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# DATA PROTECTION, PROPERTY RIGHTS AND VALUE CREATION

Ivanina Mancheva[1]
*e-mail: i.c.mancheva@unwe.bg*

## Abstract

*The study discusses data protection and property rights in terms of how value is created. The paper highlights specific features of the data: Data are public goods. Their value is not defined in advance, but their processing requires significant upfront investment. The data-based economy relies on network externalities that depend on user participation. Critical questions arise such as who should hold the property rights of data collected through various devices, processed by AI, combined with other pieces of information, etc. What are the economic justifications for the introduction of property or other rights over data? Disclosures about the misuse of personal data led to new regulations like the GDPR. But the research shows that without clarity about the contribution of various participants in the value chain and their rights, new regulations could prove to be a challenge. On the other hand, the uncertainty about property rights undermines innovation.*

**Key words:** digitalization; data economy; data; information; public goods; property rights; intellectual property; privacy; value

**JEL:** D23, D46, D82, H40

## Introduction

Data are the basis of the information economy and has the potential to change not only the markets for digital goods and services but also the production of goods in the physical world and even services such as healthcare, in which the role of the human factor is decisive. Their volume and role will grow exponentially: according to the European Commission, while in 2018 more than 33 zetabytes of data were generated worldwide, this number will reach 175 zetabytes in 2025. Data use is still weak, more especially in Europe. The data economy, which includes Business intelligence, Big data-based apps, vertical applications, etc., has provided 2.4% of EU GDP (2% for Bulgaria in 2018) according to DataLandscape, a study commissioned by the EC.

This explains why data control is becoming a target for corporations, civil society organizations, and states (digital sovereignty). In recent years, the issue of data rights, including property rights, has been at the center of discussions.

[1] PhD student, Department of Economics, University of National and World Economy, Sofia, Bulgaria

While a number of civil society organizations advocate open access to public data and the sharing of company-owned data, the processing of personal data has been restricted in the context of privacy. On the other hand, there are proposals to establish property rights, which would restrict access to non-personal data too. These initiatives follow the traditional approach, according to which clear property rights stimulate investment and the efficient allocation of resources.

The features of data make it difficult to define and enforce rights over them. In addition, the very nature of the data, which implies cooperation and combination, makes the arguments in favor of establishing full ownership not enough to make a case for it. There are some complications related to the unclear a priori value of the data and the overlapping rights of different participants in the value creation, which we will discuss in more detail below.

These issues have come to the fore since the European Commission proposed the European Data Strategy and introduced the European General Data Protection Regulation (GDPR), which set a global standard for privacy.

The above justifies the need to study the possibility of establishing exclusive rights over the data in terms of creating value from them. In this sense, the object of the study are property rights and other rights establishing control over the data, and the subject - the possibility of establishing such rights in terms of the value creation based on data. In addition we examine not only property rights, but also modern data protection regimes which suggest distinct layers, pre-selection, and conditionality.

The main aim of the study is to examine whether the establishment of exclusive rights over data is appropriate in view of their description as public or mixed goods and their role in value creation. The following competing sets of arguments are analyzed: on the one hand, property rights are an incentive for the more efficient use and protection of investments in data processing, but, on the other hand, the promotion of the free flows of data and their combination increases value creation.

To achieve the goal of the study, several specific objectives which correspond to the sections of the main body are set:

- Analysis of the characteristics of the data from the perspective of imposing exclusive rights on them;
- Analysis of the creation of data value through interaction between the persons who contribute to their collection and processing, on the one hand, and users, on the other;
- Review of concepts of property rights, intellectual property and various forms of data protection, including privacy rules;

– Analysis of existing practices and initial formulation of criteria and conditions of alternative models of protecting the rights of the participants in the value chain - data as a service.

The main thesis is that the establishment of property rights should be based not only on the scarcity of a resource and their relationship with the subject, but also on its role in the value chain. This goes beyond the traditional understanding of property rights, especially in the economic literature. Additionally, the paper examines the conditions for the establishment of separate property rights down the value chain.

The study is mostly descriptive and relies on a qualitative approach, with the aim of describing lasting trends, causal structures and mechanisms with lasting properties. It combines the methods of comparative study, analysis and synthesis. The following main distinctions are assumed:

– between data as a resource (raw data) and data (databases) as a commodity, which implies scarcity or production costs;
– between data as a stock and data flows in accordance with the approach of Ostrom and Hess (2007), which distinguishes between a resource system and flow of resource units.
– between data as a commodity and data-based services, hence between property and contract law;
– between value of data and data-based value creation;
– between property rights and data protection, especially rights to privacy.
– between the economic characteristics of the data and the applicable legal regime.

The distinction between private and public costs and benefits of data use is also discussed. In this context, the relationships between public good, social value, public domain or public property are of particular interest.

Outside the scope of the study remain the issues of welfare maximization and market structures. The analysis focuses on economic principles and does not take into account the differences between particular legal systems.

## Economic nature and role of the data

Data have become a strategic resource that helps improve corporate governance and efficiency and can provide additional sources of revenue by creating new data-based services or by selling data. To emphasize their key role, they are often referred to as "new oil" or "infrastructure of the modern economy" (Haupt, 2016).

There is no common definition of data, but a clear distinction is made between raw and processed data. According to Ackoff (1999): "Data are symbols that represent the properties of objects and events. Information consists of processed

data, the processing directed at increasing its usefulness." He distinguishes between information, which consists of description, and knowledge, which consists of instructions.

Likewise, Haskel and Westlake (2018) distinguish between raw (sensory, transactional, traffic, etc.) and processed data, the latter being "cleaned, formatted, combined or structured in a way that makes them suitable for some kind of analysis." According to them, information is synonymous with processed data. They also draw attention to the difference between tacit and explicit knowledge, pointing out that intangible assets (e.g. code or design) can exist separately and independently of the object and can be used repeatedly.

For the purposes of the study, the data are defined as a form of presenting facts in a way that makes them suitable for interpretation, processing and analysis. The distinction between raw and processed data is a starting point for studying the process of value creation. From an economic point of view, the treatment of data as a commodity means that they can be exchanged, that production costs have been incurred and/or they are scarce.

Usually, when we talk about data, we mean data in a digital context. This is because in an analog world raw data have no independent meaning. They obtain value only by turning them into information (for example, in the process of recording, structuring and verifying households data).

The distinction between analog (continuous, qualitative) and digital (discrete) form is crucial. Information in a digital context implies the reduction of diversity to single bits. On the other hand, the intervention of a person or other intellect is needed to receive a signal and turn it into information as Gleick (2011) points out.

In addition to the distinction between raw and processed data, a dividing line can be traced between them at the semantic and syntactic level (Zech, 2016).

At the processing stage, data can be divided at the semantic and syntactic levels, but the result of the processing (analysis) exists only at the semantic level. This distinction is a prerequisite for different business models and legal mechanisms for assigning data rights.

Further, the specific characteristics of the data should be highlighted, which limits the possibility of establishing clear rights to them, and sometimes trade in them.

From an economic point of view the most important characteristics are:

First, the distinction between public and private goods is based on two features: rivalry (subtractability) and exclusivity. They reflect the scarcity of resources or restricted access to them. Exclusion may be achieved by physical barriers or by legal instruments. In practice, the more common case is when it is possible but expensive to achieve exclusivity as Ostrom and Hess (2007) noted.

The widespread belief is that data and information are public goods or club (excludable) goods. As it is not always possible to achieve de facto exclusion by

technical (cryptographic) means, attention is focused on property rights as a legal tool of restricting access to data.

But data can also be treated as a common good which is rivalrous, but non-excludable. One such example are trade secrets, where the widespread dissemination of sensitive information leads to the exhaustion of benefits. On the other hand, it can be difficult to prevent the overuse (the Tragedy of the common).

Second, data are experience goods which imply high assessment costs from the demand side. Their value is unknown before their use. Moreover, their value varies in different contexts - not only depending on the purpose, but also on the personality of the supplier and the user. The real value of data does not come from a single set of data, but from a combination of data sets from different sources.

Third, data are rarely homogeneous, standard goods that have many buyers and sellers. Due to the fact that they have different value for different companies, the investment in creating databases can become sunk cost. In addition, many data are unstructured or are in a format that does not allow compatibility or use outside an organization.

Fourth, not only the non-rivalrous nature of data, but economies of scale and scope and positive externalities are arguments for data sharing and re-use.

Fifth, the concept of non-rivalry is very similar to the idea of zero marginal costs – an additional user of data or intellectual work does not prevent the use by another. However, overconsumption is undesirable (consider trade secrets). An interesting example of property rights as a way to prevent a potential "congestion" can be found in Posner (2005). "Were "Mickey Mouse" in the public domain, the resulting surfeit of copies might produce a net reduction in the market value of the character if overexposure induced a boredom", he writes. In this situation what is abundant is the character without copyright ("Mickey Mouse" copies). What is scarce is the audience's attention (Simon, 1971).

Sixth, negative externalities, which include privacy violations, are an argument against free trade of data.

Seventh, data collection and processing can sometimes require a significant investment (unless they are a by-product of another activity) while the marginal costs are close to zero. This may limit the possibilities for the data to be traded as a commodity.

Next, the costs of establishing and enforcing property rights may be greater than the expected benefits (this is common if a good is abundant). Following Demsetz (1967), high assessment and search costs from the demand side may also prevent trade in data as a commodity.

Finally, the value of the data is largely conditional and uncertain in advance. In many companies, they are created as a by-product of another activity or are used at a later stage.

From the point of view of property rights, the important point is that in many cases the data either do not exist in a separate form or have the characteristics of a public good. Based on this, it can be concluded that, first, the establishment of rights over data is mainly motivated by the need to protect the investment in the processing. Second, in many cases, rights should be shifted down the value chain (as intellectual property rights).

The analysis should also take into account the following information characteristics of the data: volume, coverage, variety (formats), velocity (transfer rate), sensitivity (negative effects) and quality (including veracity). Veracity and coverage are determined only at the semantic level, not at the syntactic level as follows from Zech (2016) and Bennett Institute&ODI (2020).

**Data Value Creation**

The study distinguishes between value of data and data-based value creation. The latter is associated with value added and can be realized through the generation of additional revenues, reduced costs, increased customer loyalty, increased market share, creation of information content and so on.

Often, it is quite difficult to assess the value of data because for most companies data create value indirectly. Companies do not assess the value of the data they control. For most of this data used only within the organization and limited trade, there is usually no market valuation.

There is a considerable uncertainty about the value of the data, which is not predetermined but is revealed in their use.

The fact that online platforms "exchange" free digital goods for consumer data makes it more difficult to determine the value of data as well as to evaluate digital goods.

According to the Bennett Institute and ODI (2020), "there are not many 'thick' data markets with a sufficient number of buyers and sellers to ensure that the transaction prices are closely related to the fundamental economic value." This is also due to uncertainty about their potential value. Estimation based on data processing costs is included in national accounts and relates mainly to labor costs. The issue of including data produced or purchased in GDP statistics is also debatable.

Therefore, as Bennett Institute and ODI (2020) mentioned, non-market measures of data value are used. For example, the value of open data has been examined for a number of free and open data sets, such as data from the US satellite program Landsat ($2 billion per year) or data on public transport in London (£ 130 million per year from an investment of 1 million pounds per year). These estimates are often based on assumptions, for example, about data revenue. Another way to determine the economic value of the data is on the basis of opportunity costs.

The concept of value creation and value capture is widely used in business management literature as a way to describe the difference between drivers of value for customers and for third parties and how companies monetize the data. (Li, Nirei, Yamana, 2018) This distinction is useful because it allows to demonstrate that value-added operations and transactions, which facilitate value capture may involve different actors.

However, it is not fully consistent with the economist's notion of value. According to the classical theory, value is created in production, thanks to the division of labor and the interaction of factors of production. But not every product that costs labor and time and / or is valuable has economic value. In the neoclassical tradition, value is revealed in the process of exchange and depends on the alternative price of each factor of production.

Moreover, as Mazzucato (2018) points out, in neoclassical economics, the individual preferences of market participants are determinant, while social value creation is underestimated. This leads to confusion between value creation and value extraction.

In the first stages of the development of industrial society, value can easily be attributed to concrete labor and to concrete ownership of the means of production. Nowadays, it is created through many more interactions between participants, with multilateral markets being just one example. A number of activities contribute to value creation without having monetary revenue as the main purpose (e.g. open-source software). On the other hand, artificial privileges, patents or barriers imposed at different stages of value creation can lead to capturing value by the participant who has control. Value extraction (i.e. rents in the classical sense of non-produced income) is possible due to control over access to an activity, key infrastructure or resource or as a result of other privileges or a monopoly position. In this sense, property rights as an access control tool affect the efficient allocation of resources. But even when property rights are based on contribution, these rights may not be consistent with the efficiency criteria.

As Arnold Plant noted, by enabling pricing in excess of marginal cost, intellectual property rights attract resources into the creation of such property that may create a larger social product in alternative uses (Cited in Posner, 2005). Even in the absence of patents and other barriers to entry, a participant who commands access to consumers could extract more value. This demonstrates the crucial role of data access rights (data monopoly).

Creating value from data involves not only processing, but also a number of interactions, including with other users. The components of the value of the data and the factors for revealing this value entail a complex system. It includes not only a simple linear value chain but also complex networks that reflect diverse business models and interactions between different actors.

A simplified diagram of the value chain is presented below.

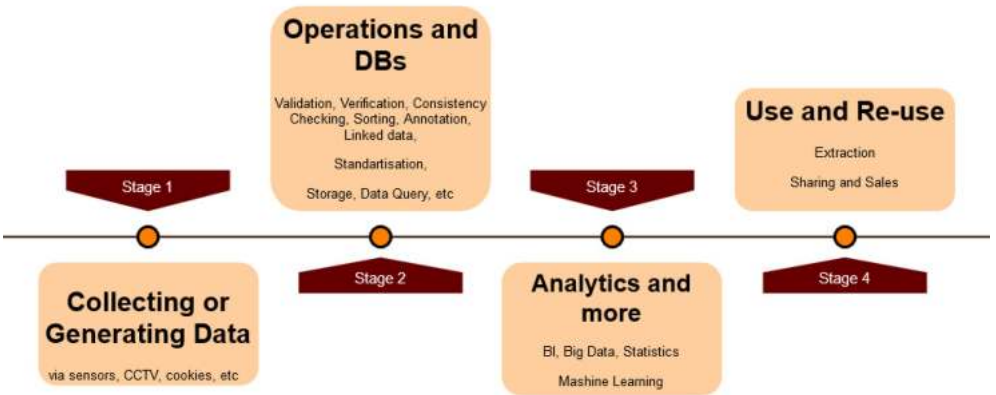


**Figure 1:** Stages of value creation

The process of value creation moves from raw individual data to (structured) databases and final goods and services based on data. It can be divided into four stages, which are not very strictly established - for example, Big Data and data trading may be present at previous stages. The first stage is related to the collection and generation of data, for example, through video surveillance cameras. At the second stage, processing is performed at a syntactic level (e.g. validation, sorting), while the third stage is performed at a semantic level, and the result is a final product - for example, a forecast, a visualization, etc. This scheme follows the economic approach of distinguishing between raw materials, intermediate goods and final goods and is not fully compatible to the building blocks of data processing: Big Data - processing large volumes of data in real time; integration of various endpoints (Internet of Things); business processes aimed at individualization of services; BI and mathematics for data analysis.

But the reverse process is also possible. The final goods and services (e.g. digitized archives) could be decomposed so that individual raw data can be extracted from them (a sort of reverse transformation).

It is necessary to pay attention to the difference with the value chain of a traditional product to which the data contribute at different stages - for example, market research, production, supply chain management, after-sales service, etc. The examples include location data used in car navigation systems.

The following two features of data value creation are discussed below - the participation of many actors (stakeholders) in the value creation and the difference between social and private value.

### *Value Co-creation*

Co-creation of value from data, and in particular from big data, is a key issue. On the one hand, it takes into account the contribution of users who generate data themselves, and thus contribute to the development of algorithms and a business analysis. From another point of view, the co-creation of value implies the development of an ecosystem based on public-private partnership.

Moro Visconti, Larocca and Marconi (2017) demonstrated that the value of data increases exponentially when combined with other disparate sources and shared widely. This leads to the idea of data collaboratives, which facilitate data sharing and co-creation of value. Hern and Rindfleisch (2010) distinguish four types of co-creation, which roughly correspond to the combinations between the types of contributions to the content (pre-selection of participants or not) and the selection criteria (from users or from the company). Other authors such as Verhulst et al, (2019) classify business models that rely on data sharing according to the following two criteria: accessibility (whether open access is provided or pre-selection is required) and commitment (whether the use of data is free and independent or has a specific purpose).

The fact that the value of the data is influenced by the user‘s personality and the purpose of use, as well as the possibilities for combining (in the context of big data) complicates the Cost-Benefit analysis.

Wider sharing depends on finding solutions to access rights, compatibility and liability rules, according to a study of the EU data economy (Deloitte, 2017). This study looks at a number of practical cases, for example, the Internet of Things, cloud services, professional machines, transport solutions. They combine many data sources, as manufacturers often seem to want to control data not only within the boundaries of their machines but also beyond, i.e. via a platform. In particular, it highlights the following issues as a source of uncertainty for businesses: property rights and access to data, the inapplicability of legislation on obligations and contracts to intangible assets and artificial intelligence., interconnection problems (due to different standards and specifications). An important question is whether liability for damage caused by autonomous devices should be attributed to the environment, to the way it is programmed, or to the quality of the data. The general rule is that liability for damage caused by an object (including a robot) would be attributed to the persons who have the object under their care, guardianship or in their custody. According to Deloitte (2017), technical, contractual, and other barriers as well as legal uncertainty place a greater burden on data access and data re-use than property rights.

### *Social and Private Costs and Benefits*

The impact of property rights on the exchange value of a good and a service is obvious. The economic value of data depends on the rights that are transferred with them: the property rights over a resource, which is burdened with encumbrances or other restrictions, reduces the value of that resource. Property rights can create new restrictions on the use of a resource (in addition to natural ones) and make it more expensive  increasing their scarcity.

The relationship between property rights and value in terms of social welfare requires more consideration to be taken into account. As Pigou (1920) famously says, "the economic welfare of a community consists in the balance of satisfactions from the use of national dividend ... over the dissatisfactions involved in the making it." The social value is higher than the private value when a transaction creates value in addition to that received by the parties involved in a transaction. Data sharing may contribute to it indirectly – for example, when the government provides more efficient public services, when the environment is cleaner and people have happier lives and are healthier (Bennett Institute, 2020). It also increases trust between parties, reduces transaction costs, and increases the efficiency of exchange.

The two forms of data value – social and private, can differ significantly due to the externalities. The personal information, for example, has value not only to the subject of data, but to others and to society as a whole (Kerry and Morris, 2019). However, the traditional economic approach is not fully applicable to personal data, because the data subject is not normally involved in transactions for his data and the idea of alienation of personal data is in principle controversial. With regard to non-personal data, there are considerations related to trade secrets and costs for the preparation of information for transfer, including compliance costs. When data is reused, an organization may waive a certain financial advantage (which leads to opportunity costs) while contributing to the public good.

On the other hand, the benefits to society from the use of data need to be compared with the potential harms and costs to society. On the individual level the costs or harms of acquiring and using data can be seen in terms of restrictions on access for reasons of confidentiality, as well as in terms of the damage that results from the use of data (for example, in cases of profiling or blackmail). When it comes to society as a whole, we should take into account threats to use data to manipulate public choices or to track and impose authoritarian regimes. The analysis should also include the opportunity costs for society in cases of non-data sharing. In general, the disclosure of personal data may be socially beneficial or unacceptable depending on the circumstances. These issues are not studied enough.

The analysis of social benefits and costs is closely tied to the assessment of externalities, as the possibilities to internalize them depend on property rights and transaction costs. The property rights economics has been introduced in the 1960s as an analytical unit to address the problems arising from the problem of social cost.

From the point of view of Law and Economics movement of the ownership is seen as the right to carry out specific actions, which right is accompanied by certain liabilities. According to Coase (1960) the failure to develop an adequate theory of negative externalities "stems from a faulty concept of factor of production". It is usually considered a physical entity which the business owns and uses instead of as a right to perform certain actions. Coase (1960) noted that "the right to do something which has a harmful effect (such as the creation of smoke, noise, smells, etc.) is also a factor of production... The cost of exercising a right (of using a factor of production) is always the loss which is suffered elsewhere in consequence of the exercise of that right - the inability to cross land, to park a car, to build a house, to enjoy a view, to have peace and quiet or to breathe clean air." The individual decisions should be made in the context of social arrangements and in such a way that the sum of gains exceeds losses. The solution depends on whom the loss is left on and which party could take measures at the lowest cost.

Likewise, as Demsetz (1967) asserts "property rights develop to internalize externalities when the gains from internalization become larger than the cost of internalization." In his historical example, the benefits of internalization are related to the development of the derived product (fur trade). That is because the increase of the value of the derivatives leads to the transition of a resource (land) from public to private good.

As a rule, property rights are established when the benefits of controlling a resource outweigh the transaction costs, including the search cost, the bargaining cost and the cost of enforcement and exclusion of free riders. When it comes to data, the benefits of controlling a resource may not be directly related to its value, but to the value of derivatives, i.e. they can be realized downstream the value chain.

Next, transaction costs are not only a prerequisite for establishing or not property rights, but also determine the possibility to achieve a socially optimal allocation of resources. In his classical work Coase argues that the market (renegotiations) brought about the same allocation of resources regardless of initial entitlements (assuming no transaction costs) so all externalities can be priced and internalized. Calabresi (1968) firstly opposed to that view arguing that initial entitlements are a way to prevent privileges of the strongest and that the transactions could improve the allocation of resources only in the short-run. In Calabresi's conception, the

initial distribution of property rights matters, and the absence of such rights leads to the supremacy of the stronger.

When the transaction costs are high the alternatives of renegotiation are: structural rules (like anti-trust laws), liability rules (compensation for negative externalities), taxation, governmental spending, or letting the market have free play (Calabresi, 1968). This approach adheres to welfare economics and does not address some problems of market structures and anticompetitive issues such as lock-ins. It follows from Calabresi and Malamed (1972) that with high transaction costs and/or asymmetric information, ex-ante negotiation is impossible or difficult and the initial allocation of property rights matter. In addition, Coase's approach to negotiating externalities requires all possible uses of a resource to be clear in advance. These conditions are not met in the data markets, where uncertainty is high.

The described approach to the property rights economics of the 1960s and 1970s is predominantly concentrated on the bundle of rights in the context of welfare economics. The next section discusses the traditional approach, but also the issues related to intellectual property rights, as well as data protection beyond property rights - for example, privacy rules. This evolving legislation does not always reflect the above-mentioned issues related to externalities and the co-creation of value.

## Rights over Data: Property Rights and Data Protection

Property rights can be described as one of the regimes regarding the protection of information in a broad sense. The latter includes a wider range of rights and obligations to protect different types of information and digital goods and services, for example, trade secrets.

The question of whether data can and should be own is debatable, depending on whether the data exist in a separate form and, if so, whether they are a commodity (Allen, 1990). In economic terms, increased attention to the issue of data property rights can be explained by the increasing value of their derivatives, as well as by diminishing, often to zero, copying costs.

Establishing data ownership is the subject of several legislative initiatives. Some proposals include exclusive property rights over personal data, data exchanges and data dividend. From this point of view, it is tempting to look at the EU General Data Protection Regulation as an instrument of basing privacy protection on property systems. This shift in data protection is disputable. The main argument against it is that the system of information rights (intellectual property rights and privacy rights) should be balanced with the free flow of information. (Kerry and Morris, 2019). The Max Planck Institute for Innovation and Competition, which opposed the 2016 EC proposal for a legislative framework

establishing exclusive rights with regard to data processing, rejects the need for additional legal protections at the stage of data collection and creation (Drexl, J. et al, 2016).

At the political level, these views can be summarized as follows: On the one hand, there are views that current legislation, including intellectual property rights, does not provide sufficient protection and thus reduces the investment incentives and the growth potential of the data economy. On the other hand, restrictions on free access to data will limit the possibilities for their use, combination and new applications. The EC Communication on the development of a new competition instrument of 2 June 2020, for example, states that the lack of access to data or the accumulation of data leads to a structural lack of competition, even if market participants do not have an anti-competitive behavior (Antitrust: Commission consults stakeholders, 2019). There are also considerations related to difficulties in administering such regulations.

According to the approach adopted in the study, the grounds for establishing data rights are considered in terms of their participation in the value chain - depending on whether it is raw data, databases or results with a high degree of processing, for example, visualizations and predictions.

There are two approaches to monetize data - one is to sell them as a commodity, which implies the existence and transfer of property rights, the other is to sell services based on data. If the data that is the subject of a transaction are defined at the syntactic level (bits and bytes), they would be treated as a commodity. Semantic information implies that the data is used as a service as Zech (2016) suggested. Accordingly, there is a difference between property rights , limited access rights and contractual rights.

### *Property rights - nature and role*

Property rights are generally seen as the main type of control over land and other resources. They define particular actions in a specific domain that individuals can take towards other people. Its main goal is to promote the optimal exploitation of resources, to prevent congestion and to stimulate production and trade.

Property rights deter an unproductive race for access to the resource and allow for long-term strategies. They create a security of exchange and investment and thus contribute to specialization and productivity. Providing collateral, property rights improve access to credit.

Property rights are a set of entitlements that aim to provide control over a resource, which by default is limited, and these rights are exercised by excluding other individuals or groups from accessing and using that resource.

Property rights may affect the quality of a product, as the Mickey Mouse example cited above suggests. Another example is when assignment of rights

to the electromagnetic spectrum prevents the garbling of signals (Kaplow and Shavell, 2002).

The institution of the property has its origins in Roman law and is well defined in terms of property rights over tangible assets, consisting of the right of possession, use and disposal (Alchian, n.d.).

A more detailed list of 11 privileges (incidents) such as rights to manage, use, alienate, transfer or bequeath was presented by Honore (1961). The last privileges are the residual rights on the reversion of lapsed ownership rights held by others. The Bundle Theory, as opposed to the stringent interpretations, holds that there is no pre-existing list of rights, but a particular bundle of "sticks" the law grants in any given case.

As Kaplow and Shavell (2002) stated, "what we speak of somewhat loosely as property rights can be divided into more basic rights: particular possessory rights, and rights to transfer these rights." They also noted that the division of property rights may be valuable when different parties derive different benefits from them, but there are also some disadvantages of the division.

The privileges of use and the rights not to be excluded or to exclude others are defining features of property regimes (Heller, 1998). Therefore the right of exclusion is the key nexus between public good as a resource and public property as a regime of control.

Property rights depend on the main features of the object, the technology used, relationships between participants in a transaction, as well as on the set of rules and institutions required to enforce them.

There are differences between different legal systems as well as differences between property rights and ownership as Foss and Foss (2015) noted. The Anglo-Saxon legal system, which is the basis of the Law and Economics school of thought, considers property as a set of rights without being limited to tangible assets.

With regard to intangible assets, property rights are established through intellectual property rights, including patents and copyrights. Another difference between tangible and intangible assets relates to the right of alienation (sale). When it comes to intellectual property the assignment of the right to use a resource is realized through contracts - for example, through licensing agreements.

Data cannot be owned and in most cases they cannot be copyrighted or protected via patents. However, some types of data (personal data, trade secrets, medical records, traffic data, etc.) are explicitly protected, but not as property.

In accordance with the legal means of exclusion, we distinguish between public property, common property, private (individual or corporate) property and no property (open access).

Open access to data is very often mixed with public property without taking into account that property rights have many dimensions. Open data does not

mean public data when only access is granted. Following the definition of data it is doubtful whether they are nobody's property: the personal characteristics become data when measured, recorded and stored. This creates the possibility of control. The owner (creator) retains not only the core rights, but the liability to maintain and protect the dataset.

It is widely accepted that private goods should be privately owned, and public goods should be publicly provided or regulated (Cooter, Ulen, 2016), while common property has been associated with common-pool resources. In practice, the relation between public goods and public ownership is not so obvious. This view does not take into account the different layers of property rights and the specifics of mixed goods. The right to exclude plays a key role. According to Demsetz (1967): "State ownership implies that the state may exclude anyone from the use of a right as long as the state follows accepted political procedures for determining who may not use state-owned property".

As Ostrom and Hess (2007) demonstrated, „the impression that goods sharing these attributes tend everywhere to share the same property regime" may result from misunderstanding regarding the differences between common property, common-pool resources and open-access regimes: Resources are composed of resource systems (stock or facilities such as Internet) and a flow of resource units or benefits from these systems (like CPU). The property regimes differentiate between rules that limit access to the resource and "rules that limit the amount, timing, and technology used to withdraw diverse resource units from the resource system"( Ostrom and Hess, 2007).

Ostrom and Schlager (1996) identify five property rights that are most relevant for the use of common-pool resources:

- Access (the right to enter a defined physical area and enjoy nonsubtractive benefits;
- Withdrawal (the right to obtain resource units, benefits or products). Note that the difference between access and withdrawal rights may depend on whether the good is rivalrous;
- Management, i.e. processing (the right to regulate internal use and transform the resource by making improvements);
- Exclusion (the right to determine who will have access rights and withdrawal rights, and how those rights may be transferred);
- Alienation (the right to sell or lease management and exclusion rights).

There are no clear boundaries between withdrawal rights and management rights because the rights to obtain products may depend on the right to transform the resource and vice versa. In accordance of the above set of rights five classes of property-rights holders can be defined: authorised entrant; authorised user, claimant, proprietor and owner (Ostrom and Schlager, 1996). Most of the common

property regimes involve participants who are proprietors and have all rights except the rights to sell their management and exclusion rights. Only the owners possess the full bundle of rights including the right to transfer the resource.

Note that when it comes to common property the authority has a kind of collective choice rights. There may be constraints upon the timing (eg. rotation), technology and processes, quantity (quotas) and purpose of use. The use rights may be transferable, but not management and exclusion rights.

There are many variables that make the private, public or communal proprietorship/ownership more or less favorable, such as:

- rate of return (low rate of return makes private property rights less efficient because of transaction costs);
- processing (transformative) and transaction costs, including assessment costs, search costs and costs of exclusion;
- externalities;
- economies of scale;
- accurate and symmetric information about the resource, benefits and costs, etc.

Data rarely fall into the category of private goods. The factual exclusion may be difficult with mobile resources such as water. If there is no excludability or the exclusion costs are high, the choice is between common property and public property.

Considering the above common property regimes are most applicable to the data given their nature and co-creation of value. The defining characteristics include: non-rivalry, but the need of investments in maintenance and management; realization of the advantages through rights over the products from the use of data; value that increases when shared and combined. In most cases, the common property rights are limited, for example, to the right of access or right to use. The key question is whom should be given a managerial right (data custodian).

In a social context especially when it comes to common property the defining features are the size and homogenity of the group of users, if there are well established relationships and trust, etc. On the other hand, different production technologies and skills within the group of producers complicate the joint agreement on costs and benefits (Libecap, G, D., 1989b, cited in Ostrom and Hess, 2007). This brings us back to the problem of externalities. As Cooter and Ulen (2016) summarized, private bargaining is unlikely to succeed in disputes involving a large number of geographically dispersed strangers because communication costs are high, monitoring is costly, and strategic behavior is likely to occur.

If the transfer of a good is not possible, nor permitted or complicated, its owner should realize the benefits of that resource through rights over the results

or derivatives (downstream) or through service contracts. Where the derivative goods or services based on data have originality, this protection may be provided by intellectual property rights and relates to the next stage of their economic realization.

### *Intellectual property rights*

Intellectual property rights establish control over the distribution and use of works of human intellectual labor that meet the criterion of originality. Intellectual property always refers to the result of creative or intellectual activity and, unlike ordinary property rights, offers temporary protection (renewable - for example, for trademarks). It includes two categories of rights: industrial property, which includes inventions, utility models, trademarks, industrial designs and models and designations of origin, and copyright, which refers to works of art and literature.

The intellectual property right contains the following powers of the holder: to use protected work, including to receive proceeds from it or through its commercial realization; to prohibit use by third parties; to transfer it or to give permission to use through license agreements (Борисова, 2010).

With regard to industrial property, certain conditions must be met, such as novelty and usefulness, which means the invention should be capable of industrial application. A characteristic feature of industrial property is that the right-holder is obliged to use protected objects - for example, failure to use an invention within a certain period may lead to revocation of the patent, as it is considered an abuse of monopoly position.

In general, this protection is not applicable to factual data. An analogy can be made with scientific discoveries, which are existing facts, although unknown until the time of discovery and are not subject to protection. They can serve as a resource for inventions (Борисова, 2010).

A basic requirement for a product to be copyrightable is to be the result of original creative work and a purposeful search for a result. Therefore, intellectual property rights are also not applicable to data, especially to raw factual data. This refers to factual data and allows a database to include copyrighted material and protected personal data, for example photographs, which together with their metadata can be used for facial recognition, establishing patterns of behavior, etc. Despite the relatively wide scope of copyright, valuable data such as weather forecasts, stock quotes and sports scores are excluded from protection (César and Debussche, 2019).

Some features of intellectual property are of interest in view of the possibility of establishing specific data ownership rights. Firstly, the social benefits of discovering a valuable new idea or speeding up innovations have to be weighed against the possible disadvantages such as high transaction costs or cost of patent races.

Second, intellectual property rights have some limitations. For example, copyright provides protection for the form of expression of an idea and not the idea itself. This requires the object of protection to have a fixed form to facilitate its identification, as well as to have a clear definition of intellectual property rights. In some cases, copyright and patent laws enable unauthorized exploitation (fair use) of intellectual property which is another limitation of the right.

Third, the components of copyright also include non-property rights such as the right of attribution and the right to preserve the integrity of the work. These rights emphasize the connection of the work with the author‘s personality and cannot be alienated.

Fourth, copyright allows artists to receive additional income from derivative works which corresponds to the assumption of the realization of the economic potential of the data downstream the value chain. But Posner (2005) holds that the control over derivative works cannot be justified on the ground that it increases the income of copyright owners, unless the supply of copyrighted works is deemed suboptimal.

### *Sui generis property right*

As already mentioned, ideas and scientific discoveries are not subject to protection, but can be a resource for the creation of works subject to protection.

There is an exception to this rule with regard to sui generis right (special law) concerning the creation and structure of databases. Sui generis rights are typical of new intellectual property objects, for example, the topography of integrated circuits, in respect of which protection is for structure and not for content.

Directive 96/9/EC of the European Parliament and of the Council of 11 March 1996 on the legal protection of databases is related to databases which are “collections of independent works, data or other materials arranged in a systematic or methodical way and individually accessible by electronic or other means.”

It is necessary to distinguish between the individual data representing the content of the databases and its structure and the investments necessary for their creation.

Directive 96/9/EC allows double protection of databases - via copyright, which covers the intellectual creation and the original structure of databases, and the sui generis right.

The sui generis right consists of two categories of rights: the right to prevent the unauthorized extraction; the right to prevent the re-utilization (i.e. making available to the public) of all or a substantial part of the database.

The objective is to protect the investment for acquisition, verification or layout of the content. This investment may consist in the deployment of financial

resources and/or the expending of time, effort and energy. This right is limited to 15 years, but is renewed with each new investment in the database. A database does not have to be original to qualify for a sui generis right.

Databases shall be protected by copyright by reason of the selection or arrangement of their contents. This includes the decisions about data included in a database or how to organize this data. Copyright protection of databases presupposes an original product and the intellectual efforts of an author, i.e. human intervention. It would be difficult to meet the copyright requirements by creating databases by automatic means (including data collection through sensors and smart applications). Instead, the copyright protection is more applicable to the software behind the database (César and Debussche, 2019).

The implementation of the directive reveals some problems. The issue of the creation of data by automatic means is problematic in view of the permanent practice of the Court of Justice of the EU, which refers to the protection under Art. 7 of Directive 96/9 to obtaining data. The scope of these rights is interpreted narrowly, and the investment in creating data and databases is not a sufficient condition for granting protection (Court of Justice of the EU, 2009). Database content protection criteria are not fully applicable in the context of Big Data, which involves analyzing unstructured data and combining it in a new way (César and Debussche, 2019).

The Directive, despite its obsolescence, is of interest because of the distinction between investments in the creation of individual (raw) data and the creation of databases through obtaining, verifying or presenting existing data.

The reason for the distinction between new and existing data can be drawn from the fact that data are observations and measured facts, not creations of the human mind (unlike computer programs).

The degree of substitution between upstream data production and downstream use is debatable. This debate is shifting from the issue of protecting the rights of creators to the protection of innovations as demonstrated by Duch-Brown, Martens, and Mueller-Langer (2017).

Although the sui generis right prohibits the extraction and re-utilization of the contents of the database, thus preventing the copying of individual data when the database is public, its owner cannot prevent others from using it without copying the contents of the database. The Directive does not reflect the developments in technologies such as Big Data or data mining, which do not necessarily require the reproduction of data in order to perform analytics (César and Debussche, 2019).

In this context, the protection of the database (copyright and sui generis) should rather be seen as an additional protection measure granted to individual data through other forms, such as traditional copyright protection or trade secrets.

### *Privacy and trade secrets*

The economic value of the data depends on how it is used. At the same time, the use of sensitive information may harm the interests of the persons or legal entities to which it relates (data subjects). A balance is needed, which is ensured through the legal framework relating to the right to privacy and the protection of trade secrets.

Privacy and confidentiality impose restrictions on the use of data. The right of use is related to the access to data, without being limited to it. Westin (1968) defines privacy as a right "to control, edit, manage, and delete information about [individuals] and decide when, how, and to what extent information is communicated to others." Communication rights which are third-generation rights correspond to rights to exclude others in an information context. A distinction should be made between the right of access to personal data, other private data and public data.

The EU's General Data Protection Regulation (GDPR) refers to privacy and does not imply ownership of personal data. Privacy is a fundamental human right that cannot be alienated, therefore we cannot talk about ownership in the full sense.

Instead, the regulation creates non-tradable specific rights for individuals, such as the right of access, the right to information, the right to request rectification, the right to portability, the right to object to data processing without a legal basis, etc. The rights of the controller of personal data are not in conflict with these rights, except in certain explicit exceptions.

The GDPR introduces the concepts of control and processing, and sets a standard for data management in a broader context. Control means the activities that are performed by a data controller - this is the person who determines the purposes and means of processing. Processing means "any operation or set of operations carried out with personal data or a set of personal data by automatic or other means such as collecting, recording, organizing, structuring, storing, adapting or modifying, retrieving, consulting, using, disclosing by transmission, disseminating or otherwise making the data available, arranging or combining, restricting, deleting or destroying ". This definition contains a number of operations along the value chain that are performed under the presumption that access to data is granted (in relation to collection and recording data the access should be granted to the object or to the environment that allows the creation of data). The Regulation also sets the rules under which the data subject himself should be provided with the information that a controller has about him. This is because it is common for the subject not to be aware of his personal data (for example, video surveillance recordings).

The use of personal data, in turn, differs from the processing, as the former includes the right of the controller (or processor) to receive the benefits. This issue is not explicitly regulated in the regulation, nor is there a definition of use. However, an assumption for the transfer of the right to use can be made in at least two of the legal bases for processing personal data - with the consent of the data subject and for the performance of a contractual obligation.

The GDPR also introduces the notion of portability of personal data, which deserves special attention as some of its characteristics resemble property rights. This refers to the right of the subjects to transmit or receive - in processed form - data concerning them and which they have provided. However, portability shall not be confused with the right to transfer ownership of the data as „propertising" the privacy is a controversial issue.

Personal data are those that identify the individual, and it is not necessary that he or she has made any effort or incurred any costs . Following DeCew (2018) privacy can be attributed to natural rights as personal data exist due to the very fact of existence of man himself. This is how they differ from the data for which intellectual property rights are recognized.

There is a difference between the rights over personal data from a legal and and from an economic point of view. The role of the controller is to ensure compliance with the specific rights of the data subject under the GDPR. The granting of specific rights to the data subject means that all other residual rights that are not included in the specific rights in the GDPR are attributed to the data controller (Duch-Brown, Martens, and Mueller-Langer, 2017).

The next question concerns the non-personal data which are anonymized personal data and data that are not linked to an identifiable natural person. They can be collected and processed purposefully, or may be a by-product of the activity; can be private or public; protected or free to use. The right to confidentiality of available data is mainly governed by trade secret legislation and certain specific requirements.

Trade secrets, which also relate to the control of the dissemination and use of data and information, are defined in some legal systems as a separate type of intellectual property right. However, as a rule, trade secrets are additional protection that in certain cases can replace intellectual property rights - where it is impossible for exclusive rights to use information to exist, even in the presence of a confidentiality agreement. What they have in common is that they relate to valuable information for which investments, research or innovation have also been made.

Since 2016, the EU legal framework has been harmonized through Directive (EU) 2016/943 of the European Parliament and of the Council on the protection of undisclosed know-how and business information (trade secrets) against their

unlawful acquisition, use and disclosure. According to recital 16, in the interests of innovation and the promotion of competition, the provisions of this Directive should not create exclusive rights to know-how or information protected as a trade secret. This allows for parallel innovation and reverse engineering (independent discovery of the same know-how) thus offering weaker protection than patent law. This limited protection against non-disclosure of trade secrets means that once the database is published or otherwise disclosed, protection can no longer be claimed. When data used for big data analytics have been made publicly available they will not be classified as a trade secret. But there are still obstacles to data disclosure in cases of outsourcing (César, and Debussche, 2019).

The key question is whether these incomplete property rights, which in some cases no longer correspond to current trends, are sufficient to protect the rights of the participants in the data economy. A number of authors consider that it is not necessary to establish specific data ownership rights, as this would reduce the benefits of data sharing, and in practice, there are sufficient technical solutions to restrict access. Others advocate stimulating investment in data processing by limiting harm, for example, in terms of privacy. These may be limited (non-exclusive) short-term rights for the first investor in data collection as Coyle (2020) suggested. Zech (2016), for example, proposes a concept for the economically responsible operator that compares the added value of processing with the value of the data being processed.

Summarizing the above, the full ownership of the data is an inappropriate solution in most cases. The protection might be obtained via IP rights for final goods, but there is trade-off between incentives to innovate and efficiency (monopoly). Privacy legislation provides an additional level of protection, but these rights are not tradable.

Different criteria are applicable to take into account the contribution of the participants, their role in the data processing, the possible future applications, as well as the costs incurred in terms of confidentiality. Some guidelines are presented in the last section.

## In search of an alternative. Establishing standards and access rights

The intersection of confidentiality and property rights raises a number of questions, both theoretical and practical: For example, who should own the rights in cases of multiple data access and different types of processing? How should these rights be distributed up and down the value chain? How much rights should be granted and for how long? Is the secondary transfer of rights permissible? The answers to these questions call for the need for empirical studies to assess the additional benefits and costs associated with one or another regime.

The final remarks will focus on the following mostly theoretical problems: the factual means of control, the coinciding exclusive rights of many persons (mutuality) and the problem of residual control rights. Alternative solutions that treat data as a service will be discussed too.

The establishment of full ownership of the data is an extreme case, due to their nature and to the legal requirements (for example, the GDPR or the Payment Directive - PSD2). In practice, full ownership is often replaced by factual control which can be defined as the power to decide who has access to or the right to process data (use and withdrawal rights in Ostrom's terms). This control usually depends on the possibility of exclusion.

The exclusion is not the best solution with regard to data, which imply free flows. It may be difficult because of the high costs of exclusion or because more individuals have overlapping rights over data.

However, factual means of control (exclusion) are not limited to tools for preventing access (fencing), but may also include costs of measurement of quantity and other key variables. High costs of access also exclude some potential users, thus reducing scarcity. The harvesting costs that are defined as costs of actions to access resources (Hong, 2020) may serve as an example. The decline of these costs brought by technology makes resources scarce.

It is necessary to pay attention to the fact that some transaction costs, when incurred by the buyer, contribute to the exclusion, while the exclusion costs themselves (for example building physical barriers), when too high, lead to non-excludability.

Several research problems could be identified from this perspective. The first issue is how an exclusive right over data should be allocated between different participants in a transaction or interaction - a buyer, a platform, a seller, an author or a data subject. This reflects the bilateral and multilateral nature of the information that is created and utilized in the process of interactions between different entities and at the different stages of value creation.

Different participants may hold separate data rights, including the right to collect, record, organize, disclose, etc. The distribution of data rights between different stakeholders requires taking into account many circumstances, such as the control of critical infrastructure, the employment status of the creator, the necessary investments and guarantees, risk sharing and, last but not least, the role in the value chain. Given that both the value of raw data and the value of direct investment tend to be underestimated, the leading criteria should be the contribution to future value creation and to innovations.

Another issue is how to overcome the overlapping rights which are common with regard to data or intellectual property.

According to an interpretation of the Tragedy of the Commons (Седларски, 2011), the person who owns part of the property rights increases the use of the

recourse until the marginal revenue becomes zero - without caring about the loss they inflict on other users of this right or the users of the other components of the property rights.

The concept of the Anti-commons as a type of non-private property is of particular interest. Recall that when too many owners hold privileges of using the given resource, it is prone to overuse and there is a need of coordination (Tragedy of the Commons). The mirror situation is when too many owners hold the right to exclude others from using a scarce resource and no one has an effective privilege of use (Heller, 1998). In this case, many of the core rights can function as rights of exclusion without a hierarchy among owners' rights. For example, the owner of a right of possession may be able to prevent the owners of rights of the income from granting access or enabling others to use the same resource. The resource is prone to underuse because of a coordination failure as a result from the exercise of the veto power which is not socially desirable (Tragedy of the Anti-commons).

The coexistence of property rights and privacy rules leads to the inability to avoid mutual blocking. Two-sided communication rights also imply intersecting interests. There is a tension between an object and a subject of works or other results based on data.

As the example of photographic works demonstrates, the law should regulate three types of interests - that of the individual whose personal data is taken, that of the photographer who is the copyright holder, and the interest of the society to have access to information and to the works of art (Draganov, 2014). Another issue arises when a dataset contains data of many subjects which cannot exercise their rights without permission of others (e.g. CCTV recordings).

In the economic literature the residual rights of control are associated with incomplete contracts and could be treated as property rights. Residual rights are the rights to make any decisions regarding an asset's use that are not explicitly assigned in a contract as follows from Hart (1993). The owner usually retains residual rights of control while the specific right was transferred by a contract (e.g. leasing) or protected by law. The incomplete contracts exist in a world of uncertainty, complexity and high transaction costs where it may be difficult to describe, assess and verify all possible contingencies via contracts. The allocation of residual claims between contracting parties depends on their market power, on their position in the value chain as well as the transaction costs. Hart (1993) highlights the problem with contract-specific investments (sunk costs) which lead to hold-up problems and affect the bargaining power of the parties.

As regards data, the residual rights of control mean the right to determine the privileges for others, i.e. to define formats, structure, rules of access, etc. As noted by Deloitte (2017): "Without intervention, the power of deciding who gets access to the data and on which terms, will remain in the hands of the de facto

data owner, which is likely to be the entity with the most significant commercial power."

The problem of residual rights of control needs further consideration and to be extended beyond the theory of incomplete contracts. Given the multidimensionality of property rights and the diversity of data, the application of this approach to personal data could prove questionable.

Restrictions on the establishment of exclusive rights over data lead to the development of alternative concepts, business models and related legal instruments. They are very often based on residual rights. Thus contract law, trademarks, and other mechanisms are required to protect factual data and databases and to promote their use.

Combinations of contractual and copyright protection are already being applied as well as standard contractual clauses such as these developed by Open Data Commons group (http://opendatacommons.org).

Considering the data ownership as a control right, it should be noted that a key privilege in the hierarchy of ownership is the right to impose standards and criteria for the pre-selection of users. These standards which are especially important as regards public data, may include interoperability rules, requirements for accuracy, verification, etc.

The restricted access to data is linked to the concept of data as a service (e.g., access to real-time quotations) or to data-based services. Data-based services are a way to overcome restrictions on a third party's access to data or the unwillingness of the investor in that database to share it. One example is targeted advertising offered by Facebook which allows the processed data to be monetized indirectly, without disclosure. What is meant here is a dependent market, which bypasses the limitations of data protection.

The provision of data as a service (e.g. real-time access) implies a licensing. This access may be accompanied by restrictions imposed by the database administrator in order to prevent unwanted data retrieval or for price discrimination (for example, the practice of delivering financial information with a 15-minute delay at a lower price).

This leads to the question of how data as a service differ from data as a commodity? First, in the case of goods, the right of possession is granted, while in the case of data, there is no possession, but only access (for example read-only access). Unlike possession, access does not always imply exclusivity. In order to transfer the actual control over data, the database administrator should waive his rights of access. Second, the data as a service is used at the time of the service (streaming), without any rights arising in the future. The above-mentioned distinction between data as a stock and as a flow of resource units is applicable to this case. In addition, there are differences from the participants' point of view. As explained by Zech (2016), in some legal systems service contracts are non-

transferable as the identity of the provider or the user of the service are important considerations,

The existence of a secondary data market depends on the personal capacity of contracting parties. On this basis, the data are treated as non-tradable services. Their use can be limited by factual measures (technological solutions, e.g. streaming) or by legal instruments (contractual clauses).

In addition, if there is a raw data market, then the results of the processing constitute a dependent market (from the point of view of competition law). However, innovation and new technology markets exist whether or not data is treated as a marketable commodity (Zech, 2016).

## Conclusion

Traditional property rights emerged as a result of the competition for access to limited resources. Industrial property rights, on the other hand, are designed to protect and promote innovation, and copyright is designed to stimulate creativity. The question of what protection is needed to ensure the maximum utilization of data, in a way that leads to maximization of public and private benefits and optimal distribution of the result, has not yet found a consensus solution.

There may be a trade-off between suboptimal investment in datasets and suboptimal use of data.

The analysis identifies the following problems which need further consideration:

- The nature of the data makes property rights difficult to define, especially where there is co-creation of value and overlapping rights;
- The value of the data is difficult to estimate ex ante and depends on the context (stakeholders, objectives, technology);
- The value of data may increase when sharing and combining, but in some cases there is rivalry (trade secrets) and negative effects associated with unclear responsibility;
- The negative externalities as a result of the use of data or their derivatives are insufficiently studied;
- There are high transaction costs, which in some cases could exceed the value of the data.

The study demonstrates that there is no universal rule for establishing property rights over data and these rights or part of them may be attributed to different parties. In order to achieve better outcomes under different conditions, the regulators and stakeholders need a more granular approach. In this sense, the study presents a conceptual framework and criteria for further empirical analysis.

The economic goal of any property and intellectual property right is not to maximize the income of rightholders, but to achieve an efficient allocation of

resources and incomes and a socially optimal level of innovation as Duch-Brown et al (2017) stated. However, the existence of residual rights combined with restrictions on third parties'access to personal data, which are de facto used in exchange for other services, has contributed to the creation of data monopolies. As raw individual data cannot be traded or their implicit value is very low, these monopolies benefit from the value of the data-based service (downstream). The value of derivatives could be significantly higher than the data at the previous stages. But the power to control data at the previous stage which are not protected by the intellectual property rights could be a source of market power. This means that the analysis of property rights must be continued with the effects on competition, which is beyond the scope of this paper.

Co-creation of value by sharing and combining data implies new models of ownership and access to data since the current ones favor the enclosure and the value extraction, instead of the value creation. New, carefully considered solutions are needed to ensure limited (presumably non-exclusive) access rights to the processed data with clearly defined liability rules. Without such institutional innovation, the benefits of a data-driven economy will be concentrated in a small group of technology companies, and the social value of data will be lower.

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