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When ‘the’ market loses its relevance: an empirical analysis of demand-side linkages in platform ecosystems

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Abstract

Recent literature has shown that the existence of supply and demand-side non-generic complementarities (“demand-side linkages") within ecosystems raises questions about the pertinence of defining a single relevant market comprising substitute products (“substitutability approach"). However, empirical methodologies to measure these linkages and asses the competitive dynamics underpinning them are lacking. Using recent data from internet traffic between the major 246 European digital platforms, we develop such a methodology and test some theoretical findings of the ecosystems literature with major implications for competition and regulatory analysis. We corroborate that demand-side linkages are a non-negligible phenomenon: 18% of these platforms show them. However, unlike what the ecosystems literature predicts, in roughly half of the cases they do not link complementors but platforms competing in at least one market. Finally, while, as expected, we observe demand-side linkages mostly within industry-defined ecosystems, we find evidence of industry-agnostic ecosystems. These could be instigated and orchestrated by platform users instead of by a firm. We conclude that the substitutability approach is not obsolete, but needs to be complemented with alternative approaches in order to i) take into account coopetition within the same relevant market and ii) analyze how the competitive process in one market can impact the welfare generated in another (industry's) market through non-generic complementarities.

Executive summary

Competition and regulatory analysis is commonly based on a “substitutability approach" according to which a single relevant market is defined in terms of product substitutability. In this framework, the relevant market delimits the arena of competition between rival firms and the scope of the welfare effects generated by the competitive process. The development of ecosystems (notably in digital markets), understood as “a set of actors with varying degrees of multilateral, nongeneric complementarities that are not fully hierarchically controlled" (Jacobides, Cennamo, & Gawer, 2018), renders this approach insufficient for two reasons. First, if non-generic complementarities between firms active in different markets exist, the interdependencies between them have to be taken into account when analyzing competitive dynamics. Second, the nature of the relationship between firms linked by non-generic complementarities can range from pure cooperation to pure competition, including coopetition dynamics combining the two (Jenny, 2021; Crane, 2019; Lianos, 2019). Hence, active and potential competitors and coopetitors can exist outside of t he relevant market (Lianos & Carballa Smichowski, 2021).

Using data on internet traffic between the major 246 European digital platforms in 2020, this article develops and tests empirically what is, to the best of our knowledge, the first methodology capable of capturing non-generic complementarities in consumption between digital platforms and assess the nature of their competitive relationship. We use this methodology to evaluate some theoretical results of the ecosystems literature that have not been empirically tested outside of case studies despite their major implications for competition and regulatory analysis. How prevalent are demand-side linkages in the platform economy? Are demand-side linkages structured within relevant markets (e.g. lodging, second-hand cars, etc.) or cross-market? The literature on ecosystems predicts the latter. If this is the case, then the substitutability approach is ill-equipped to analyze digital ecosystems. Are platform ecosystems made of complementary firms (e.g. a transportation platform and a lodging platform, a price comparison tool and an online retailer) belonging to the same industry (e.g. tourism, retail, etc.), as the theory on ecosystems asserts? If this this is the case, alternative methodologies to the substitutability approach should consider the industry (and not the relevant market) as the scope of welfare effects, while considering each relevant market as the arena of competition. Finally, to what extent do competing platforms cooperate by developing demand-side linkages between their services? If, as the literature asserts, coopetition is commonplace in digital ecosystems, then amendments to the substitutability approach, which considers firms in the same relevant market to be pure rivals, are necessary.

Our results corroborate that demand-side linkages are a non-negligible phenomenon: 18% of the major 246 European digital platforms show them. However, unlike what the ecosystems literature predicts, in roughly half of the cases they do not link complementors but platforms competing in at least one market. Finally, while, as expected, we observe demand-side linkages mostly within industry-defined ecosystems, we find evidence of industry-agnostic ecosystems. These could be instigated and orchestrated by platform users instead of by a firm. We conclude that the substitutability approach is not obsolete, but needs to be complemented with alternative approaches in order to i) take into account coopetition within the same relevant market and ii) analyze how the competitive process in one market

can impact the welfare generated in another (industry's) market through non-generic complementarities.

When ‘the’ market loses its relevance: an empirical analysis of demand-side linkages in platform ecosystems*

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Abstract

Recent literature has shown that the existence of supply and demand-side non-generic complementarities (“demand-side linkages”) within ecosystems raises questions about the pertinence of defining a single relevant market comprising substitute products (“substitutability approach”). However, empirical methodologies to measure these linkages and asses the competitive dynamics underpinning them are lacking. Using recent data from internet traffic between the major 246 European digital platforms, we develop such a methodology and test some theoretical findings of the ecosystems literature with major implications for competition and regulatory analysis. We corroborate that demand-side linkages are a non-negligible phenomenon: 18% of these platforms show them. However, unlike what the ecosystems literature predicts, in roughly half of the cases they do not link complementors but platforms competing in at least one market. Finally, while, as expected, we observe demand-side linkages mostly within industry-defined ecosystems, we find evidence of industry-agnostic ecosystems. These could be instigated and orchestrated by platform users instead of by a firm. We conclude that the substitutability approach is not obsolete, but needs to be complemented with alternative approaches in order to i) take into account coopetition within the same relevant market and ii) analyze how the competitive process in one market can impact the welfare generated in another (industry’s) market through non-generic complementarities.

*We thank Carlo Reggiani for his valuable comments on a previous version of this article. The views and opinions expressed in this paper are the authors’ and do not necessarily reflect those of the European Commission.

1 Introduction

Competition and regulatory analysis is commonly based on a “substitutability approach” according to which a single relevant market is defined in terms of product substitutability. In this framework, the relevant market delimits the arena of competition between rival firms and the scope of the welfare effects generated by the competitive process. For example, if consumers consider both backpacks and travel bags as substitutes when shopping for luggage before a weekend getaway, firms producing these products can be said to compete in the same “short-term trip luggage” market. The development of ecosystems, notably in digital markets, renders this approach insufficient for two reasons. First, if non-generic complementarities between firms active in different markets exist, the interdependencies between them have to be taken into account when analyzing competitive dynamics. This recalls the analysis of the interdependence between markets linked through indirect network effects within a multisided platform (Franck & Peitz, 2021; Evans & Noel, 2005; Filistrucchi et al., 2014). However, unlike in multisided platforms, the markets linked by non-generic complementarities between legally independent firms might be unknown to antitrust authorities and regulators who cannot observe them. Second, the nature of the relationship between firms linked by non-generic complementarities can range from pure cooperation to pure competition, including coopetition dynamics combining the two (Jenny, 2021; Crane, 2019; Lianos, 2019). Hence, active and potential competitors and coopetitors can exist outside of the relevant market (Lianos & Carballa Smichowski, 2021).

The concept of “ecosystem” is built on the notion of non-generic complementarities in production and consumption. 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.

Although there is an extensive literature on (digital) ecosystems, few contributions on the topic apply quantitative methods. More important for this article, to our knowledge, there are no quantitative contributions to the ecosystems literature that measure non-generic complementarities in consumption ("demand-side linkages" hereafter). This article develops and tests empirically what is, to the best of our knowledge, the first methodology capable of capturing non-generic complementarities in consumption between digital platforms and assess the nature of their competitive relationship. We use this methodology to assess some theoretical results of the ecosystems literature that have not been empirically tested outside of case studies despite their major implications for competition and regulatory analysis. How prevalent are demand-side linkages in the platform economy? If they are not, then the substitutability approach remains a robust methodology. Otherwise, new methodologies need to be developed. Are demand-side linkages structured within relevant markets (e.g. lodging, second-hand cars, etc.) or cross-market? The literature on ecosystems predicts the latter. If this is the case, then the substitutability approach is ill-equipped to analyze digital ecosystems. Are platform ecosystems made of complementary firms (e.g. a transportation platform and a lodging platform, a price comparison tool and an online retailer) belonging to the same industry (e.g. tourism, retail, etc.), as the theory on ecosystems asserts? If this this is the case, alternative methodologies to the substitutability approach should consider the industry (and not the relevant market) as the scope of welfare effects, while considering each relevant market as the arena of competition. Finally, to what extent do competing platforms cooperate by developing demand-side linkages between their services? If, as the literature asserts, coopetition is commonplace in digital ecosystems, then amendments to the substitutability approach, which considers firms in the same relevant market to be pure rivals, are necessary.

Our results confirm some of the expected outcomes of the ecosystems literature, but also provide unexpected insights with implications in terms of competition and regulatory analysis and the research on ecosystems. We find demand-side linkages between 18% of the major 246 European platforms, which corroborates that non-generic complementarities in consumption are a non-negligible phenomenon in the platform economy. However, we find that 52% of the demand-side linkages occur between firms that are competing in at least one of the markets they link within their multisided platforms. Then, although coopetition is prevalent in platform ecosystems, it takes other forms than those described in the ecosystems literature. Not only do firms compete within an ecosystem for a share of the value jointly produced; in the case of platform ecosystems, they also compete in at least one relevant market to sell substitutable services or products in roughly half of the cases. As a corollary, contrary to what the literature on ecosystems describes, demand-side linkages between complementors are rather rare in the platform economy. Hence, the substitutability approach is not obsolete, but requires to be complemented with other approaches in order to i) take into account coopetition within the same relevant market and ii) analyze how the competitive process in one market can have an impact of the welfare generated in another market. Finally, we find that, as the literature on ecosystems predicts, most demand-side linkages are structured around industries. In particular, we obtain five clusters of markets in which they can be observed: (1) generalist and specialized marketplaces; (2) tourism information and booking services and maps; (3) web portals and various services; (4) price comparison and specialized marketplaces and (5) social networks, marketplaces and health news. The latter is the most striking result, as it shows that ecosystems can structure across industries. Hence, quantitative methodologies like the one presented in this article should be adopted when doing competition and regulatory analysis of platform ecosystems in order to detect unexpected industry-agnostic demand-side linkages. Moreover, this striking result puts into question whether, as argued in the ecosystems literature, ecosystems are always the result of firms' orchestration or, on the contrary, they can also be instigated and orchestrated by users.

The rest of the article is structured as follows. Section 2 reviews the contributions of the literature regarding the blind spots of the substitutability approach in presence of non-generic complementarities. Section 3 describes the data used and the transformations made to analyze it. Section 4 explains the methodology developed to measure demand-side linkages between platforms. Section 5 presents the main results and their implications. Section 6 concludes and indicates directions for further research.

2 The substitutability approach put to the test by non-generic complementarities

Although deviations from the substitutability approach are common under certain circumstances[1], only recently has the fast development of digital

[1]When competition analysis involves the activities of a firm present in more than one market (input foreclosure, margin squeeze, self-preferencing, tying and bundling and, more recently, multsided platforms), its scope is widened to analyze the interdependencies between markets.

ecosystems and related antitrust concerns inspired an emerging literature on how a particular type of interdependency between legally independent firms, non-generic complementarities, challenges this approach.

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)[2] 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). Ecosystems can present 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 non-generic. 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 firm 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 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.[3] 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).

Based on this framing, Jacobides & Lianos (2021) conclude that, when analyzing ecosystems, the substitutability approach ("standard relevant market approach" in their words) is not appropriate because it focuses on substitutability to define the scope of its analysis. Instead, they argue that

[2]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).

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

rather than focusing on a particular market, competition analysis should be based on the impact that dominance in a given core market by a firm can have on other markets linked by complementarities. The emerging literature on data-driven mergers (De Corniere & Taylor, 2020; Chen et al., 2020) shows it by modeling the welfare effects of mergers between firms in seemingly unrelated markets when supply-side linkages linkages between these markets exist and take the form of data from one market being useful to compete in another market. Hoffmann & Johannsen (2019) study the effects that supply-side linkages between markets within a digital conglomerate (notably economies of scope in data re-use and data-driven network effects) have on merger analysis. They argue that since data collected in a market can be used to gain a competitive advantage in another (especially when the two markets share a user base), merger control should focus on a general strategy of anti-competitive behaviours the merged entity could undertake that may not be linked to a specific relevant market.

Crane (2019) and Lianos (2019) add an additional reason to focus on cross-market linkages in competition analysis: intra-ecosystem competition. They argue that firms belonging to the same ecosystem do not compete over selling substitutable products in a relevant market but rather over the value generated by the complementarities that exist between their products. Hence, cross-market interactions between firms of an ecosystem are “coopetitive” in that they combine elements of cooperation and competition (Jenny, 2021; Gawer & Henderson, 2007; Ceccagnoli et al., 2012). For example, app stores and applications present two-way non-generic complementarities: more apps make an app store more valuable (consumers value more app stores where they can find a variety of apps) and the app store makes each app more valuable (app developers can easily reach clients through a one-stop shop). In that respect, app stores and app developers cooperate within the apps ecosystem. However, they also compete for the revenue generated by this cooperation. This competition manifests in the commissions on apps and in-apps purchases, as well as on non-price strategies such as app stores requiring the use of their in-app purchase systems.

Recent articles have studied how cross-market linkages based on generic and non-generic complementarities can be a vehicle for anti-competitive behavior that cannot be captured using the substitutability approach. Graef (2020) introduces the concept of “hybrid differentiation” to define a “conduct whereby a platform differentiates among non-affiliated services in an effort to favor its own business”. She uses the example of Google’s intention to remove the app Unlocked from Play Store in 2018 to illustrate it. This app shows users advertising or other content when they unlock their phone and gives users points they can exchange for mobile credit, data, entertainment or loyalty points in return. Although Google does not compete in markets in which Unlocked is present (nor does it intend to), it used its gatekeeper power in the app stores market to exclude Unlocked from Play Store because the app makes it harder for Google to monetize its activities through advertisement. Another strand of literature has developed several concepts to assess the different ways through which digital platforms have economic power over firms present in other markets that builds on the complementarities between the two. Although terminologies and definitions vary slightly, concepts such as “gatekeeping power” (Commission, 2020), “strategic market status” (Furman, 2020) or “structuring digital platform” (ARCEP, 2019) qualify situations in which a platform is in a position to control or significantly influence access to certain markets, customer groups or market segments. This can be done in several manners that do not necessarily entail exclusion such as giving less prominence to a firm in search results. Rahman (2018) employs the notion of “scoring power” to describe how information platforms have power over firms present in other markets through the scoring or recommendation algorithms, as these can be a important source of potential clients for other firms.

In these cases, contrary to the exertion of market power within a relevant market, a platform can benefit in many ways (obtaining a payment, avoiding jeopardizing its business model, increasing the number of transactions in the platform, etc.) by exerting power over firms that are present in other markets and are not competitors. In other words, the scope of the welfare effects of competition in a platform’s market can spill over to other markets in which it is not active. More interestingly, sometimes these forms of complementarities-based power are exerted by firms that do not hold it or “market power parasites”. Blickstein Shchory & Gal (2021) study two situations in which market power parasites rely on gatekeeping or scoring power: fake reviews and black hat practices.[4] This illustrates how, in presence of strong demand-side linkages, the arena of competition between two firms can go beyond the relevant market(s) in which they are both present.

The literature sheds light on how non-generic complementarities challenge the substitutability approach. However, the shortcomings of the substitutability approach in the context of (digital) ecosystems rely on theoretical results of the ecosystems literature that have not been tested

[4]Black hat practices are behaviors that distort the search engine’s performance and are banned by its guidelines, such as adding redundant information to a website to increase its prominence in search results.

empirically outside of case studies, notably in the case of demand-side linkages. Moreover, implementing alternative approaches that overcome these challenges requires being able to identify these complementarities in order to expand the arena of competition and the scope of welfare effects. Being mostly theoretical, the literature at the crossroads of antitrust and the economics of (digital) ecosystems has so far not tackled this practical issue. Nevertheless, there have been empirical contributions to the ecosystems literature on which this article builds to tackle this issue. 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.

3 Data

3.1 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.[5] 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.

[5] 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.

3.2 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.[6] 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

[6] 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[7] 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.

3.3 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

[7]The list of the 166 platforms can be found in Table 4 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.

4 Methodology

4.1 Calculation of a proxy of demand-side non-generic complementarities and choice of a threshold

In order to capture non-generic 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 doing a specific investment and hence does not imply that there are *non-generic* 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 non-generic 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 non-generic 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 non-generic 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 non-generic 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 non-generic 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).[8] Hence, our indicator can be interpreted as the share of total inter-platform demand-side non-generic complementarities traffic that takes place between legally independent firms.

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 non-generic 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 non-generic 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 non-generic complementarities in consumption from B to A requires distinguishing incidental traffic from significant traffic. Only the latter should be considered to reveal non-generic complementarities in consumption. A threshold of share of total received visits needs to be determined to make

[8] Emphasis added.

that distinction. It could be determined qualitatively on the bases 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 bases 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.[9] 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 non-generic complementarities in consumption from B to A.

4.2 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)function they perform. For example, the fashion online retailer platform Boozt is classified under topic “Retail”, subtopic “Fashion”, function “Marketplace” and subfunction “Vendors”, the latter being distinct from subfunction “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)function 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 subfunction) 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)functions 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.

[9] 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 function and the subtopic	Booking & Airbnb
Direct competitors medium	Platforms that share the function and partially share the subtopic	TripAdvisor & Airbnb
Indirect competitors high	Platforms that share the function but not the subtopic	Google Search & Skyscanner
Complementors high	Platforms that do not share the function 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 function 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 function or not, respectively.

Let us now develop on the examples that illustrate how we classified competitive relationships between platforms. Booking and Airbnb share the function (“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 function “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 function (“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 functions: 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 function nor the subtopic. Hence, they are considered to be unrelated.

4.3 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 function 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.

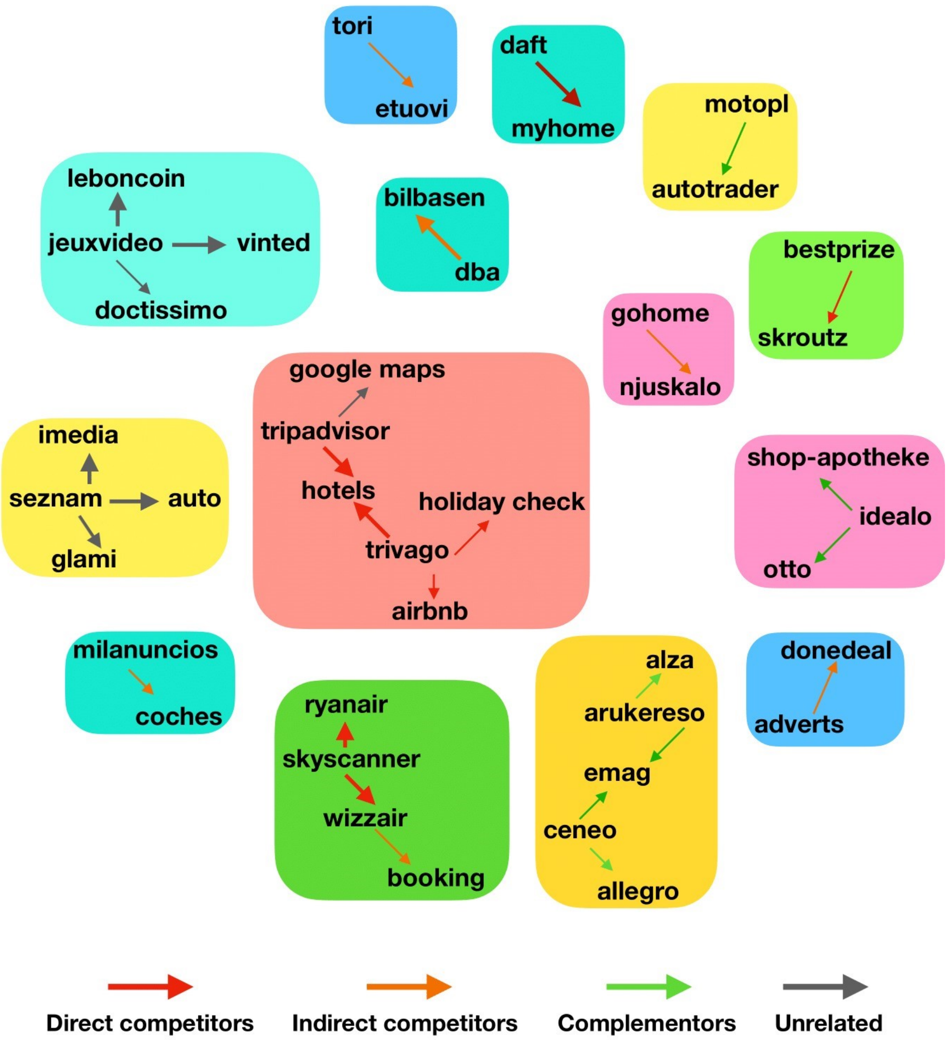
5 Results

The main goal of this article is to test empirically some key findings of the ecosystems literature with major implications for competition and regulatory analysis. In order to do so, we focused on the following three research questions. How prevalent are demand-side linkages in the platform economy? Are demand-side linkages structured within relevant markets (e.g. lodging, second-hand cars, etc.) or cross-market? Are platform ecosystems made of complementary firms (e.g. a transportation platform and a lodging platform, a price comparison tool and an online retailer) belonging to the same industry (e.g. tourism, retail, etc.), as the theory on ecosystems asserts? In this section we use the methodology described above to answer them. The results, which confirm some findings of the ecosystems literature and challenge other, corroborate the importance of widening the scope of competition and regulatory analysis beyond the relevant market when dealing with digital platforms.

5.1 Extent and intensity of demand-side linkages

Figure 1 summarizes the main findings of the empirical analysis. The network represents the 44 platforms (nodes) that are connected through demand-side linkages (links) 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 and painted areas correspond to 15 subgraphs of firms connected to each other through demand-side linkages, which we can assimilate to demand-side of 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 ecosystems.

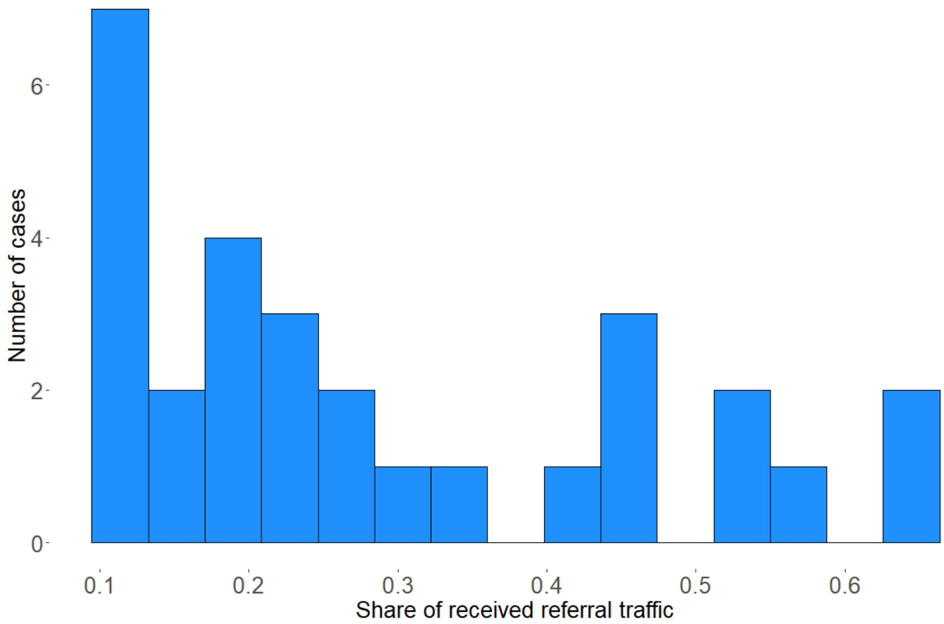
Figure 1: Significant desktop referral traffic between the major legally-independent European platforms in 2020



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 linkages in the platform economy, 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 but are 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

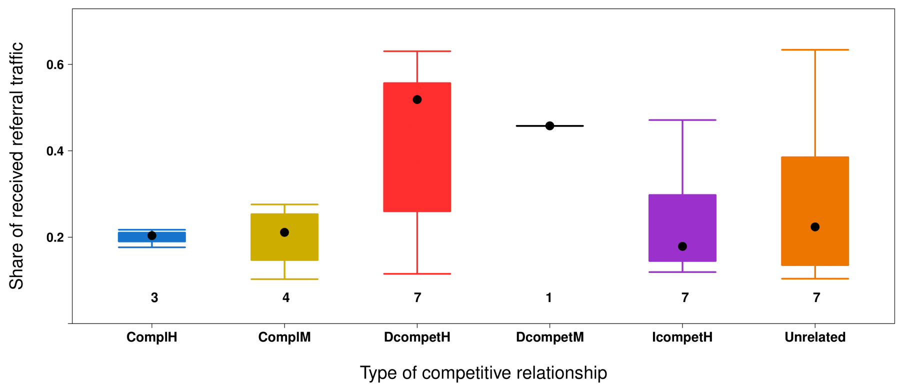


It should be noted that demand-side linkages between platforms with common ownership (e.g. Gmail and Google Search, both owned by Alphabet) are excluded from the results presented because the concept of ecosystems requires firms to be legally independent. However, as mentioned above, firms with common 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, non-generic complementarities in consumption are a non-negligible in the European platform economy. This confirms the relevance of the concept of ecosystems in the platform economy. However, in order to assess whether the existence of demand-side linkages has implications in terms of competition and regulatory analysis, we have to assess whether i) these platforms are located in different relevant markets and ii) if coopetitive dynamics between them are common. In any of these two cases, the substituability approach would be insufficient. We shall adress these two points in the following subsections.

5.2 The competitive relations and relevant markets underpinning demand-side linkages

Figure 3 shows that platforms competing in at least one relevant market are responsible for roughly half of the demand-side linkages detected.

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.

Demand-side linkages between the major European platforms are roughly divided between firms that are competitors in at least one of the markets in which they are present (52%) and firms without any apparent link (38%). Contrary to what the findings of the ecosytems literature would indicate, demand-side linkages between complementors are underrepresented (24% of the total) and not particularly intense. Among cases involving competing firms, direct and indirect competitors are roughly equally represented. The latter category comprises cases in which two multisided platforms overlap in one of the markets in which they are present. For example, the generalist Finish classifieds marketplace Tori has a "housing" category that overlaps with the Finish real estate marketplace platform Etuovi's market.

It should be noted that the degree of demand-side complementarities is significantly higher among direct competitors. While all other categories have a median share of received significant referral traffic of about 20%, direct competitors' is close to 50%. Going back to Figure 1, we can see that most of the cases involved relate to platforms located in tourism-related markets that offer overlapping bundles of services. For example, Hotels receives 46% of its referral traffic from TripAdvisor. Although both offer, among other things, a lodging booking service, TripAdvisor's competitive advantage lies in user-generated reviews of tourism related services such as hotels, restaurants or tourist attractions. Consequently, it sends traffic to its rival Hotels in order to benefit from more reviews and a higher traffic to its website.

These results show that although coopetition is commonplace in the platform economy, it takes other forms than the dynamic of competition between firms located in different relevant markets for the value created within ecosystem that the literature discusses (Jenny, 2021; Crane, 2019; Lianos, 2019; Lianos & Carballa Smichowski, 2021). Half of the platforms presenting demand-side linkages compete in at least one relevant market. When firms are direct competitors, the intensity of their demand-side linkages is considerably higher than for the rest of the platforms.

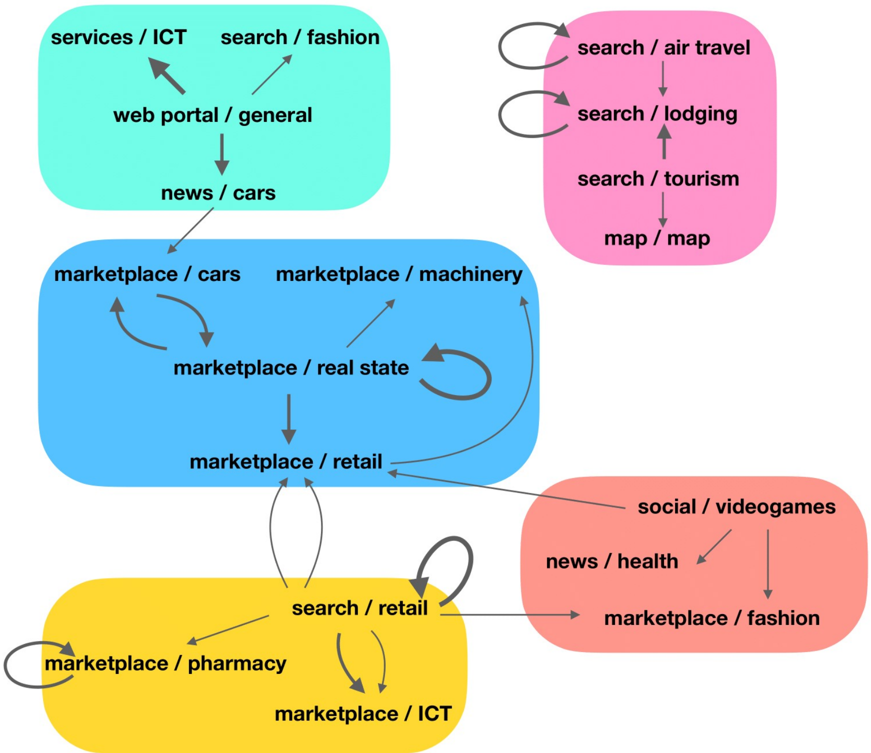
The implication is that the substitutability approach remains relevant yet insufficient to do competition and regulatory analysis. In the case of firms located in the same relevant market, this approach remains pertinent but requires adaptation. On the one hand, as the substitutability approach postulates, the scope of competition and welfare effects are constricted to a relevant market. On the other hand, unlike in the substitutability approach, these firms are not simply rivals: they simultaneously cooperate by generating non-generic complementarities in consumption with each other and they compete over the provision of substitute services. These between-platforms complementarities should be taken into account in a similar manner to how within-platform indirect network effects (which are an expression of non-generic complementarities in consumption) are taken into account when analyzing platforms' competitive environment and strategies. In the case of firms presenting demand-side linkages but located in different relevant markets, the substitutability approach remains useful but insufficient for other two reasons. First, strong shared user relationships between platforms located in different relevant markets (notably if these are in the same industry) can be the basis of one of the firms entering the other’s market through envelopment (Eisenmann et al., 2011; Cennamo, 2019). Hence, competition and regulatory analysis could consider potential competitors (i.e. a competitive constraint) that, contrary to what the substitutability approach would assume, are located in different relevant markets. Second, contrary to what the substitutability approach considers, the scope of the welfare effects generated by competition in one market spillover to another.

Let us develop on the second reason with an example. Suppose that firm 1 active only in market A creates demand-side linkages with the firm 2, the latter being only active in market B. Assume there is no risk of envelopment. If one wanted to do regulatory or competition analysis of firm 1 or market A, the substitutability approach would be pertinent to delimit the arena of competition and the competitive constraints faced by firms active in market A. However, the welfare effects of the competitive process would radiate from market A to market B. Following the findings of the literature on ecosystems, one would expect these two markets to be in the same industry. For example, market A could be the retail price comparison industry and market B the (online) retail market. In this case, an analyst with sufficient industry knowledge could identify the markets that are likely to be connected through demand-side linkages within an industry. Otherwise, empirical approaches to identify and measure the intensity of these complementarities would be crucial. In the next subsection we will examine to which extent platform ecosystems are structured around industries.

5.3 Industry composition of platform ecosystems

Figure 4 shows that although, as expected from the ecosystems literature, platform ecosystems tend to be structured around an industry, there are also cases of industry-agnostic ecosystems.

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.

This figure represents linkages at the market level (as opposed to the platform level depicted in Figure 1) defined as unique combinations of a platform's main function and subtopic. Figure 4 shows that platforms active in generalist and specialized marketplaces, price comparison and gaming forums markets are the central nodes that structure subgraphs connecting multiple other markets. Moreover, they connect to each other in turn, creating linkages across subgraphs. In contrast, markets related to tourism and online maps are connected to each other but do not show any complementarity with other markets. The level of complementarity is higher in the tourism and marketplaces related markets, as the thickness of their links shows. Moreover, these markets show several loops, which indicates that demand-side linkages between direct competitors are common in them.

The most striking case is the subgraph represented in the lower-right side of Figure 4. This corresponds to the ecosystem detected around the platform Jeux Vidéo in the upper-left side of Figure 1. Jeux Vidéo sends traffic to three platforms located in seemingly unrelated markets that do not belong to the same industry: Le Bon Coin (classifieds marketplace), Vinted (fashion classifieds marketplace) and Doctissimo (health-related news).

There are many possible reasons why demand-side complementarities between legally-independent platforms can form industry-agnostic ecosystems. All of them are rooted in the particularities of digital platforms. First, a platform can be multi-purpose in the sense that it can offer multiple products and services in different relevant markets (Franck & Peitz, 2021; Crémer et al., 2019). For example, Google.com is both a search engine and a scoring website, as it embeds in its search results the scoring and comments of restaurants from Google Maps users or movie ratings when users search for them. Although one could deduct from all the features of a platform like Google the possible complementarities it might have with firms active in other markets, the importance of these complementarities ultimately depends on how consumers use the platform. Second, consumers can use a single feature of a platform in different manners, creating so a link with another relevant market. For example, the links going from Jeux Vidéo to Le Bon Coin, Vinted and Doctissimo indicate that consumers use the forum functionality provided by Jeux Vidéo to create communities around different types of interests beyond gaming. As a result, a gaming-oriented forum becomes a gateway to platforms active in three other relevant markets. Third, using their gatekeeping and scoring power, some platforms prone to link to multiple markets (e.g. a marketplace) might give more prominence to certain types of platforms either because the latter payed for prominence or because of how the display or search algorithms are built. For example, the fact that the fashion price comparison platform Glami is complementary with the web portal Seznam could be due to the fact that the latter pays the former to add links that can steer consumers interested in fashion to Glami. It might also be the case that Seznam detects the interest of its community of users in combining the information they get from the platform with a fashion price comparison tool and hence it includes links to it to render its portal more valuable to its user base.

These results lead us to three major implications. First, some markets/platforms are more important than others in extending the arena of competition and welfare effects to other markets both because of the intensity of the complementarities they have with them and the number of markets they link. Second, the existence of industry-agnostic ecosystems implies that regulatory and competition analysis of the platform economy not only requires defining relevant markets (in plural) connected through demand-side linkages, but also quantitative methodologies to detect and measure the intensity of these linkages. Indeed, as the example of the ecosystem around Jeux Vidéo illustrates, in absence of an empirical methodology to measure demand-side linkages, regulators and antitrust agencies might not detect to which markets the welfare of effects of competition in one market might spillover. Third, the example of Jeux Vidéo suggests that non-generic complementarities might not always be, as the ecosystems literature asserts, orchestrated by firms. In this case, the industry-agnostic nature of the ecosystem is coherent with a “user-orchested” ecosystem. We shall develop on the implication of this in the next section.

6 Conclusion and implications for further research

In this article we implemented a novel methodology to detect demand-side non-generic complementarities between legally-independent digital platforms and analyze the competitive dynamics underpinning them. Our findings corroborate the importance of not limiting competition and regulatory analysis to defining a single relevant market through the substitutability approach. Instead, they indicate that expanding market definition to also consider markets linked through non-generic complementarities can be pertinent when analyzing platform ecosystems. This is because, when demand-side complementarities exist, the arena of competition and the scope of the welfare effects generated by the competitive process are multi-market.

The results of this article open three avenues of research. The first one relates to the phenomenon of “user-orchestrated ecosystems”. Our results show that in some cases (e.g. JeuxVidéo), 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 non-generic complementarities, it cannot 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-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 Video’s, it seems like users are playing the role of orchestrators. This contrasts with the prevailing view in the ecosystems literature according to which this activity is carried out by the focal firm. 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 second avenue of research related to firms’ responses to user-orchestrated ecosystems. If firms (and notably digital platforms) adapt ex-post to user-generated demand-side complementarities, 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?

Third, much work remains to be done to develop methodologies that measure demand-side and, to a lesser extent, supply-side complementarities. The approach proposed in this article is not without limitations. Alternative approaches within this research line can only contribute to a better understanding of the dynamics of ecosystems.

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Appendix

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

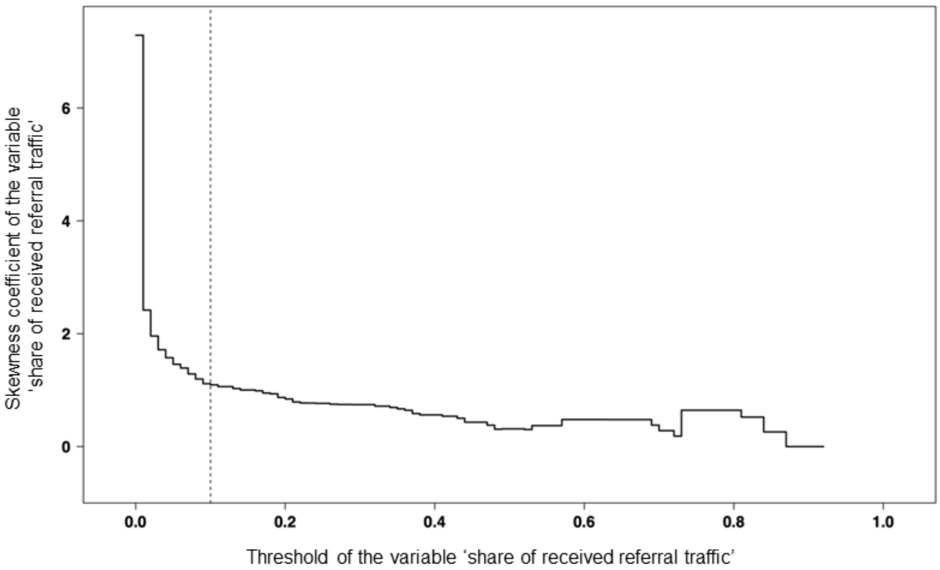
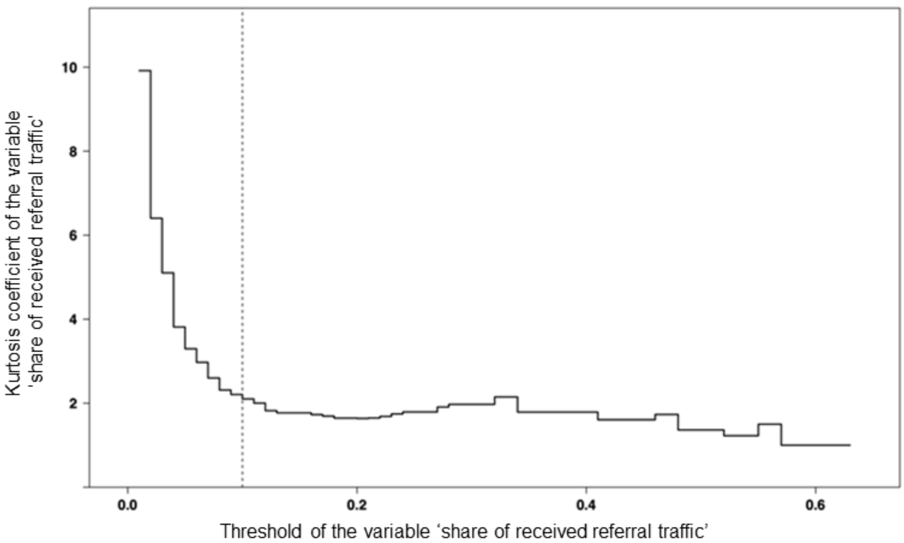
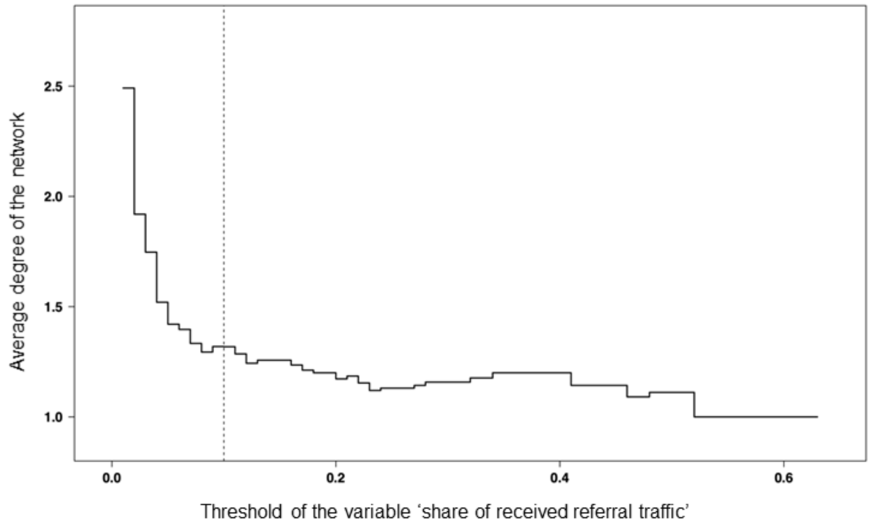


Figure 6: Relation between the threshold of the share of received traffic chosen and the kurtosis coefficient



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 4: 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	

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