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The Economics of Data Space

Policy Paper

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1 Introduction

As the world becomes more digital, consumers increasingly rely on applications to manage important aspects of their lives, such as health, personal finance, shopping, and travel. As digital literacy progresses, users become more aware that these applications collect their usage data, and in turn expect their data to be used by companies to build high-quality services they would benefit from.

Since 2020, in the context of its European strategy for data, the European Commission has been developing Common European Data Spaces in several sectors deemed strategic, such as energy, agriculture, health, and mobility. This policy aims at unlocking the value of data by enabling efficient collaboration among various data holders within a domain or sector, through the provision of innovative data-driven applications, for the benefit of EU citizens and companies. Eventually, these domain-specific Common European Data Spaces should interconnect to create a single market for data.

Through its Horizon Europe and Digital Europe programmes, the EU has supported several data space initiatives. Additional funding has been provided by EU member states through various programmes (e.g. France 2030).

While public funding has been a key factor in kick-starting this new ecosystem, it was never intended to be permanent. Consequently, data spaces now face the increasingly pressing challenge of identifying suitable business models to become economically viable without relying on continuous streams of public funds. The recent difficulties faced by AgDataHub illustrate how difficult this can be.

Why is this the case?

A viable sectoral data-collaboration platform might look as follows: it gathers a large number of actors from the sector, operating at different stages of the value-creation process. Each member provides high-quality data but can also profit from the data provided by the other users to offer innovative services to end users, even on its own, or sometimes through collaboration, on a per-project basis, with some other participants. In this ideal scenario, participants agree on a data-collaboration technology (e.g. data sharing vs. analytics sharing) and a profit-sharing scheme that properly incentivizes collaboration on new data-driven applications or attracts new players to join the data space. Platform costs are fully covered, and innovative services are adequately financed. Positive externalities are harnessed, and the data space benefits all its participants—and society as a whole.

However, practitioners have found it difficult to achieve this ideal outcome. As we will see, this is not surprising in light of modern economic theory. The aim of this report is to discuss the analytical tools provided by that theory which can help us understand these difficulties and thereby improve our comprehension of data spaces and the strategies that could make them as effective as possible. At this stage, our primary aim is to present existing analytical tools and explain their use, their advantages, and their limitations. We believe that these tools will help clarify and sharpen the policy choices that data spaces need to address. A secondary aim is to identify important extensions of these tools that could be developed in the future.

So why is designing useful data spaces difficult? There are two types of arguments. Some arguments relate to the peculiar characteristics of the resource at stake, that is, data. Others arise from the fact that a data space can be seen as a multi-sided platform. Together, these create difficult problems that lead to outcomes which are suboptimal for the data space itself, but also for broader social welfare. As will be clear from the rest of the report, these arguments not only shed light on the nature of the challenges but also highlight key factors that must be considered when designing sustainable business models for data spaces.

The report is organized as follows: Section 2 sets the terminology used in this report. Section 3 highlights the economic characteristics of data. Section 4 summarizes key lessons from the economics of multi-sided platforms and discusses their applicability to data spaces. Section 5 sheds light on other key design decisions that a data space must consider, namely cost- and profit-sharing schemes and the type of technical infrastructure for sharing data. Section 6 concludes and offers some perspectives for future research.

2 Terminology

Before starting the analysis, it is useful to define the concepts we will be using.

A good or service involves *network externalities*, when the value of the good or service for one user increases when other agents use the same good or service.

For the purpose of our analysis, we define a *platform* as an organization that connects users to facilitate interactions or transactions among them. Platforms create value by enabling exchanges rather than producing goods or services themselves. They rely heavily on network effects, as the participation of one user increases interaction possibilities for other users.

The literature we review in the next section has focused on two-sided or multi-sided platforms that create value by enabling interactions between distinct sides of a market. Examples include online marketplaces connecting buyers and sellers, ride-sharing apps connecting riders and drivers, and online travel agencies (OTAs) connecting travelers and hotels.[1]

[1] Social media platforms are examples of more complex platforms: their core activity does not involve clearly distinct sides as all users can exchange content or communicate. However, they exhibit strong network externalities and, once advertising is taken into account, can be viewed as multi-sided platforms connecting content creators, advertisers and users.

A *marketplace* is a particular type of platform that enables transactions between buyers and sellers of goods and services. Typically, a marketplace involves services such as matching sellers with potential buyers, information provision, and price discovery. It may also offer ancillary services such as billing, delivery or dispute resolution. In general, a marketplace monitors and taxes the transactions it enables.

A *data space* is an organization that fosters data sharing among its members. Members contribute in two ways. First, they provide access to their data while retaining full sovereignty over it—data spaces are different from common data lakes where all the data would become common "property". Second, they develop new services or applications by exploiting the available data, both their own and the other participants' data. From the above perspective, a data space can be viewed as a platform in which interactions occur when two (or more) parties enter into a data-sharing agreement. Throughout the report, we will highlight the many instances where the economic literature on platforms illuminates the functioning of data spaces and the instances where data spaces depart from the models of platforms studied in the existing economic literature.

3 Key Economic Characteristics of Data

Certain characteristics of data create complex issues for internal pricing within data spaces.

Data is "non-rivalrous"—its use by one party does not diminish its availability or its usefulness to others; other examples of non-rivalrous goods would include national defense or public art. As many non-rivalrous goods, sharing data requires very little resources. In economic terms, making data available to more agents has low or zero marginal costs. This implies that, once data has been collected, it would be efficient to set the access price at zero or at a very low level. However, such policy would radically undermine incentives to collect and organize data in the first place. Therefore, the internal pricing scheme adopted by data spaces must strike a balance between encouraging the creation of useful data and promoting its widespread sharing (see, e.g. Jones and Tonetti, 2020).

Although data is non-rivalrous, it is not necessarily a public good.[2] Various exclusion mechanisms can be employed to ensure that only a subset of the participants in a data space benefit from (part or all of) the data as access to a participant's business data can be restricted and monitored. This implies that it is possible to charge for data access.

[2] A public good is a good that is non-excludable (no one can be prevented from using it), as well as non-rivalrous. For instance, clean air is a public good: once the air is unpolluted for one agent, it is unpolluted for others.

Without exclusion mechanisms, the price of data within the data space would be zero. While the issue of data collection costs might be addressed via membership fees, free-riding becomes a significant risk. Participants may wish to use abundant, high-quality data from others while being reluctant to share their own, especially if they are competitors or vertically integrated firms concerned about revealing sensitive information (e.g. cost structures). This highlights the importance of governance and trust-building mechanisms within data spaces to foster cooperative behavior.

Beyond internal pricing challenges, data possesses economic characteristics that may hinder the emergence and growth of data spaces—particularly in competition with large digital incumbents. Data collection and processing exhibit significant economies of scale. Fixed costs to establish processing infrastructure are high, and therefore average costs decrease with data volume. Hence, preexisting large data holders enjoy cost advantages that make creating competing data spaces difficult. These cost advantages are reinforced by so-called data-driven network effects: Firms with larger datasets can train better models, deliver more accurate predictions, and improve services. This, in turn, attracts more users and generates more data—a feedback loop that entrenches the market position of incumbents and raises barriers to entry.

Finally, data sharing generates externalities—positive and negative. For instance, sharing health data can foster innovation and help track pandemics, benefiting society, but it can also raise privacy concerns. These externalities mean the level of data sharing in the economy may not be socially optimal, justifying public intervention through subsidies or regulation.

It is also worth noting that, according to economic theory, information embodied in data has no intrinsic value. Its value stems from its potential to change behavior by improving decision-making under uncertainty. For an agent taking an action (for instance, a company setting the price of one of its products), the value of information is the difference in expected profit between the best action taken with the information and the best action taken without it. The value increases with the likelihood that the data influences the agent's behavior and the magnitude of its impact. For instance, Disney provides visitors to its amusement parks with information about upcoming shows and the wait times for attractions or restaurants. This information has value for visitors, as it helps them make better decisions when planning their visit. Disney does not directly sell the data, but does so indirectly: enhancing the visitor experience enables it to charge higher prices.[3]

[3] A complete analysis would take into account the fact that Disney curates the data and helps visitors interpret it through its app.

4 Data Spaces as Multi-Sided Platforms

Multi-sided platforms have become prominent economic players across a wide range of sectors, including retail, media, transportation, hotel services, telecommunications, and financial services. This section sets out the case for viewing data spaces as a specific form of multi-sided platform. Drawing on established findings from the platform economy literature, we identify key principles that can inform the development and governance of data spaces. In addition, we highlight several structural and functional characteristics of data spaces that remain under-examined in current research and policy discussions, underscoring the need for further analysis in this emerging area.

4.1 Main features of multi-sided platforms

Platforms are institutions that connect users. They have existed for centuries. For instance, the fairs organized by towns in the Middle Ages were platforms. Platforms display several traditional economic characteristics, which we find in other industries, such as returns to scale and switching costs. However, they also exhibit a set of novel features that distinguish them from more conventional market institutions. The most prominent of these is the presence of multi-sided externalities—situations in which the actions of users on one side of the platform have a direct impact on users on another side of the market.[4] The concept of "multi-sidedness" reflects two core dimensions. First, externalities arise between distinct groups of users who engage with the platform for different purposes. Typically, platforms facilitate interactions between two or more types of participants, each forming a distinct side. For example, in e-commerce platforms, buyers and sellers represent separate sides of the market. Similarly, in the case of search engines or social media platforms, users and advertisers constitute two distinct participant groups. Second, platforms manage these different sides asymmetrically—for instance, by applying different pricing structures to each group. This strategic differentiation in treatment allows platforms to balance participation incentives and optimize overall engagement.

Multi-sided externalities occur when participants on one side of a market are affected by the number and characteristics of participants on other sides (Rochet and Tirole, 2003; Caillaud and Jullien, 2001, 2003; Armstrong, 2006). A clear illustration is seen in consumers' decisions to purchase smartphones or video game consoles, which often depend on the availability of applications or games—typically

[4]Platforms can be "one-sided" when all the users play the same role: for instance, a social media platform under its pure form connects users who all play the same role. They are "multi-sided" when they connect different types of users. Most of the recent interest in the economic literature has been on multi-sided platforms and our discussion will focus on those.

developed by third parties active on another side of the platform. More generally, the expected value of joining the platform depends on the presence or likely presence of users on the other side(s). Therefore, user expectations about cross-side participation are central to platform dynamics and must be taken into account in platform design.

A common underlying feature is that the services offered by the platform to one side are complementary to those provided to the other side(s). In other words, improvements in the quality or attractiveness of services on one side of the platform tend to increase demand on the other side(s).[5] As a consequence, platforms frequently regulate the interactions between their sides. These interventions are often beneficial, as they help align incentives across user groups and enhance the overall efficiency of the platform. By facilitating cross-side coordination, platforms can generate services that are not only better but also more affordable for users on one or more sides. For instance, a marketplace might enforce a minimal quality on the products sold on the platform. This clearly benefits the buyers, but it will often also benefit the sellers as more buyers are attracted by the good reputation of the platform.

To a large extent, the description above fits key features of data spaces. Participants in a data space provide data and/or team up to develop innovative end-user services based on shared data. For many applications of the theory to data spaces, it can be useful to view them as platforms having three sides:

- data providers, who make data available;
- service developers who write the software which uses the data;
- service providers who make the services available to end users.

These three sides are exposed to multi-sided externalities:

- developers care about the presence of data providers, as the larger the volume and diversity of data the higher the value of the services that can be developed on top of it;[6]
- data providers care about the presence of developers, who develop innovative services that consume, and thus give value to, the data;

[5] On some two-sided platforms, users on one side may experience a negative externality from the presence of users on the other side, as in the case of advertising. However, at least one side derives a positive externality, for which the general principle is valid.

[6] For a sectorial data space, having a large diversity of data is key, as innovative end-user services typically merge data coming from data providers having complementary activities in the target sector (e.g. an airline company and an airport operator). Just "stacking" similar data coming from direct competitors (e.g. two airline companies) is less likely to generate value for end users.

- developers care about the presence of service providers, and vice versa, as innovative services are the end-products of the data space.

As we will discuss again below, it will quite often be the case that one agent plays several roles, *i.e.,* is active on several sides of the market.

4.2 Pricing strategies

The presence of multi-sided externalities has direct implications for a platform's pricing strategy. In particular, it gives rise to monetization models that differ significantly from those found in traditional product markets. It is common for platforms to adopt asymmetric pricing structures, charging different prices to different user groups depending on their role. Because platforms have the ability to monetize activity on multiple sides, determining how to allocate the total cost of service provision across these sides represents a complex and strategic decision, that we discuss below.

Externality-adjusted prices

Consider a platform that intermediates interactions between two sides of a market and charges positive prices to participants on both sides. The platform adjusts its pricing strategy to account for the presence of cross-group externalities. Specifically, attracting additional users on one side, let us say side A, of the market increases the platform's value to participants on the other side, side B, thereby increasing the demand on side B and enabling the platform to generate additional revenue by raising prices and/or selling more products or providing more services. This strategic trade-off gives rise to an implicit cross-subsidy between user groups. In the case of a monopolistic platform charging users fixed participation fees, the pricing behaviour can be formally captured by the following rule (see Armstrong, 2006, and Rochet and Tirole, 2006):

$$\begin{aligned}\text{Price} = \text{cost} + \text{mark-up (as in a standard product market)} \\ - \text{value created on the other side.}\end{aligned}$$

This rule indicates that, on each side of the market, the platform sets prices based on the conventional trade-off between profit margin and sales volume, but modified to account for the additional revenue generated through cross-side externalities. Specifically, a new participant on one side of the platform increases the value of the platform to users on the other side, making the platform adjust its pricing accordingly. To repeat a bit more formally: assume there are two sides, A and B. If the presence of one more user on side A increases the value of the platform to users on side B by x euros, the price to the users on side A will be decreased by x euros (for given mark-up). One good way to think about this is as follows: the net cost of serving users on side A is equal to the cost of hosting them *minus* the benefit they provide to the platform by increasing its value to the users on side B.

The rule implies that the stronger the positive externality a group exerts on the opposite side, the lower the price it is likely to face. Three important observations follow:

a) First, consistent with the general effects of network externalities, when all cross-side externalities are positive, the platform will tend to set lower prices than it would in the absence of such effects. (The platform benefits as, by so doing, it increases the number of users on both sides.)

b) Second, in cases where externalities are asymmetric across sides, the resulting prices may be highly asymmetric: One side of the market may be charged a significantly lower price—and in some cases, even a price below cost—if the value that it generates for the other side is sufficiently high to justify the mark-down.

c) In some cases, it may be optimal for the platform to forgo profit, or even incur a loss, on one side of the market in order to enhance profitability on the other side.

An illustration of this concept can be seen in TikTok's monetization strategy: creators (one side) are offered generous incentives, including payouts, exposure through algorithms, and tools to grow their audience—all at little to no cost to them, while advertisers and brands (another side) are charged premium rates to reach TikTok's large, highly engaged user base.

To sum up, a platform relies on both the total price and the price structure to maximize its profit: it charges an overall mark-up and uses cross-subsidization to optimize its profit. For instance, credit card associations charge a positive fee to merchants but distribute points and goodies to credit card holders to boost usage.

A consequence of the pricing analysis above is that an intervention (e.g., by a regulator) that reduces prices on side A of the market may hurt the agents on side B. Indeed, the platform can find it less attractive to attract more users on side A, and thus, in turn, reduce its incentives to subsidize side B (the so-called see-saw effect). It is thus essential to assess the effect of any proposed intervention on both sides, even if only one side is directly concerned.

Note that the pricing strategy described above requires identifying sides and their participants. As we will discuss later, the identification of sides is not straightforward in the case of data spaces because some participants may be active on multiple sides. However, the general underlying principle still applies: contributions to the platform's fixed costs should be inversely related to contributions to value creation.

Zero prices

As noted previously, when network externalities between the two sides of a platform are asymmetric, it is possible for the price charged to one side to fall below cost. The platform may even be willing to subsidize a side which brings very large benefits to the other side. However, it is often impossible to charge "negative prices", for instance because users could connect while not really using the platform—this would be the case for instance for video sharing platforms where viewers (side A) are extremely valuable to advertisers (side B) In this case, the platform will offer its services for free to one side. (Other examples include free newspapers or television channels.)

When the platform is limited by the zero price bound, it will often try to attract the valuable side by offering additional services, or "freebies," alongside core services (Amelio and Jullien, 2012). For instance, Google offers consumers other free services such as Gmail and Google Calendar in addition to its free core service Google Search. When one side receives free access, the pricing model for the paying side must be adjusted. While an extra user on the paying side does not directly increase revenue from the free side, their presence encourages more users to join the free side. Because paying users derive value from greater participation on the free side, this feedback loop enhances the value of the platform for paying users. Consequently, there is an "indirect" network effect among paying users, driven by the engagement levels on the free side.

In light of the above, a data space may consider offering free or subsidized access to some partners who can provide valuable data, even if they do not themselves benefit from the data provided by others.

Fixed fees vs. usage fees

Beyond these general considerations on price asymmetry in platforms' pricing strategies, data spaces should also be very much concerned with the precise pricing structure they have to set up, in particular the balance between usage-related fees and fixed participation fees. Indeed, transaction volume depends on the full pricing structure, including fixed and usage fees.

Membership and service fees affect participation, while usage fees influence willingness to trade. To cover its costs, the platform must choose the right balance between these two components, subject to the following trade-off: While fixed participation fees induce less distortions of usage, variable usage fees provide more insurance that the cost for participants will align with the value received (see e.g. Jullien et al., 2021).

The initial difficulty in generating activity often leads new entrants to prefer usage-based tariffs over participation fees, as a way to attract users. With usage-based pricing, users only pay when the platform succeeds, effectively serving as insurance against the risk of a failed startup (Caillaud and Jullien, 2003).

More generally, White and Weyl (2016) argue that the ability to design tariffs that "insulate" the final utility derived by users on one side from unexpected variations in participation on the other side can help to build a critical mass and succeed in attracting both sides.[7]

B2B bargaining and price personalization

Business-to-business (B2B) data spaces exhibit two key characteristics that set them apart from business-to-consumer (B2C) platforms and social networks. First, the potential number of participants is, in many cases, relatively limited. Second, these participants are often highly heterogeneous in their ability to contribute to and benefit from data sharing. They may operate in different industries or different points along a value chain, generate distinct types of data, and vary in their capacity to develop and commercialize new services. In such a context, a platform may find it optimal to personalize its services and negotiate prices directly with users, tailoring its offer to the specific characteristics of each participant. A relevant analogy can be found in shopping malls—two-sided platforms that facilitate interactions between buyers and retailers—where contracts are typically negotiated individually with each shop.

Jullien (2011) shows that the insights from the literature on multi-sided markets extend to settings with personalized pricing. One way to conceptualize this is to treat each individual as a distinct "side" of the market. As in the case of multi-sided platforms with uniform pricing within sides, optimal personalized pricing entails implicit cross-subsidization: participants who benefit more from network externalities subsidize those who contribute more to them. As a result, some users may generate seemingly negative margins, while others contribute to covering the platform's costs.

A key question in this context is whether it is optimal for a data space to engage in bargaining over personalized prices or to commit to equal treatment of participants through standardized access conditions. When the platform bargains with some potential users, the outcome depends on (i) the bargaining power of each party, (ii) the network benefits expected by the user, and (iii) the user's contribution to the utility of other platform members. As a result, users who contribute

[7] Examples include pay-per-click tariffs for advertising and non-linear tariffs for video game developers. See White and Weyl (2016) for further details.

significantly to network externalities are better positioned to negotiate favorable terms. However, when the platform has strong bargaining power, it can capture a large share of the surplus generated by the user's participation. In this case, the platform may find it optimal to negotiate personalized prices with users who derive substantial network benefits, thereby increasing its revenue. This ability to appropriate a greater share of the value also creates incentives for the platform to enhance that value by offering more attractive terms to other users (Adachi and Tremblay, 2020).

4.3 Entry and divide-and-conquer strategies

So far we have focused on mature platforms whose main strategic issue is to leverage network effects and find the right balance between margins, volumes and coordination between the various sides of the market. For new platforms, other issues arise. Indeed, when network externalities are large, a new platform face a "chicken and egg" problem: even if the architecture of the platform is great, it is of no use if there are no users—the first user does not gain any benefit. The platform needs to bring on board enough participants on at least one side to prime its activity.

To overcome this issue, a new platform must subsidize the participation of certain users in order to build a customer base, and subsequently exploit the "bandwagon effect" by charging high markups to other users who anticipate substantial and secure network benefits. This strategy is referred to in the literature as divide-and-conquer (Caillaud and Jullien, 2003), whereby, in the early stages of the platform, one group of users is subsidized ("divided") to attract participation, while the other group is monetized ("conquered"). Deciding which side to divide and how to do it is then a key strategic decision of the platform.

Divide-and-conquer strategies may however be difficult to sustain. First, they require losses on at least one side with uncertain prospect on the other side, which obviously raises financial issues. Second, they may require negative prices which may not be feasible, in which case quality and freebies can act as substitutes for negative prices. In this context, bundling several platform services may be an effective tool to conquer a new platform market (Amelio and Jullien, 2012; Choi and Jeon, 2021). Third, they may raise fairness issues as similar participants may be treated differently.

4.4 Platform competition

One of the key drivers of competition in platform markets is, as discussed above, the presence of network effects. When more users join a platform, it becomes more valuable to all users, thereby reinforcing its market position. Even small initial advantages can become amplified over time, leading to a "tipping" effect where one platform captures the entire market. This phenomenon can occur even when competing platforms offer similar services and pricing, simply because users join the platform they believe others will choose.

Despite this tendency toward monopolization, several factors can allow for sustained competition within the market. Platform differentiation plays a critical role. If platforms offer unique features, target specific users, or specialize in certain services, they may retain users despite having smaller networks. Interoperability, where platforms allow interaction across systems, may also reduce the disadvantages of smaller networks. However, dominant platforms often resist interoperability mandates since it reduces their competitive edge.

When firms anticipate tipping, there is intense competition for the market as firms sacrifice profits to build markets shares. Successful platforms then benefit from an "incumbency advantage" (Biglaiser et al., 2019), as it is difficult to convince individuals or firms to leave an established platform to join a new platform with a small customer base. But even in this case, entrants with superior quality offerings can challenge incumbents, if they are willing to incur losses early on to build market share and ultimately replace the incumbent. The longer the planning horizon and the higher the quality of the entrant, the more aggressive it can afford to be initially (Hałaburda et al., 2020).

When the market structure stabilizes with more than one platform, competition within the market depends heavily on differentiation. Platforms may differentiate through the types of products or services offered, the structure of their pricing, or the business models they adopt. For example, platforms might attract different types of users by varying the degree of network benefits across their user base. In some markets, such as job search or credit cards, this leads to asymmetric networks where one platform has more users of a certain type and the other has more of another.

When a platform faces a competitor, gaining a customer on one side of the market not only creates value on the other side of the market for this platform, but also reduces the attractiveness of its competitor. This "double dividend" aspect encourages competing platforms to be aggressive. We provide below the pricing rule for a platform facing competition.

$$\begin{aligned}\text{Price} &= \text{cost} + \text{mark-up} \\ &\quad - \text{value created on the other side} - \text{value destroyed at the competitor.}\end{aligned}$$

There are two main differences with the formula which we presented above for the monopoly case. First, the markup is generally lower in competitive settings than under monopoly (this is to be expected: competition reduces the profits of the suppliers). Second, there is a stronger price adjustment to externalities between sides, as the platform accounts for the effect of the platform's sales on the network benefits provided by rival platforms as well as its own.

This rule shows that competition may intensify cross-subsidies and asymmetry in prices: competition tends to reduce the overall mark-up but may raise the differences between the revenues generated by the various sides.

In sum, while monopolization is a natural tendency due to demand-side dynamics, it is not inevitable. Effective competition, both for and within the market, can occur under the right conditions, particularly when entrants are forward-looking and consumers are open to multi-homing (see below) or platform switching.

Finally, in a platform market, the implications of competition for economic efficiency are far from clear-cut. A key finding of the literature is that more competition may lead to a *decrease* in both user welfare and economic welfare. One reason is that a larger number of platforms can hinder interactions among market participants, thereby weakening network externalities. This negative effect of fragmentation may outweigh the standard benefits of competition on prices, ultimately leading to an overall negative effect (see, for instance, Correia-da Silva et al., 2019).

The above discussion sheds light on competition among data spaces, but it is important to note that data spaces may also face competition from entities offering alternative solutions for data sharing (e.g., hyperscalers). In this case, it is likely that some participants in the data space also engage with these competing entities. This situation raises additional issues, which we discuss below.

4.5 User participation patterns

Single-homing vs multi-homing

A key driver of competition in platform markets is the pattern of consumption of platform services: agents "single-home" when they concentrate all their activity on one platform, while they "multi-home" when they use several platforms.

Multi-homing substantially affects the nature and implications of competition between platforms. First, it reduces the competitive pressure faced by a platform on the multi-homing side. To see why note that, while single-homers compare the prices of each platform, the decision to multi-home or single-home only depends on the comparison between the gain from joining the second platform and its price, and not on the price set by the first platform.[8]

Consider the following example. A seller considers listing a product on two different websites, each with 1000 buyers who exclusively use that site. The seller earns a value of €20 per buyer. The value obtained by the seller is thus €20000 on each website (1000 × €20). If the seller is restricted to using only one website

[8] For instance, the price of the iCloud affects the demand for Dropbox only through its effect on single-homers.

among the two (i.e., to single-home), then competition between websites drives platforms' fees down to cost of service. But if the seller can multi-home (as is often the case), each website can charge a price of €20000 as the seller is willing to pay this amount to reach the distinct buyers of each website.

Moreover, reconsidering the previous formula for two-sided pricing under competition, note that attracting a multi-homing user creates less competitive leverage on the other side of the market, because the term "value destroyed at the competitor" becomes equal to zero (as the user remains available for interactions on the competing platform).

Second, multi-homing on one side leads to "incremental pricing" (Ambrus et al., 2016; Anderson et al., 2018): when platforms set their prices simultaneously on the multi-homing side and, then, agents on that side decide which platform(s) to join (if any), each platform can only charge the additional value it creates with respect to its rival. As an example, consider again our example of a seller listing on two websites. Suppose now that 500 buyers multi-home and visit the two websites, while 500 buyers single-homing on each website (hence, there are still 1000 buyers on each website). In this case, instead of charging a price €20000 to the multi-homing seller, each website can only charge €10000 ($500 \times 0 + 500 \times$ €20) which corresponds to the difference between the value the seller derives from accessing the two websites (i.e., $1500 \times$ €20 $=$ €30000) and the value it derives from accessing one website, (i.e., €20000).

Lower competitive pressure combined with lower value of multi-homers for the platforms implies that the presence of multi-homers on one of the sides of the market weakens competition on that side (Doganoglu and Wright, 2006). However, multi-homing on one side may exacerbate competition for exclusive relationships on the other side. Typically, multi-homing has the following two effects: it raises each platform's user base, but incremental pricing tends to reduce the benefits per user (Armstrong, 2006). This may lead to lower prices for single-homers, and provides strong incentives to sign exclusive deals (Armstrong and Wright, 2007).

Another key point is that, at the user level, the benefit of multi-homing depends on how many agents on the opposite side of the market also multi-home. Indeed, the user's gain for multi-homing is to increase the number of possible interactions by combining different populations active on several platforms. For example, an individual may use both Uber and Lyft if this makes it possible to reduce the waiting time. This gain is lower if many users multi-home on the other side (in our example, if many drivers are active on both platforms), since the effective expansion is then small.

In the case of data spaces, we expect data providers to multi-home, that is to share their data through multiple channels. This is the consequence of the semi-public good nature of data, as the same data can be exploited by multiple developers.

Multi-sided participants

An important characteristic of a data space is that participants are not necessarily confined to a single side of the platform: the same user may both provide data to certain players and consume data provided by the same or other players. Hence, depending on the use case, a participant may be a data provider, a service developer, or both.

While the literature typically focuses on the differential treatment by the platform of clearly identified sides with distinct participants, the analysis extends to situations where the platform can differentiate prices across different groups of users, that do not constitute sides per se (see Jullien et al., 2021; Belleflamme and Peitz, 2023).

Compared to a standard multi-sided market where the different sides do not overlap, the presence of "multi-sided participants" can improve the internalization of cross-side externalities. For example, a company considering joining a data space as both a data provider and a developer will take into account the value created for both roles, reducing the need for cross-subsidization.

4.6 Platforms as private regulators

An important characteristic of platforms is the autonomy they grant to their members regarding how interactions are conducted. This autonomy is a key source of two-sidedness, and it is recognized as a distinguishing feature of platforms compared with more traditional intermediaries (Hagiu and Wright, 2015a,b). However, effective coordination may sometimes require platform intervention, and platforms may seek to *regulate* interactions between users. Indeed, if platforms can monetize the efficiencies resulting from their interventions, they will be incentivized to increase the total value generated by user interactions on the platform.

Market design and conduct regulation

There are numerous examples of regulations implemented by platforms.[9] For instance, platforms may restrict access by setting entry requirements (such as solvency requirements in financial exchanges).[10] They may also use the threat of delisting participants to discipline their behavior (Jeon et al., 2024).

Platforms can also engage in price regulation, for example by imposing price caps. A price cap, for instance, applies to applications sold on Apple's App Store.

[9] In this subsection we focus on regulations which are introduced by the platform in order to improve its usability, as those regulations are more relevant to the European Data Spaces. In practice, some regulations are designed to artificially maintain the market power of dominant platforms.

[10] See Reillier and Reillier (2017).

Ride-hailing companies (e.g., Uber or Lyft) directly control transaction prices. Platforms may also influence pricing by requiring users to adopt specific pricing algorithms or by issuing price recommendations. For example, Airbnb provides hosts with non-binding price suggestions based on data analytics. These pricing interventions generally aim to improve trade efficiency—either by leveraging the platform's data or by limiting the market power of certain participants. While they may enhance efficiency, such measures also affect how surplus is distributed among participants.

Platforms may also play an enforcement role by establishing reimbursement policies and mediating disputes between users. For example, certain e-commerce sites collect payment when an order is placed but release the funds to the seller only after the item has been delivered and any potential issues with the buyer have been resolved.

Most platforms can influence user searches by offering recommendations, as seen on platforms as diverse as YouTube and Amazon. Moreover, feedback and rating mechanisms play a key role in building trust among users. The widespread adoption of these feedback systems to inform or discipline participants is one of the main innovations that have fostered the emergence of online platforms. For example, Amazon allows buyers to rate sellers and leave comments about their transactions.

The literature suggests that some level of intervention by a data space in transactions between participants may be desirable. For instance, the data space could act as a trusted third party, offering services such as contract design and dispute resolution.

Vertical integration

Sectoral data spaces are usually governed by consortia of stakeholders, primarily data holders, rather than by a single profit-maximizing firm that is not part of the platform's user base itself. This form of "vertical integration" is common as it helps jump start the platform. However, careful governance is required to prevent misalignment between the interests of integrated stakeholders and those of other participants (see Hagiu et al., 2022, or Anderson and Bedre Defolie, 2024).

Vertical integration ensures a certain level of activity within the data space, reassuring prospective participants that they will find a meaningful supply of both data and developers. This helps overcome the "chicken-and-egg" problem common in multi-sided platforms.

Platforms can use vertical integration as a way to regulate a marketplace: they can then use the price they set to influence the prices of other sellers on the platform. For instance, if a platform finds that the price of a certain product is too high on its marketplace, it may decide to act itself as a seller for that product.

While improving coordination and enhancing the value of the service may constitute an objective justification for vertical integration, such integration can also be viewed as restrictive of competition—whether on the platform, across platforms, or in relation to new entrants. Assessing the impact of these practices requires a careful balancing of internal efficiency gains against potential harm to competition.

Vertical integration may also give rise to delicate governance issues, as it creates a tension between short-term and long-term considerations. In the short run, there may be a temptation to favor the integrated players over the platform's long-term developments.

Disintermediation

One can argue that data spaces are subject to a risk of disintermediation, whereby participants once matched on the platform continue to interact outside the platform, evading fees, regulations and pricing policies set by the platform to ensure its long-term viability. A data space needs to protect itself against this risk.[11] This can be done contractually or by offering complementary services that raise the value of trading on the platform. Such complementary services could include, for instance, support for compliance with regulations (e.g. DGA, GDPR) and technical standards (e.g. data connectors), or participation to the design of a domain-specific ontology. Moreover, the data space may market itself as an entry point to the future single market for data envisioned by the European Commission, enticing participants to operate within the platform rather than outside.

The threat of disintermediation also affects the pricing strategy of a data space. One way to mitigate disintermediation is through a front-loaded pricing scheme—charging more for the first transaction than for subsequent ones (Enache and Rhodes, 2025). However, such a strategy may conflict with the need to offer introductory prices to attract new companies to the data space.

Disagreement on the value of data

Designing pricing schemes is difficult even under the assumption of fully rational agents. In practice, however, participants in a data space may exhibit various behavioral biases. For instance, they might overestimate the value of their own data while underestimating that of others. As a result, data providers and service developers may have diverging views on the value of data. This can reduce the number of transactions or limit the number of projects developed within the data space, thereby undermining its viability.

[11] Hagiu and Wright (2015a) provide a discussion of various measures that a platform may implement to mitigate the risk of disintermediation.

Therefore, data spaces face the challenge of promoting transactions in a context where there are significant disagreement over the value of the traded good. This calls for mechanisms that can prevent or mitigate the adverse effects of such disagreement. To our knowledge, the existing economic literature offers very limited guidance on this issue. One potential approach is to provide credible and transparent valuation methodologies or to involve neutral third parties that can help bridge the gap between data providers and users. Another possible solution is to encourage contractual arrangements or partnerships in which part of the payment is contingent on data usage, thereby giving participants opportunities to reduce uncertainty and resolve valuation disagreements over time.

5 Key Decisions about Data Space Design

In addition to the aspects discussed in the previous sections, data spaces must make several important design choices. In this section, we focus on the choices that data spaces need to make regarding cost-sharing and value-sharing mechanisms, as well as data-combination technologies.

5.1 Cost-sharing and value-sharing mechanisms

When setting up a new data space or developing a new data-driven service, individual contributions from participants are likely to vary. Regarding costs, some participants may bring superior technology or expertise, leading to significant cost reductions. Moreover, some participants may join the data space later, after the platform is already in place. Regarding value, participants contribute data that powers innovative applications. For a given application, some datasets may be deemed more critical than others for implementing the features that make it valuable to end users.

How should the costs incurred to build a data space and the value created by new services be shared?

A fair sharing mechanism

When contributions to cost reduction or value creation differ, equal sharing may appear unfair. Perceived unfairness is an issue to the extent that it may deter highly skilled or data-rich companies from joining the platform and collaborating with members to build valuable services.

While fairness is not easy to define, one possible approach is to establish a set of desirable properties that any sharing solution must have in order to be considered *fair*. This is the approach taken by Shapley (1951) in his seminal contribution to cooperative game theory.

A *fair* sharing solution must have four properties. These properties, described in a profit-sharing context, are as follows:

- *Symmetry:* Players with equal contributions are treated equally, receiving the exact same share. This is an obvious necessary condition for fairness.
- *Efficiency:* All the profits are distributed. Not doing so would be unfair to the players as a whole. This is akin to a "no waste" condition.
- *Dummy player:* A player who does not contribute receives nothing.
- *Additivity:* If the total profits to be shared come from several independent projects, the profits received by any player are the sum of the fair shares received from all the projects. This property simplifies the problem at hand, allowing the sharing of a global profit by considering only the individual projects that contributed to it.[12]

At this point, the term "contribution" must be precisely defined. Intuitively, the contribution of a player is the additional gain the player brings to a project when they participate. However, such contributions depend on the group of players already involved in the project (a *coalition*), which may be the group of all the other players or a smaller group. Therefore, to properly account for what a player can bring to a project, we must consider their marginal contributions to each possible coalition of players among all the players (except themselves).

For instance, with three players, the contribution of the first player is fourfold: *(i)* the value of the project if they carry it out alone, that is, if they join an empty coalition, *(ii)* their marginal contribution if they join the second player to carry out the project, *(iii)* the same, but with the third player, and *(iv)* their marginal contribution if they join a coalition of the second and third players.

Since a player's contribution is composed of several components, and since the sharing rule cannot distribute more than what the project yields, paying the player the average of all these components seems to be a reasonable sharing rule to consider. The weight of each component should reflect the relative frequency of the situation in which the corresponding contribution occurs, out of all possible sequences of coalition formation. Therefore, the weight of a component is the number of permutations of the coalition that the player joins.

Is such a rule fair? Shapley (1951) shows that distributing gains based on each participant's weighted average marginal contribution across all possible coalitions

[12] It has been shown that this property can be relaxed while maintaining Shapley's main axiomatic result (see, e.g., de Clippel (2018)).

satisfies the four properties that define fairness. Moreover, Shapley (1951) demonstrates that this is the *only* rule satisfying these four properties. The value paid following this sharing rule is called the *Shapley value*. Therefore, once the requirement to satisfy the four properties above is stated for the sharing solution, the Shapley value must be used.

Example: Cost sharing

Consider a group of three firms—A, B, and C—collaborating to build a shared infrastructure at a total cost of 22 million euros. How should this cost be shared among the firms?

To compute the Shapley values, we must evaluate the cost reductions each firm brings when joining every possible coalition of the other firms. Assume that the service provider would charge 10 million euros per firm for building separate infrastructures. In this case, the three firms save $3 \times 10 - 22 = 8$ million euros by contracting for a single, large shared infrastructure. Furthermore, due to synergies between A and B, and between A and C, the service provider would charge only 15 million euros to build an infrastructure for each of these two pairs—resulting in a 5 million euro saving per pair—while it would charge 19 million euros for a joint infrastructure for B and C, resulting in a saving of only 1 million.

Figure 1 depicts all possible coalitions among the three firms, along with the cost of building the infrastructure for each group.

The Shapley values are computed as follows. We list the six possible sequences of coalition formation, and for each, we report the cost reduction that each firm contributes when joining the coalition in the specified order. For example, when A joins the other two firms (e.g., the sequences beginning with BC and CB), it contributes a cost reduction of $(19 + 10) - 22 = 7$ million euros. As shown in Table 1, the Shapley value of a firm is then calculated as the average of its marginal cost contributions across all six sequences.

Firm A has the greatest impact on cost reduction. It bears $10 - 4 = 6$ million euros, which is less than the amount borne by each of the other two firms, B and C, who each contribute $10 - 2 = 8$ million euros. Together, these contributions exactly cover the total infrastructure cost of 22 million euros.

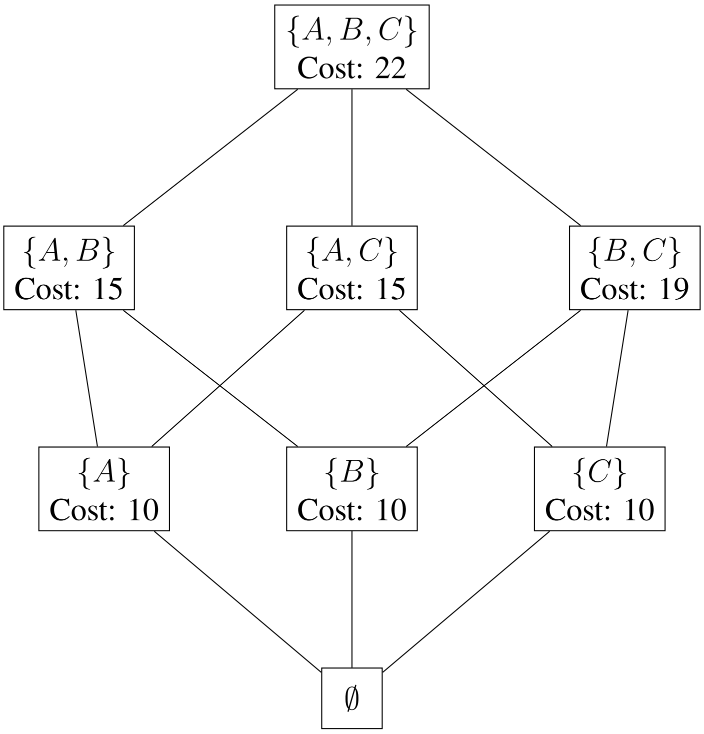

Figure 1: Coalition structure and associated infrastructure costs

Table 1: Marginal contributions and Shapley values of the cost sharing game

Marginal contribution / Order of entry	A	B	C
ABC	0	5	3
ACB	0	3	5
BAC	5	0	3
BCA	7	0	1
CAB	5	3	0
CBA	7	1	0
Total	24	12	12
Shapley value	4	2	2

Example: Profit sharing

Now, let us assume that the three firms use this infrastructure to develop a new service for which end users pay, generating a profit of 10 million euros. How should this profit be shared?

Contributions are as given in Table 2, leading to the marginal contributions shown in Table 3.

Table 2: Gains per coalition in the profit sharing game

Service developed by	Profits
None	0
A	1
B	2
C	3
A and B	5
A and C	6
B and C	7
All three firms	10

Table 3: Marginal contributions and Shapley values of the profit sharing game

Marginal contribution / Order of entry	A	B	C
ABC	1	4	5
ACB	1	4	5
BAC	3	2	5
BCA	3	2	5
CAB	3	4	3
CBA	3	4	3
Total	14	20	26
Shapley value	$2\frac{1}{3}$	$3\frac{1}{3}$	$4\frac{1}{3}$

Shapley values sum up to 10, the total profit. Firm A (resp. C), which contributes the least (resp. the most), receives less (resp. more) than the others. However, the gain each firm receives is not strictly proportional to the gain it obtains when carrying out the project alone. Indeed, Shapley values incorporate all the potential synergies among the three firms, including what happens when only two firms carry out the project.

Concluding remarks on the Shapley value

Cooperative game theory offers a fair solution through the Shapley value, which distributes gains based on each participant's weighted average of marginal contributions across all possible coalitions. This method satisfies efficiency and fairness properties. It can look like a theorist's toy, but has been applied successfully to real-world situations as diverse as airport landing charges (Littlechild and Owen, 1973), telephone billing (Billera et al., 1978), or transportation costs (Samet et al., 1984).

Applying directly this method to data spaces is not feasible as computing Shapley values requires extensive information and assumes cooperative behavior which, for data spaces, would make direct implementation difficult and potentially unstable. However, it provides some important lessons. First, the proper basis for rewarding participants is the *value* that they bring to the project, not the quantity of data, not the cost that they incurred, but the value that they bring to the collectivity. Second, this value is the incremental value: what they bring which others do not bring. For instance, two agents which would bring the same data would be "penalized" by the fact that their data is not unique.

5.2 Data-combination technology

A key decision for firms collaborating on data is the choice of a technical architecture. Data access, *i.e.,* who can access what, is especially important when participants are competitors, concerned that their data may be used against them.

Two polar cases are data sharing and analytics sharing (sometimes called "data collaboration" by practitioners). Under data sharing, firms use the platform to access others' raw data and conduct analytics themselves. Under analytics sharing, firms contribute data and receive insights from analytics run on the pooled dataset. Importantly, in this case, firms do not have direct access to the data contributed by others. Carballa Smichowski et al. (2025) compare these two data-combination mechanisms in a setting where firms can join a platform enabling inter-firm data combination. Specifically, the platform sets fixed membership fees, as well as a per-unit transfers to participants that depend on how much data they contribute. Firms decide whether to join the platform and, if so, how much data to contribute.

Under data sharing, firms can combine the data acquired via the platform with their entire own data endowment, including data they do not share with the platform. By contrast, under analytics sharing, firms derive value solely from the insights generated by the platform, and these insights become more valuable as the firm contributes more data.

A key feature of analytics sharing is enhanced data security, as it limits access to and transfer of raw data, thereby reducing the risk of breaches. Carballa Smichowski et al. (2025) show that analytics sharing is optimal from the platform's perspective only when its security advantage is above a certain threshold, which increases with the firms' data endowments. The larger a firm's endowment, the greater the benefit it derives from combining platform-extracted data with its entire data stock under a data-sharing regime. Accordingly, the security advantage of analytics sharing must be higher to offset the foregone benefits of data sharing. Another key insight from Carballa Smichowski et al. (2025) is that analytics sharing typically induces greater data contributions, as it eliminates free-riding: firms must contribute data to benefit from the platform's analytics, unlike in data sharing where firms can gain access to others' data without contributing their own. Note, however, that a key difference between the environment considered by Carballa Smichowski et al. (2025) and current data spaces is that the former assumes that once data is contributed to the platform, any firm that joins can access it—or access analytics derived from it. In contrast, data spaces typically grant firms full sovereignty over their data, and access to data or analytics is governed by bilateral (or multilateral) transactions between participating firms. This core feature of data spaces significantly mitigates the free-riding issue discussed above.

6 Conclusions and Perspectives

The economic literature on personal data—especially concerning its collection and use for price discrimination, advertising, and personalized services—has grown considerably over the last two decades. By contrast, research on the sharing of non-personal data for the purpose of creating new services, particularly in the context of data spaces, remains very limited.

Throughout this report, we have shown how various strands of economic theory can shed light on some of the key challenges faced by data spaces. In particular, the economics of multi-sided platforms and cooperative game theory offer relevant insights into the design of efficient pricing schemes, the governance of platform environments, and the fair distribution of costs and benefits.

However, while established economic theory provides a valuable foundation for thinking about data spaces, it remains insufficient to fully capture the complexity of real-world data spaces. A dedicated research agenda is needed to address distinctive features of data spaces that are not adequately addressed in the existing literature. One such feature is the presence of agents that simultaneously occupy multiple roles—such as data providers, users, and service developers—blurring the boundaries between distinct sides of the platform and complicating the analysis of incentives and cross-side externalities. Another critical issue concerns the design of pricing schemes in environments where participants may hold widely divergent and subjective valuations of data, leading to negotiation frictions and suboptimal data sharing. Furthermore, transactions within data spaces are decentralized and must comply with data sovereignty requirements, in sharp contrast to the centralized architectures typically studied in recent literature on business-to-business data sharing. Without targeted research on these dimensions, key factors essential to the design of viable, value-generating business models for data spaces risk being overlooked.

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