely rival) platforms or users generated, do they react through envelopment? Or through other strategies aimed at capturing some of this unexpectedly jointly created value with other platforms? What determines the choice of strategy (if any) when complementarities arise "spontaneously" from users or other platforms? How does this reaction vary depending on the nature of coopetitive dynamics between the platforms linked through demand-side linkages?

Finally, much work remains to be done to develop methodologies that measure demand-side and, to a lesser extent, supply-side nongeneric complementarities. The approach proposed in this article is not without limitations. In particular, it is only suited to analyze demand-side linkages between platforms. Alternative approaches within this research line can only contribute to a better understanding of the dynamics of (inter-platform) ecosystems.

References

Adner, R. (2017). Ecosystem as structure: An actionable construct for strategy. *Journal of management*, *43*(1), 39–58.

Ansari, S., Garud, R., & Kumaraswamy, A. (2016). The disruptor's dilemma: Tivo and the us television ecosystem. *Strategic management journal*, *37*(9), 1829–1853.

Autio, E. (2021). Orchestrating ecosystems: a multi-layered framework. *Innovation*, 1–14.

Baldwin, C. Y. (2020). Design rules, volume 2: Chapter 6—the value structure of technologies, part 1: Mapping functional components. *Baldwin, CY (2020)"The Value Structure of Technologies, Part*, *1*.

Barlow, M. A., Verhaal, J. C., & Angus, R. W. (2019). Optimal distinctiveness, strategic categorization, and product market entry on the google play app platform. *Strategic Management Journal*, *40*(8), 1219–1242.

Basole, R. C. (2009). Visualization of interfirm relations in a converging mobile ecosystem. *Journal of information Technology*, *24*(2), 144–159.

Battistella, C., Colucci, K., De Toni, A. F., & Nonino, F. (2013). Methodology of business ecosystems network analysis: A case study in telecom italia future centre. *Technological Forecasting and Social Change*, *80*(6), 1194–1210.

Binken, J. L., & Stremersch, S. (2009). The effect of superstar software on hardware sales in system markets. *Journal of Marketing*, *73*(2), 88–104.

Bogers, M., Sims, J., & West, J. (2019). What is an ecosystem. *Academy of Management Proceedings*, *2019*(1).

Boudreau, K. J., & Jeppesen, L. B. (2015). Unpaid crowd complementors: The platform network effect mirage. *Strategic Management Journal*, *36*(12), 1761–1777.

Bourreau, M., & De Streel, A. (2019). Digital conglomerates and eu competition policy. *Available at SSRN 3350512*.

Brandes, U., Delling, D., Gaertler, M., Gorke, R., Hoefer, M., Nikoloski, Z., & Wagner, D. (2007). On modularity clustering. *IEEE transactions on knowledge and data engineering*, *20*(2), 172–188.

Casadesus-Masanell, R., & Campbell, N. (2019). Platform competition: Betfair and the uk market for sports betting. *Journal of Economics & Management Strategy*, *28*(1), 29–40.

Cenamor, J. (2021). Complementor competitive advantage: A framework for strategic decisions. *Journal of Business Research*, *122*, 335–343.

Cenamor, J., Usero, B., & Fernández, Z. (2013). The role of complementary products on platform adoption: Evidence from the video console market. *Technovation*, *33*(12), 405–416.

Cennamo, C. (2019). Competing in digital markets: A platform-based perspective. *Academy of Management Perspectives*(ja).

Cennamo, C., Ozalp, H., & Kretschmer, T. (2018). Platform architecture and quality trade-offs of multihoming complements. *Information Systems Research*, *29*(2), 461–478.

Crémer, J., de Montjoye, Y.-A., & Schweitzer, H. (2019). Competition policy for the digital era. *Report for the European Commission*.

Cusumano, M. A., & Gawer, A. (2002). The elements of platform leadership. *MIT Sloan management review*, *43*(3), 51.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319–340.

Eben, M., & Robertson, V. H. (2021). The relevant market concept in competition law and its application to digital markets: A comparative analysis of the eu, us, and brazil. *Graz Law Working Paper*.

Eisenmann, T. (2008). Managing proprietary and shared platforms. *California management review*, *50*(4), 31–53.

Eisenmann, T., Parker, G., & Van Alstyne, M. (2008). *Opening platforms: how, when and why? harvard business school* (Tech. Rep.). Working Paper. http://hbswk. hbs. edu/faculty/teisenmann. html [feb 03 2009].

Eisenmann, T., Parker, G., & Van Alstyne, M. (2011). Platform envelopment. *Strategic management journal*, *32*(12), 1270–1285.

Eisenmann, T., Parker, G., & Van Alstyne, M. W. (2006). Strategies for two-sided markets. *Harvard business review*, *84*(10), 92.

Evans, D. S., & Noel, M. (2005). Defining antitrust markets when firms operate two-sided platforms. *Colum. Bus. L. Rev.*, 667.

Filistrucchi, L., Geradin, D., Van Damme, E., & Affeldt, P. (2014). Market definition in two-sided markets: Theory and practice. *Journal of Competition Law & Economics*, *10*(2), 293–339.

Franck, J.-U., & Peitz, M. (2021). Market definition in the platform economy. *CRC TR 224 Discussion Paper Series 2021*.

Gallagher, S. R. (2012). The battle of the blue laser dvds: The significance of corporate strategy in standards battles. *Technovation*, *32*(2), 90–98.

Gawer, A. (2014). Bridging differing perspectives on technological platforms: Toward an integrative framework. *Research policy*, *43*(7), 1239–1249.

Gawer, A. (2022). Digital platforms and ecosystems: remarks on the dominant organizational forms of the digital age. *Innovation*, *24*(1), 110–124.

Gawer, A., & Cusumano, M. (2008). Mit sloan management review. *How companies become platform leaders*, *49*(2), 28–35.

Gawer, A., & Cusumano, M. A. (2014). Industry platforms and ecosystem innovation. *Journal of product innovation management*, *31*(3), 417–433.

Gawer, A., Cusumano, M. A., et al. (2002). *Platform leadership: How intel, microsoft, and cisco drive industry innovation* (Vol. 5). Harvard Business School Press Boston.

Gawer, A., & Henderson, R. (2007). Platform owner entry and innovation in complementary markets: Evidence from intel. *Journal of Economics & Management Strategy*, *16*(1), 1–34.

Gueguen, G., & Isckia, T. (2011). The borders of mobile handset ecosystems: Is coopetition inevitable? *Telematics and Informatics*, *28*(1), 5–11.

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

Hannah, D. P., & Eisenhardt, K. M. (2018). How firms navigate cooperation and competition in nascent ecosystems. *Strategic Management Journal*, *39*(12), 3163–3192.

Hou, H., & Shi, Y. (2020). Ecosystem-as-structure and ecosystem-as-coevolution: A constructive examination. *Technovation*, 102193.

Iansiti, M., & Levien, R. (2004). Strategy as ecology. *Harvard business review*, *82*(3), 68–78.

Jacobides, M. G., Cennamo, C., & Gawer, A. (2018). Towards a theory of ecosystems. *Strategic management journal*, *39*(8), 2255–2276.

Jacobides, M. G., Cennamo, C., & Gawer, A. (2020). Distinguishing between platforms and ecosystems: Complementarities, value creation, and coordination mechanisms. *Working paper, under review*.

Jacobides, M. G., Cennamo, C., & Gawer, A. (2021). Distinguishing between platforms and ecosystems: complementarities, value creation and coordination mechanisms. *Working paper*.

Jacobides, M. G., Sundararajan, A., & Van Alstyne, M. (2019). Platforms and ecosystems: Enabling the digital economy. In *World economic forum briefing paper. world economic forum: Switzerland.*

Kapoor, R. (2014). Collaborating with complementors: What do firms do? In *Collaboration and competition in business ecosystems.* Emerald Group Publishing Limited.

Kapoor, R. (2018). Ecosystems: broadening the locus of value creation. *Journal of Organization Design*, *7*(1), 1–16.

Kapoor, R., & Lee, J. M. (2013). Coordinating and competing in ecosystems: How organizational forms shape new technology investments. *Strategic management journal*, *34*(3), 274–296.

Karhu, K., & Ritala, P. (2021). Slicing the cake without baking it: Opportunistic platform entry strategies in digital markets. *Long Range Planning*, *54*(5), 101988.

Katz, M. L., & Shapiro, C. (1986). Technology adoption in the presence of network externalities. *Journal of political economy*, *94*(4), 822–841.

Kretschmer, T., Leiponen, A., Schilling, M., & Vasudeva, G. (2022). Platform ecosystems as meta-organizations: Implications for platform strategies. *Strategic Management Journal*, *43*(3), 405–424.

Lee, C., & Kim, H. (2018). The evolutionary trajectory of an ict ecosystem: A network analysis based on media users' data. *Information & Management*, *55*(6), 795–805.

Marchand, A. (2016). The power of an installed base to combat lifecycle decline: The case of video games. *International Journal of Research in Marketing*, *33*(1), 140–154.

Moore, J. F. (2006). Business ecosystems and the view from the firm. *The antitrust bulletin*, *51*(1), 31–75.

Niedermayer, A. (2013). On platforms, incomplete contracts, and open source software. *International Journal of Industrial Organization*, *31*(6), 714–722.

OECD. (2019). *Introduction to online platforms and their role in the digital transformation.* ORGANIZATION FOR ECONOMIC.

Ozalp, H., & Kretschmer, T. (2019). Follow the crowd or follow the trailblazer? the differential role of firm experience in product entry decisions in the us video game industry. *Journal of Management Studies*, *56*(7), 1452–1481.

Panico, C., & Cennamo, C. (2022). User preferences and strategic interactions in platform ecosystems. *Strategic Management Journal*, *43*(3), 507–529.

Parker, G., & Alstyne, M. V. (2008). Managing platform ecosystems. *ICIS 2008 Proceedings*, 53.

Pierce, L. (2009). Big losses in ecosystem niches: How core firm decisions drive complementary product shakeouts. *Strategic management journal*, *30*(3), 323–347.

Safronova, V. (2017). Instagram is now a dating platform, too. here's how it works. *The New York Times. https://www. nytimes. com/2017/12/21/style/instagramthirst-traps-dating-breakups. html*.

Song, H., Jung, J., & Cho, D. (2017). Platform competition in the video game console industry: Impacts of software quality and exclusivity on market share. *Journal of Media Economics*, *30*(3), 99–120.

Teece, D. J. (2010). Technological innovation and the theory of the firm: the role of enterprise-level knowledge, complementarities, and (dynamic) capabilities. In *Handbook of the economics of innovation* (Vol. 1, pp. 679–730). Elsevier.

Thomas, L. D., Autio, E., & Gann, D. M. (2014). Architectural leverage: Putting platforms in context. *Academy of management perspectives*, *28*(2), 198–219.

Tiwana, A. (2013). *Platform ecosystems: Aligning architecture, governance, and strategy*. Newnes.

Xue, L., Song, P., Rai, A., Zhang, C., & Zhao, X. (2019). Implications of application programming interfaces for third-party new app development and copycatting. *Production and Operations Management*, *28*(8), 1887–1902.

Zhao, Y., Von Delft, S., Morgan-Thomas, A., & Buck, T. (2020). The evolution of platform business models: Exploring competitive battles in the world of platforms. *Long Range Planning*, *53*(4), 101892.

Zhu, F., & Liu, Q. (2018). Competing with complementors: An empirical look at amazon. com. *Strategic management journal*, *39*(10), 2618–2642.

Appendix

Figure 5: Relation between the threshold of the share of received traffic chosen and the skewness coefficient

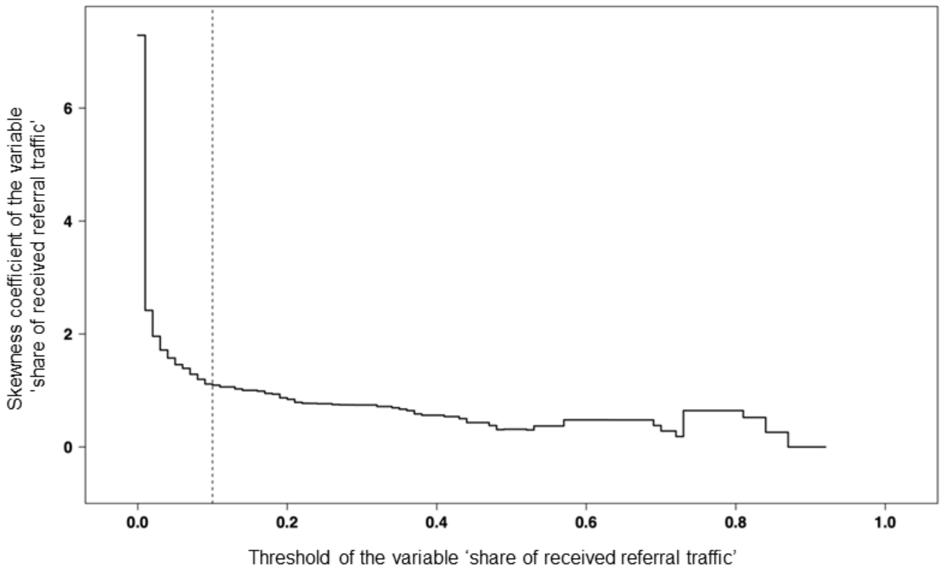
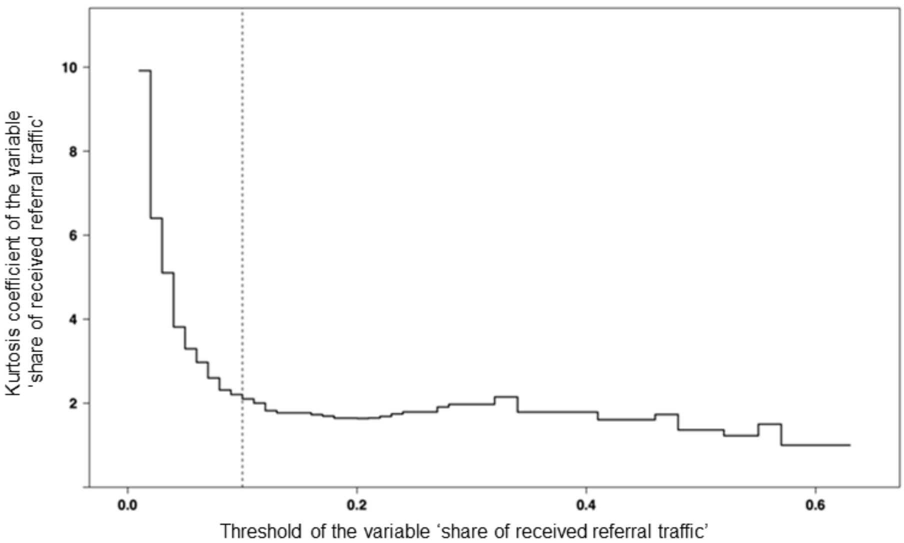
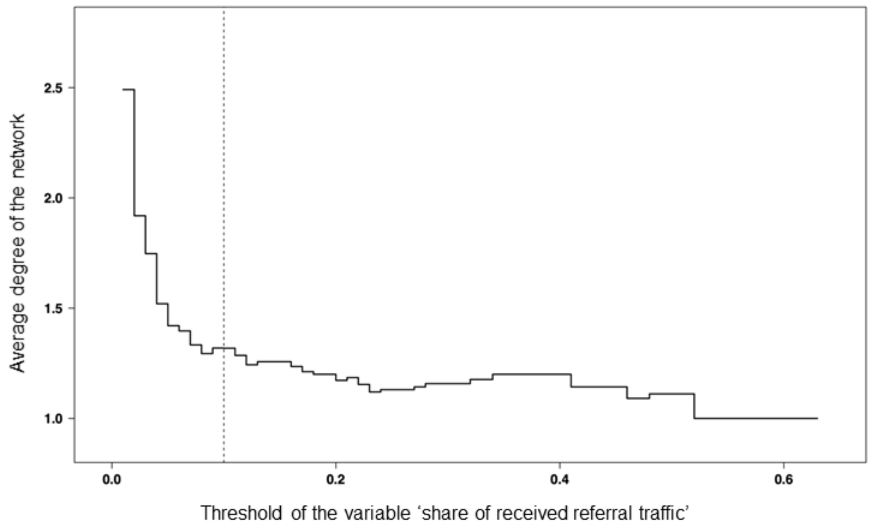


Figure 6: Relation between the threshold of the share of received traffic chosen and the kurtosis coefficient



NB: outlier threshold values below 0.01 excluded

Figure 7: Relation between the threshold of the share of received traffic chosen and the average degree of the network



NB: outlier threshold values below 0.01 excluded

Table 5: List of the original 166 platforms identified

Platform			
admitad	daft	instagram	ryanair
adverts	damejidlo	invia	sapo
airbnb	dba	jeuxvideo	sbazar
aliexpress	deliveroo	jofogas	seloger
allegro	dh	just-eat	seznam
alvolante	dinnerbooking	lafourchette	shein
alza	directbooking	landwirt	shop-apotheke
amazon	docfinder	laredoute	shopalike
argos	doctissimo	leboncoin	shutterstock
arukereso	donedeal	lieferando	skroutz
asos	drive	lieferservice	skyscanner
auto	duckduckgo	linkedin	snapchat
autobazar	e-shop	marktplaats	spitogatos
autoscout24	ebay	medicitalia	sreality
autotrader	eltenedor	milanuncios	standvirtual
autotriti	emag	mjam	startpage
autovit	etuovi	mojekrpice	startpagina
bazar	facebook	momondo	subito
bazos	fdm	moto	taboola
bergfex	finn	myhome	takeaway
bestprice	flickr	netdoktor	tori
bilbasen	foodpanda	netpincer	totalcar
bing	funda	nettiauto	tradera
blablacar	gebrauchtwagen	njuskalo	tripadvisor
blocket	geizhals	nocowanie	trivago
bol	glami	norwegian	trovaprezzi
boligsiden	glovoapp	ok	twitch
bonprix	gohome	olx	twitter
boohoo	google	otodom	ubereats
booking	hemnet	otomoto	verkkokauppa
boozt	heureka	otto	vinted
car	holidaycheck	outbrain	vk
cargurus	hotels	pinterest	vrisko
cars	hybel	pochivka	vuokraovi
carsireland	idealista	pricerunner	willhaben
carzone	idealo	prisjakt	wizzair
casa	imedia	publi24	yahoo
cdiscount	immobiliare	pyszne	yandex
ceneo	immobilienscout24	qwant	youtube
coches	immoweb	ready	zalando
compari	immowelt	reddit	
custojusto	imot	rightmove	