

RESEARCH ARTICLE

Towards a data-driven European twin transition: an analysis of the EU data sharing strategy from a conceptual lens of Pareto efficiency

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Abstract

COVID-19, climate change, and Russia's invasion of Ukraine have underscored the importance of environmental sustainability and digitalisation for maintaining the EU's economic stability, social resilience, and global position. Green and digital transition strategies have emerged as a response to these immediate challenges, aiming to mitigate their negative impact on European citizens and businesses and ensure the EU's smooth transition to an environmentally sustainable digital economy. While green and digital transitions are often viewed as separate issues of conflicting nature, their interaction presents an immense potential for the EU's increased growth and global competitiveness, indicating the importance of a twin transition for the future of Europe. As an intersecting central element of both the green and digital transitions, data can play a critical role in the achievement of the European twin transition. Through regulation, data sharing can be used as an effective instrument to leverage data towards the EU's mutually reinforcing green and digital transitions. Embracing this approach, this article first demonstrates how data as an economic good can be leveraged through regulation as a catalyst for the twin transition by using data sharing as a redistribution mechanism that reallocates the socio-economic value of data. It then adopts Pareto efficiency as a conceptual benchmark to analyse to what extent the current EU data strategy contributes to the twin transition based on this framework. Finally, the article concludes with a brief discussion on how the Digital Omnibus may affect the interplay between the EU's data strategy and its twin transition.

Policy Significance Statement

The data-driven twin transition approach promises a single policy solution for the convoluted issue of tackling the adverse implications of climate change and rapid digitalisation on the environment, society, and economy by channelling data as the mutual element of green and digital transitions. Data sharing can be utilised as an instrument to leverage data in line with this approach and expand the scale and scope of the value that can be created from data for twin transition purposes. Addressing this potential, this article illustrates the role data sharing can play in the European twin transition and evaluates the EU data strategy from this perspective using an economics lens.

1. Introduction

The climate crisis and exponential growth of digitalisation are, arguably, the two greatest global challenges of our time, with their transformative effects on the environment, society, and economy. The green and digital transition strategies have been developed by governments and international

organisations across the world to counter the unprecedented ramifications posed by these two phenomena and ensure a smoother adaptation process to the new normal.

Organisation for Economic Co-operation and Development (OECD) defines green transition as “the economy-wide shift away from activities with high environmental impacts and natural resource dependence, toward practices that respect planetary boundaries and promote long-term sustainability, resilience, and societal well-being globally” (OECD, 2025). According to the European Commission, “green transition represents a societal transformation that seeks to respond to the interwoven crises of climate change, biodiversity loss and ecological degradation” (European Commission, 2026). As these definitions suggest, green transition is a multidimensional concept which calls for coherent changes across economic, social, political, and cultural domains (European Commission, 2026). When it comes to digital transition, it refers to a socio-technical shift with economic and institutional aspects (Colovic et al., 2025), which represents a movement from analogue to digital processes to improve performance and productivity (Rosário and Dias, 2022). While these two concepts seem to concern two separate issues, they are closely interlinked. In fact, an effective social and economic green transition of a country or territory is only possible if it is upheld by and carried out in sync with the digital transition, whilst a digital transition is deemed as successful as it is sustainable.

Green and digital transitions are the two sides of the same coin, both being the future-facing adaptation processes rendered inevitable by the demands of our “environmentally dying” but “technologically thriving” world. Still, they potentially challenge each other and are not easy to synchronise for a lot of reasons, the most prominent one being the aggravating impact of the digital transition on environmental degradation. The digital transition is driven by technology whose ecological impact is steadily increasing in parallel to its progress, which exacerbates the climate crisis by causing a substantial rise in greenhouse gas (GHG) emissions and fuels overconsumption of natural resources (Digital Global, 2022). The information and communications technology (ICT) sector’s share in the world’s total carbon emissions was estimated to range between 1.5% and 4% (Ferreboeuf et al., 2021; Malmodin et al., 2024; World Bank, 2024) and predicted to reach up to 6%–7% of the global emissions by 2040 (Belkhir and Elmeligi, 2018).

In addition to the emission-related impacts, the growing demand for digital devices prompted by the digital transition creates new resource dependencies brought on by an increase in the extraction of rare earth elements, such as cobalt and lithium, which are generally mined in ways harmful to the environment and biodiversity (Digital Global, 2022). The explosive surge in the production of digital equipment, devices, and infrastructure—thanks to the expeditious pace of digital transition—gives rise to soaring electronic waste (e-waste) that contains toxic components and pollutes the environment (Forti et al., 2020).

That said, the digital transition has tremendous potential to positively contribute to the green transition, provided technology is harnessed in an environmentally sustainable manner. According to the recent predictions, ICT technologies can reduce global GHG emissions by up to 20% by 2050 (IEA, 2021) as well as increase efficiency in productivity and save resources in various ways, such as by enabling accurate prediction and optimisation of energy consumption (Finck and Mueller, 2023), providing smart and circular solutions for manufacturing and supply chain management, and allowing effective monitoring and reporting of carbon emissions by industry (Coeckelbergh, 2021). Digital technologies can also promote climate mitigation and environmental protection by increasing the efficiency of environmental tracking, waste management, and forecast of weather events and natural disasters (Onyango and Ondiek, 2021), facilitating transition to de-centralised and renewable energy systems (World Bank, 2024), guiding environmental policy-making and governance (Onyango and Ondiek, 2021), and raising awareness of consumers on their environmental footprint (Coeckelbergh, 2021).

Amongst these contrasting facts regarding the relationship between digital technology and environmental sustainability, twin transition refers to a process of parallel and mutually reinforcing green and digital transitions (Tabares et al., 2025) enabled by the cultivation of synergies through the incorporation of environmental sustainability principles and objectives into digital transition goals and the harnessing of digital technologies for environmental protection and enhancement. Twin transition is more than a sum of

separately conducted green and digital transition processes and requires a single agenda that strives for a simultaneous and consonant process of dual transition. A successful twin transition can help evade the trade-off between digital innovation goals and ecological considerations and expedite a smooth shift into a digitally competent and environmentally sustainable society.

Still, unlocking the synergies between these two intrinsically conflicting processes through a single agenda has challenges, which require a myriad of actions to overcome, ranging from adopting a multidimensional and cohesive strategy and a practical roadmap of investments and initiatives to taking regulatory measures and building public awareness and civil society engagement. An optimal way of developing a mutually complementing and practically feasible twin transition strategy is to find an intersection between green and digital transitions to use as a leverage point to balance their clashing demands and reciprocal repercussions on each other. This is where data enters the scene.

Data constitutes “the backbone of the green and digital transitions” (Muench et al., 2022) as a core element of both processes. Lying in the intersection of green and digital transitions as a versatile resource with productive value (Frischmann, 2012), data holds great potential to accelerate the twin transition.

The role of data in the digital transition is quite evident. It underpins the digital transition by virtue of being the “fuel” powering the process, as all advanced technologies and digital solutions rely on data to function. The volume and quality of data and how it is utilised determine the scope, scale, and limits of the digital transition to the point that there is no digital transition without data. The wide availability of diverse, accurate, and machine-readable data through sharing can facilitate innovation, ensure interoperability of digital ecosystems, enhance cybersecurity and resilience of digital infrastructure, help track the progress of digitalisation, provide knowledge transparency, and inform digital policy and regulation.

The connection between data and the green transition, on the other hand, is far more complex than that. On a negative note, the generation, collection, storage, use, and sharing of data have a deteriorating effect on the environment, with their large share of the global carbon footprint. Data centres consume enormous amounts of electricity to power the servers, storage systems, and networking devices, as well as water to cool them down, which heightens the energy demand and makes a considerable addition to the total world emissions (Technology Carbon Standard). Embodied emissions of data centre hardware add up to the operational GHG output and make up around 20% of total data centre lifecycle emissions, in addition to the large piles of e-waste caused by such hardware with short replacement cycles (Thangam et al., 2024).

Nevertheless, data is a critical asset for the green transition and can notably accelerate the process despite its aggravating effect on environmental deterioration. Easily accessible quality data is key to the green transition as a critical input for improving environmental governance and climate change adaptation, driving green innovation, understanding sector impacts, and developing and maintaining sustainable production and service processes. According to a recent study, the sharing and efficient utilisation of data significantly contribute to green growth and transformation by breaking the temporal and spatial constraints of information exchange in favour of environmental sustainability (Cappa et al., 2021).

Against this background, this article argues that data, as an economic good integral to both green and digital transitions, can be leveraged for the twin transition by utilising data sharing as a redistribution mechanism through regulation. Based on this framework and adopting Pareto efficiency as a conceptual standard, it then discusses to what extent the European Union’s (EU) current data strategy contributes to the twin transition and provides recommendations on how to better integrate the twin transition as a key objective into the EU data regulation framework. Finally, the article concludes with a brief discussion on how the Digital Omnibus may affect the interplay between the EU data strategy and the European twin transition.

2. Methodology and structure

According to the Pareto efficiency (optimality) theory introduced by the Italian economist Vilfredo Pareto, a policy change for allocation of resources is socially desirable if either every agent is made better off or at least some are made better off without making the others worse off (Johansson, 1991). This article applies this theory to the multi-objective policy setting of the twin transition from a theoretical lens in a

way that conceptualises data as the resource—based on its characteristics as an economic good—green transition and digital transition as competing agents (policy objectives), and data sharing as a redistribution mechanism that reallocates access to data and thereby its socio-economic value. Within this framework, the article shows how increasing data sharing through regulation can positively contribute to the twin transition and analytically evaluates the EU data strategy from this aspect against a conceptual benchmark of Pareto efficiency in a normative setting. The criterion for this article’s Pareto efficiency benchmark is whether the EU data strategy, through its approach to and regulation of data sharing, theoretically facilitates at least the green or the digital transition without hindering the other.

The article’s scope is limited to green and digital transitions as policy objectives and does not primarily consider other factors—apart from data protection in relation to its effect on data sharing—such as considerations of competition law, intellectual property rights, or fairness, which could affect Pareto efficiency. It does not attempt to compute an actual Pareto efficiency point or perform formal optimisation modelling. Instead, it uses the logic of Pareto efficiency as a heuristic lens for a systemic legal analysis. This approach allows the article to bridge legal analysis with economic reasoning while remaining consistent with established methods in legal scholarship.

The article is structured as follows:

First, it conceptualises data as an economic good by drawing on the literature, with particular focus on its characteristics of non-rivalry, excludability, and non-subtractability, laying the foundation for the illustration of data sharing as a redistribution mechanism with the potential to manipulate these characteristics in favour of the twin transition.

Second, it portrays data sharing as a mechanism of data redistribution that can facilitate the twin transition by arguing how increased data sharing can generate economies of scope and economies of scale as well as increasing returns in a twin-transition-promoting manner, while addressing potential challenges, such as the environmental impact and rebound effects of data sharing, which may hinder, offset, or even reverse the progress towards the twin transition.

Based on this foundation, the article then performs a systematic legal analysis on whether the EU’s data strategy leverages the power of data sharing through regulation in a Pareto-efficient-like manner from a twin transition viewpoint that it at least improves one of the transitions without negatively impacting the other. In this analysis, the article refers to the common European data spaces (CEDS), the Data Governance Act (DGA) (Regulation 2022/868), the Data Act (DA) (2023/2854), and the Open Data Directive (ODD) (2019/1024) as the strategy’s flagship instruments that reflect the EU’s recent focus on data sharing as a redistribution mechanism. The article also interprets the regulatory tension between data sharing and data protection objectives in relation to its potential influence on the twin transition as a critical point that illustrates the EU’s evolving view on data and how it should be regulated.

Finally, the article concludes with final remarks on its analysis and a brief forward-looking reference to the European Commission’s Digital Omnibus proposal (European Commission, 2025) in relation to the potential implications of the introduced amendments on the efficiency of data sharing as a redistribution mechanism for the EU’s twin transition.

3. Conceptual framework

3.1. *Data as an economic good*

In the literature, data is conceptualised under four main theories that have different views on the nature and function of data. Ordoñez (2013), Fajgelbaum et al. (2017), Bergemann and Bonatti (2019), Jones and Tonetti (2020), and Veldkamp and Chung (2024) consider data as a natural by-product of economic activity, which is incidentally generated as a secondary outcome of economic processes, such as manufacturing, selling, and operating, but may acquire value afterwards and be used for various purposes. Arrieta-Ibarra et al. (2018) and Posner and Weyl (2018) regard data as labour, a value generated by users as a form of unpaid or undercompensated work disproportionately captured by technology companies. Frischmann (2012), Ducuing (2020), and Bietti (2025), on the other hand, treat data as infrastructure and emphasise its collective and systemic dimensions, saying that data’s primary function is to act as a binding

connector and backbone of social and economic practices. Data is also increasingly recognised in scholarship as a form of capital that generates economic value, drives technological development, influences decision-making and governance, and enables competitive advantage (Sadowski, 2019; Pentland et al., 2021).

Yet, these theories are not mutually exclusive and can even be contextualised in the form of a systematic cycle throughout the lifespan of data, which is generated as labour or a by-product of an economic activity and turns into capital or infrastructure by being collected and refined by companies and other entities. This complementarity between these theories stems from their shared view on the economic value of data, which lies at the core of the meta concept of “data as an economic good.”

In neoclassical economics, goods are mainly classified along the axes of rivalry and excludability. An economic good is deemed rival if its consumption by one person reduces its availability to others or deprives them of using it at the same time. A good is considered excludable, on the other hand, if its consumption can be prevented by certain agents. According to these criteria, goods are distinguished into two main categories: public goods and private goods. Goods that are non-rival and non-excludable are classified as (pure) public goods, whereas those that are rival and excludable are categorised as (pure) private goods (Samuelson, 1954; Cornes and Sandler, 2012).

Nevertheless, time has proven that these two categories are not adequate to classify all economic goods, as some goods exhibit the characteristics of rivalry and excludability only to a certain extent, within a certain group, or for a limited time (Purtova and Maanen, 2024). This led to the introduction of club (toll) goods and common resource goods (common pool resources) as new categories (Purtova and Maanen, 2024).

Club goods were first conceptualised by Buchanan (1965) and refer to goods that are non-rival, like public goods, but excludable, usually through fees or membership, in addition to being non-depletable. Common resource goods or common pool resources, on the other hand, are goods that are non-excludable but rivalrous.

Some scholars argue that data is a common pool resource (Regan, 2002, 2015; Zygmuntowski et al., 2021), stating that data is subtractable and excluding its beneficiaries is difficult. Yet, literature predominantly agrees that data is non-rival (Moody and Walsh, 1999; Varian, 1999; Savona, 2019; Jones and Tonetti, 2020; Corrado et al., 2024; Purtova and Maanen, 2024), with zero or very low marginal cost of reproduction and distribution (Newman, 2010; Duch-Brown et al., 2017; Koutroumpis et al., 2017). Data is also commonly considered non-subtractable as the quantity or quality of data does not generally diminish with use (Moody and Walsh, 1999; Purtova and Maanen, 2024). Accordingly, data is typically regarded either as a pure public good or a club good. Differing from many other traditional public goods, however, data can be easily transferred and applied in different contexts (Günther et al., 2022).

As a non-rival and highly portable economic resource, data can be used by any number of firms or people, even simultaneously, without being depleted (Jones and Tonetti, 2020). On the contrary, the use of data by more users gives rise to network effects, thereby generating higher resource utilisation efficiency (Arrieta-Ibarra et al., 2018; Savona, 2019). Furthermore, while traditional economic factors tend to exhibit diminishing returns after a certain point and eventually lead to a progressive decrease in the efficiency of resource allocation (Wu and Xie, 2024), data is typically considered to demonstrate increasing returns to scale (Banalieva and Dhanaraj, 2019).

The increasing value creation potential of data ultimately rests on its reusability enabled by its non-rivalry (von Ditzfurth and Lienemann, 2022). According to Varian (1999), the non-rivalry of data emphasises “data access” rather than “data ownership,” meaning that more value can be generated from data if it is widely accessible rather than privately owned (Jones and Tonetti, 2020; Purtova and Maanen, 2024). This is where excludability matters. Varian (1999) states that the exclusion of consumption in the context of data is socially inefficient and too difficult, implying that data is “practically” non-excludable. Similarly, Regan (2002) and Zygmuntowski et al. (2021) regard data as excludable but find such exclusion of consumption highly difficult in practice. On the other hand, Newman (2010) considers the excludability of data contingent on policy decisions and regulation, while Duch-Brown et al. (2017)

and Jones and Tonetti (2020) argue that the excludability of data depends on technical and/or legal intervention.

Indeed, limiting access to data through regulatory attribution of exclusive data ownership rights and rigid data protection frameworks can render it excludable and even turn it into a private good, which may lead to data concentration, data fragmentation, and reduced interoperability. This may give rise to the tragedy of data anti-commons, which occurs when excessively fragmented data ownership rights or strict data protection rules result in the blocking of access to, and therefore, the underutilisation of data (Heller, 2008).

The legal rules on by whom data is owned and how it is transmitted between different actors can determine the characteristics of data, and thereby the extent and limits of value that can be created thereof. Different laws can form different markets and direct them towards fairer and equitable socio-economic outcomes (Groza and Botero Arcila, 2024). Therefore, the economic, legal, and social dimensions of data are closely intertwined, with an intervention in one dimension having an impact on the others. Particularly in the digital age, data regulation stands as a pivotal joint connecting the economy, technology, law, and society. This suggests that the potential of data as an economic resource can be channelled through regulation to achieve socio-economic goals such as the twin transition by utilising data sharing as a form of redistribution mechanism that reallocates and maximises the potential value of data.

3.2. *Data sharing as a redistribution mechanism*

The potential of data as an economic resource and of data sharing as a redistribution mechanism capable of creating Pareto improvements for the twin transition lies in the economic characteristics of data. Unlike many traditional resources, a copy of a dataset can typically be transmitted to another user without diminishing either the quantity or quality of data available to existing users. Therefore, in principle, wider access to the same dataset can enable additional socio-economic value creation without leaving incumbent users worse off. This distinguishes data from conventional scarce resources and provides the economic foundation for conceptualising data sharing as a redistribution mechanism capable of facilitating Pareto-efficient outcomes, subject to practical constraints such as infrastructure costs, legal restrictions, and environmental rebound effects. Economically, data sharing can generate economies of scope, economies of scale, and increasing returns, which can translate into innovation and environmental benefits that simultaneously support both the green and digital transitions.

Sharing data across public authorities, organisations, businesses, and individuals to be reused multiple times for diverse purposes can generate economies of scope by spreading the cost of collecting data across many uses and making each use cheaper (Moody and Walsh, 1999; Duch-Brown et al., 2017). As the same dataset is shared and used by many different actors and less data is collected, processed, and stored, the average cost per user may fall and give rise to economies of scale. In the twin transition context, reusing datasets collected for one purpose for other objectives across sectors and by various actors for lower costs, such as satellite data both for climate monitoring by public authorities and agricultural optimisation by private companies, can make green technologies and digital sustainability solutions scalable and expand their application, facilitating green and digital transitions simultaneously in line with the Pareto efficiency principle.

Exchanging complementary datasets rather than keeping data separated in silos can lead to synergy gains while decreasing the total amount spent per dataset (Martens, 2021). When complementary datasets are combined, “super-additive” insights derived from data linkages enable more value to be derived from the aggregated data than when datasets are kept separate, generating increasing returns to scope (Duch-Brown et al., 2017; Martens, 2021; Bernal, 2024). Aggregated datasets can significantly enhance the accuracy and performance of green technologies, such as renewable energy forecasting, resource optimisation systems, simulation technologies, and precision agriculture tools, contributing to long-term sustainability and eco-friendly innovation at the same time.

The more data is shared across agents, the more goods and services can be produced with the same amount of input, yielding increasing returns to scale. Without data sharing, the same datasets need to be

created/collected by each user, which is economically and socially wasteful. In that regard, data sharing may turn data into a circular resource by taking advantage of the inherently sustainable nature of secondary data (Jetzek et al., 2019) and enabling its multiple reuses by various actors for more value creation than one single actor can achieve with the same input.

Having said that, data sharing itself has a non-negligible amount of carbon footprint and may lead to rebound effects that may offset or even reverse environmental benefits generated through data sharing. Rebound effects occur when efficiency gains trigger an increase in demand and result in less energy savings than efficiency is expected to produce (Khazzoom, 1980). This means that if data sharing boosts efficient data-driven value creation as desired, yielded efficiency improvements, such as energy savings, may be counterbalanced or even overridden by a rise in consumption (Santamaría Echeverría, 2025). This perfectly illustrates the composite interaction between data sharing and twin transition, which may be influenced by various factors.

Regulation can play a key role in anticipating and strategically synthesising these factors towards leveraging the power of data sharing in accordance with twin transition principles. A data strategy that recognises data sharing as a catalyst for unlocking data and promotes it across sectors through regulation in a digitally competitive but environmentally conscious manner is the first step towards that end. An effective data strategy that operates in accordance with twin transition goals requires an evaluation of established norms and practices against the changing landscape of environmental and digital developments and should be backed by a strategically efficient and internally consistent regulatory framework in that direction.

Based on this promising possibility of using data sharing by regulatory means as a mechanism for redistribution for the benefit of the twin transition, Section 4 will analyse to what extent the EU's data strategy, with reference to its underpinning regulatory framework, leverages data sharing in a Pareto-efficient-like manner.

4. A legal analysis from an economics lens: The EU's data strategy in its contribution to the twin transition through data sharing

The EU's new data strategy is outlined by the European Commission in its recent communication "Data Union Strategy—Unlocking Data for AI" (European Commission, 2025). The strategy recognises data sharing as a powerful tool to harness data, with the primary focus on increasing the EU's digital competitiveness in the international arena. Accordingly, it identifies three priorities, which encompass scaling up access to data for AI, streamlining rules on data to make data sharing easier, and removing unjustified barriers to international data flows to strengthen the EU's global position. Its vision is to create "a sovereign European data economy where data flows securely and responsibly, powering AI, fuelling innovation, and reinforcing competitiveness" (European Commission, 2025). Data scarcity, regulatory complexity, and rising global competition are identified as the main challenges to fulfilling this vision. Acknowledging data as "a core strategic resource" (European Commission, 2025), the strategy declares the limited availability of high-quality, diverse data and reluctance to data sharing as a "key market failure" (European Commission, 2025) and commits to responding to this issue by facilitating data sharing. According to the European Commission, based on OECD estimates, an increased exchange of data between European businesses can lead to macroeconomic worth ranging from around 1% to 2.5% of the European GDP (OECD, 2019; European Commission, 2020a; von Ditfurth and Lienemann, 2022).

In addition to its role as a mechanism for economic growth, the EU regards data sharing as a means of redistribution that can ensure the competitive balance of the EU data economy, in which organisations of all sizes use their data assets collaboratively rather than a few very powerful technology firms exclusively controlling large amounts of data. Currently, many European businesses, especially those that operate at a small scale, struggle to access adequate volumes of quality data due to data concentration or data fragmentation (von Ditfurth and Lienemann, 2022). The level of data exchange among businesses is relatively low despite the fact that huge amounts of data are generated daily by individuals and

organisations (von Ditfurth and Lienemann, 2022). According to the European Commission's estimations, around 80% of machine-generated data remains unused (Jorzik et al., 2024).

The new data strategy strives to solve this problem through regulation-induced data sharing by either mandating or incentivising data sharing among various actors. By redistributing access to data, the EU aims to deconcentrate the European data market and enable a fairer allocation of data-driven values among market actors. Overall, the strategy signals a shift of focus in the EU's approach to data from an emphasis on data protection to a focus on data-driven competitiveness, the first notable sign of which was seen in the 2020 European strategy for data (European Commission, 2020b).

The 2020 data strategy laid the legal and institutional foundations for the current one by envisioning the creation of a single market for data where high-quality data freely flows, creating growth through value creation "while minimising the human carbon and environmental footprint" (European Commission, 2020b). It adopted a human-centred, "open but assertive" (European Commission, 2020b) approach to data, which sought a balance between the increased flow and broad use of data and the protection of privacy, security, safety, and ethical standards (European Commission, 2020b). Similar to the new strategy, data scarcity and insufficient sharing and reuse of data were considered among the main setbacks to the EU's transition to a genuine data economy, which inspired a series of regulatory initiatives, including the CEDS, the DGA, the DA, and the ODD.

4.1. Common European data spaces

The CEDS are designed to provide safe, reliable, and privacy-preserving platforms for pooling, sharing, and using personal and non-personal data (European Commission, 2024). While they are created to provide an EU ecosystem of large volumes of strategically connected and interoperable data, they are distinguished from open data platforms by virtue of being meticulously regulated based on "European values" (European Commission, 2020b), with a focus on personal data, consumer protection, and competition law (European Commission, 2020b). The CEDS are important instruments for harnessing the true potential of data with less risk to other legal parameters, as they provide a trustworthy data infrastructure that promotes data sharing in a secure environment compliant with EU data protection principles.

In the 2020 data strategy, the European Commission named nine areas in which the CEDS were to be created, including the Green Deal, mobility, energy, and agriculture (European Commission, 2020b), and to gradually become interconnected to form a single European market for data. The Green Deal Data Space (GDDS) is particularly prominent from a twin transition perspective, along with those operating in the sectors of agriculture, energy, and mobility. The GDDS provides an interoperable and trusted digital ecosystem for high-value environmental data sharing in line with Green Deal objectives, including climate neutrality, emission reduction, biodiversity protection, zero pollution, renewable energy, smart mobility, and transition to a circular economy.

The new data strategy aims to scale up the CEDS and link them to AI infrastructure through data labs and AI factories, with an aim to turn the EU's data assets into "fuel" for AI development (European Commission, 2025). In the context of the GDDS, the strategy explicitly refers to environmental digitalisation and how it can fast-track the process by enabling data-driven cross-sector solutions in green technology (European Commission, 2025).

The CEDS are one of the few areas in which the green aspect of the twin transition is properly addressed in the context of the EU data regulation. The potential contribution of the CEDS to the digital transition may still outweigh their likely benefits for the green transition, as all foreseen data spaces promote innovation one way or another while only certain ones support environmental sustainability. However, they still have the potential to generate Pareto improvements in the sense that they can foster at least the digital transition while not slowing down or even simultaneously facilitating the green transition. Therefore, they can prove to be a critical asset that drives the twin transition forward if trust and active participation in them are established through regulatory incentives. The DGA, the DA, and the ODD are critical in that regard, with their mutual mission to remove barriers to data and encourage data sharing.

4.2. Data Governance Act

The DGA aims to increase data availability and facilitate voluntary data exchange in the EU by establishing trust in data sharing and data intermediaries, strengthening mechanisms of exchange, laying the foundation for and encouraging data altruism practices, and addressing technical obstacles. It stipulates a set of conditions for the reuse of certain data held by public sector bodies, lays down a mandatory notification procedure and compliance framework for data intermediation service providers, proposes a voluntary registration mechanism for data altruism organisations, and provides a framework for the establishment of a European Data Innovation Board (Art 1(1), DGA).

The new governance mechanisms introduced under the DGA set out to create a more collaborative economy by establishing harmonised rules for fair access and reuse of data, particularly for innovation and public interest purposes (Pathak, 2024). The DGA has a strong distributional constitution, which seeks to empower SMEs for innovation through data sharing and mitigate the concentration of data in the hands of a few big tech companies dominating the market. This distributional character of the DGA can directly benefit the digital axis of the twin transition by supporting the integration of new players into the technology market to drive innovation. It may also contribute to the green transition by increasing the flow and utilisation of environmentally relevant data for green transition purposes, provided that the derived benefits compensate for the potential boost in the ecological footprint of data sharing.

An important mechanism created by the DGA, in line with its commitment to create an interconnected, diverse data ecosystem where data assets are used collaboratively, is the new legal regime for data intermediaries. Data intermediaries can be defined as entities that mediate between data users and data holders who want to make their data available to potential users within a commercial framework (Janssen and Singh, 2022). In addition to easing data sharing among market actors, data intermediaries are expected to reduce transaction costs of data by taking advantage of economies of scale, guarantee interoperability (Martens et al., 2020), and ensure compliance with data protection regulations (von Grafenstein, 2022; Richter, 2023). That said, data intermediaries may face considerable operational burdens and legal uncertainty regarding compliance with data protection law when personal data is involved (Carovano and Finck, 2023), as there are terminological and operational uncertainties regarding how the DGA and the General Data Protection Regulation (GDPR) (Regulation 2016/679) would work together in practice. While the GDPR prevails over the DGA in the event of a conflict on the protection of personal data and privacy (Para 1, Art 1(3), DGA; Para 2, Art 1(5), DA), the ambiguities and confusion on the practical co-application of the instruments on certain matters persist. This may discourage companies from becoming data intermediaries if the procedural burden and the risk of penalties for non-compliance with the GDPR outweigh the benefits.

Similar issues arise in the context of the data altruism framework introduced under the DGA as a voluntary, not-for-profit data sharing mechanism for objectives of general interest. Despite dedicating a whole chapter to data altruism, the DGA does not clarify what is considered a general interest. It provides some examples, which encompass “healthcare, combating climate change, improving mobility, facilitating the development, production and dissemination of official statistics, improving the provision of public services, or public policy making” (Recital 45, DGA) and leave the rest to the Member States. While data altruism is promising in twin transition terms, with its potential to increase data sharing for purposes of climate adaptation and environmental protection, the ambiguity of the concept, its voluntary nature, and the interoperability issues regarding overlapping aspects of the DGA and the GDPR may inhibit its effective application in practice. A notable example of possible implementation issues relates to consent.

Under Article 21(3) of the DGA, data processing by data altruism organisations is only allowed with consent from the data subject or, if the data is made available by a data holder, permission from the data holder. The DGA, however, does not state any specifics about the conditions for obtaining a valid consent, including any clarification about how the provision would cooperate with the complex set of rules on consent for personal data processing under the GDPR, which may differ depending on a range of factors, such as the age of data subject, the involvement of sensitive information in the processing, and the purpose (De Hert, 2023). Considering the voluntary and non-profit nature of the activity, this kind of uncertainty,

which generates a risk of non-compliance with the GDPR, may dishearten potential candidates for data altruism organisations, diminishing the benefits to be gained from the practice. These conceptual ambiguities are exacerbated by the contrasting ideologies of the GDPR and the DGA, the former of which aims for meticulous protection of personal data, while the latter strives to liberate it.

From a Pareto-efficient twin transition lens, the DGA heavily favours the digital transition over the green one, as its objective of facilitating data flow in the EU by encouraging voluntary data exchange is economically motivated, with no consideration paid to the environmental sustainability dimension of data. While imposing horizontal data sharing obligations without any restrictions regarding the type of data, sector, or the purpose of reuse, the DGA creates opportunities conducive to the green transition, these are ancillary to the objective of increasing innovation. Potential green benefits to be derived through the data sharing under the DGA may even be reduced or reversed by a potential surge in innovation triggered by the Act. Whether the DGA can support the EU's twin transition in a Pareto-efficient fashion is therefore conditional on many factors, including the purposes the new data sharing regimes are employed for, the scale of increase in innovation, and the resulting deteriorating impact on the environment.

4.3. *Data Act*

The same “data sharing versus data protection” dilemma persists when it comes to the other flagship legal instrument of the new EU data strategy, the DA. The DA complements the DGA by laying down the rules for who can make use of data under what conditions. It sets out a path to remove the barriers to data sharing while giving individuals and businesses more autonomy over the data generated through them. The DA covers both personal and non-personal data (Art 1(2), DA), with a particular focus on those generated within the framework of the Internet of Things (IoT) technology (Art 1(2)(a), DA).

The DA's main purpose is to facilitate data sharing in an “equitable” way by devising a fairer allocation of value to be derived from data through redistribution of access rights and obligations. By endowing a wide range of stakeholders with control over their data and increasing data availability for innovation, the DA is set to maximise data-driven value creation (Groza and Botero Arcila, 2024).

Unlike the DGA, which primarily approaches data holders as rights holders, the DA positions them as entities with certain data sharing obligations (Pathak, 2024). Furthermore, an individual or an entity can fall within different categories under the different instruments of the EU data regulation framework, which risks confusion and uncertainty in implementation. The same person or organisation can be a “data controller” or “data processor” under the GDPR, while being a “data holder” or “data user” under the DA and the DGA (De Hert, 2023). This issue is not magically solved by the fact that the GDPR prevails over the DA and the DGA in the event of a conflict on the protection of personal data and privacy (Para 2, Art 1 (5) DA; Para 1, Art 1(3), DGA). In addition to the unclarity regarding the interplay between the GDPR and the new data sharing legal frameworks, how the provisions of the DA and the DGA would work together when there is an overlap is not tackled by either of the Acts (Hennemann et al., 2024). If not clarified, these interoperability issues may ultimately compromise the EU data strategy's overarching goal of maximising data-driven value.

These concerns aside, the DA provides a notable data sharing mechanism for cultivating data for the twin transition, which can be initiated under specific circumstances to access otherwise undisclosed data to reuse it for certain environmental purposes. Article 14 of the DA introduces an obligation for data holders to make data available to public sector bodies, the Commission, the European Central Bank, and Union bodies in the event of an exceptional need for those to be able to carry out their statutory duties in the public interest. What constitutes an exceptional need within the meaning of Article 14 is clarified under Article 15.

Under Article 15, there is deemed to exist an exceptional need where the requested data is necessary to respond to a public emergency and cannot be acquired by any alternative means in a timely and effective manner under equivalent conditions (Art 15(1)(a), DA), or, provided only non-personal data is involved, the lack of the data is preventing the body from fulfilling a specific task in the public interest (Art 15(1)(b) (i), DA) and the body exhausted all other means to obtain such data (Art 15(1)(b)(ii), DA). Recital 63 of

the DA describes exceptional needs as “circumstances which are unforeseeable and limited in time, in contrast to other circumstances which might be planned, scheduled, periodic or frequent,” and points out public emergencies as primary examples of such situations. Article 2(29) of the DA explicitly defines public emergency as an exceptional situation, which is limited in time and negatively affects the population of the EU or a Member State, posing a risk of serious and lasting repercussions for living conditions or economic stability, financial stability, or the substantial and immediate degradation of economic assets. Recital 64 of the DA includes emergencies resulting from natural disasters, such as those aggravated by climate change and environmental degradation, among examples of possible public emergencies, and states that in such situations “the public interest resulting from the use of the data will outweigh the interests of the data holders to dispose freely of the data they hold.”

Under these provisions, climate change management and natural disaster prevention, relief, and recovery may qualify for an exceptional need, and data may be shared to address such issues of environmental importance. In fact, IoT data, such as that coming from smart cars, mobile phones, and energy systems, can be extremely valuable for weather forecasting and climate monitoring towards prevention of and responding to extreme weather events and natural disasters (Kerber, 2023), improving the accuracy of predictions, and enabling more-targeted precautionary or counter measures.

To increase the value to be created from such data with important potential, Article 21(1) of the DA allows data received under an exceptional need to be shared with individuals or organisations in view of carrying out scientific research or analytics compatible with the purpose of the request (Art 21(1)(a)) or national statistical institutes and Eurostat for the production of official statistics (Art 21(1)(b)) to be used on a not-for-profit basis or for a recognised public interest mission (Art 21(2)). This means that data about or related to the environment (Finck and Mueller, 2023) transmitted under these provisions can potentially be used for green innovation purposes, mutually benefitting both green and digital transitions in a Pareto-efficient-like manner. Cultivating this potential, however, depends on how flexibly the conditions of “not-for-profit basis,” “for public interest,” and “compatible with the request purpose” are interpreted. A strict interpretation of these conditions may restrict the applicability of the provision. Similarly, the requirements for a request for data sharing based on an exceptional need, such as the necessity of the data to perform a public interest task and the inability to acquire it in any other way, may be too onerous for the requesting public body to fulfil. Together with the burden of proof of the existence of an exceptional need (Art 14, DGA), such a complex process may discourage public bodies from taking advantage of the provision, and limit the potential benefits to be derived in favour of the twin transition from a Pareto efficiency perspective.

These legal barriers can be partially lowered through a broader interpretation of the public interest underlying the concept of an exceptional need. While the exceptional need mechanism under Article 14 is primarily associated with public emergencies or other similar exceptional circumstances, environmental sustainability constitutes a recognised public interest under EU law. Article 11 of the Treaty on the Functioning of the European Union (TFEU) requires environmental protection requirements to be integrated into the definition and implementation of all Union policies and activities (Art 11, TFEU). In its Notice on access to justice in environmental matters, the European Commission declared the preservation, protection, and improvement of the quality of the environment, and more specifically, “clean air, safe and adequate water resources, a healthy biodiversity and the avoidance of waste” as general public interests (European Commission, 2017). Similarly, the Court of Justice of the European Union (CJEU) has consistently recognised environmental protection as a ground capable of constituting an overriding reason relating to the public interest (Sbrolii et al., 2022).

In light of these considerations, requests for data that demonstrably support environmental preservation and enhancement, climate change management, biodiversity protection, pollution prevention, and resource efficiency could, adhering to the proportionality conditions, be interpreted more broadly as falling within the scope of exceptional need on public interest grounds. In this way, the requested data can still be protected through data protection safeguards and other data-related rules and standards while the DA is better aligned with twin transition objectives. Such an interpretative approach can facilitate environmentally beneficial uses of data within legal limits without compromising compliance with the EU data protection framework or requiring legislative amendment.

Another promising contribution of the DA to the twin transition is the obligation it imposes on data holders to make IoT data available to users and third parties of the user's choice (Art 3–5, DA). IoT data can help significantly improve green innovation, environmental monitoring, energy optimisation, and many other purposes, complementing both innovation and environmental sustainability. By establishing mandatory rights and obligations that open up such data to wider sharing and reuse, the DA unlocks otherwise withheld and exclusively profited information for broader socio-economic value creation. In general, the DA appears to present a higher potential than the DGA in respect of facilitating the EU's twin transition in a Pareto efficient manner, with the possibility of facilitating both transitions albeit having a more direct focus and impact on the digital transition.

4.4. Open Data Directive

When the roles are reversed and it comes to the sharing of data held by public authorities, the ODD sets forth the minimum rules based on the principle that anyone should be able to access and reuse data held by public sector bodies (Fia, 2021). The ODD prescribes several obligations for public sector bodies regarding how to respond to a request for reuse, such as processing requests in a timely manner (Art 4 (1), ODD), communicating the grounds for refusal for a negative decision (Art 4(3), ODD), making the data available in an open machine-readable, accessible, findable, and re-usable format where possible and appropriate (Art 5(1), ODD), and not subjecting the reuse to any conditions unless those are objective, proportionate, non-discriminatory, and justified based on public interest (Art 8(1), ODD). Nevertheless, since the ODD is an EU Directive, the exact application of these provisions depends on how the ODD is transposed into national laws, which may result in divergences in the implementation of rules and standards, particularly in light of the discretionary approach of the ODD towards data formatting, licensing, terms of use, and technical standards.

A significant contribution of the ODD to the twin transition is its introduction of the concept of “high-value datasets.” The ODD instructs the European Commission to adopt implementing acts that formulate a number of datasets on a non-exhaustive list of specified categories (Art 14(1), ODD), including “geospatial,” “earth observation and environment,” “meteorological,” and “mobility” (Annex I, ODA), to ensure easy and free-of-charge availability of public information with significant potential to yield socioeconomic and environmental benefits and innovative services (Art 14(2)(a), ODD). The concept of high-value datasets, similar to the CEDS, is built upon the notion of open data, which is the core idea that underpins the ODD and reflects the EU data strategy's vision of broader data access and availability in Europe.

On the one hand, open data ecosystems can foster the transmission of knowledge for innovation and environmental progress and reduce the environmental footprint of data through increased resource efficiency gained from easy access and wider availability of data. On the other hand, they may compound the already existing trade-off between data protection and increased data sharing in the context of personal data. Even when a piece of data is not technically “personal” as defined under the GDPR, it may still give rise to privacy and data protection violations when combined with other data, which makes it possible to infer otherwise hidden patterns or links among data and identify data subjects. The anonymisation techniques used for small datasets do not provide a complete safeguard in large open data spaces, considering the immensity of data and numerous links therein, in combination with the capability of big data analysis techniques (ECLAC, 2014).

This trade-off between respecting data protection rules and bolstering data sharing, along with the complex operational interplay between the GDPR and the new data sharing frameworks, may negatively impact the twin transition not only by halting the pace of green innovation but also drawing attention further from the environment as an already neglected parameter among the risks posed by the emerging data sharing economy in the EU. Notwithstanding, by introducing high-value datasets on several strategic areas, including the environment, and facilitating the sharing of data held by public sector bodies for further use under safeguards, the ODD signals that it can contribute to both the digital and green transitions if implemented by Member States in such a direction.

4.5. *Analytical findings and recommendations*

At first glance, the EU's approach to data as an economic resource to be maximised by increased sharing seems to be in a harmonious link with the idea of a data-driven twin transition. It paves the way for leveraging data sharing as a mechanism of redistribution towards “recycling” data for the optimum value creation with the least economic impact, in alignment with the conceptual Pareto efficiency benchmark. However, this link is rather indirect and consequential, with an evident imbalance favouring the digital over the green transition.

In the current picture, the EU's efforts to unlock data stem from and revolve around the fact that the EU is behind its top international competitors, the United States and China, in the AI race. Framing over-regulation and regulatory fragmentation as the core reasons for this relative digital incompetence, the EU strives to “liberate” data for AI-driven innovation by simplifying and streamlining its data regulation rules. With fostering digital innovation in the EU as one of the main goals, there is little doubt that this approach favours the EU's digital transition. Its potential effect on the European green transition from a Pareto efficiency lens is, however, questionable, as neither the new data strategy nor its flagship regulatory instruments incorporate environmental sustainability as a data regulation objective (Santamaría Echeverría, 2025). When defining its vision, the strategy refers exclusively to sovereignty, secure and responsible data movement, AI, innovation, and competitiveness, with no mention of how the environmental sustainability dimension of data would be factored into this vision. The rest of the strategy does not do much better either in terms of embracing environmental sustainability as an essential aspect of the EU's approach to data.

The closest the strategy gets to addressing the environment is its mention of greener transport and energy services, environmental digitalisation, ecological monitoring, and green digital technologies among the objectives of the CEDS and its promise of a future Cloud and AI Development Act, which is expected to support and accelerate the roll-out of the EU's sustainable data centre infrastructure. Still, the potential contribution of these to the green transition, juxtaposed with a possible upsurge in the data-related environmental footprint to be induced by a potential burst in innovation, is unlikely to be significant. This suggests that the impact of the data strategy on the green transition is currently contingent on whether the environmental data-driven gains exceed the ecological footprint and rebound effects generated through increased data sharing, emphasising the role of the data sharing regulation in the achievement of the twin transition. Unless the green transition is embedded as “a normative compass” (Ducuing, 2020) for data regulation in a balanced and harmonious way with other legal principles and policy objectives, including the digital transition, the EU data strategy in its existing state is unlikely to support the European twin transition in a Pareto-efficient-like fashion as described in this article.

A more balanced integration of twin transition objectives into the EU data strategy may be achieved by embedding a form of “green conditionality” into data sharing regulation. Green conditionality is a concept that originated to describe the greening of international aid (Olmos Giupponi and Hofmeister, 2024) and generally refers to linking financial support, rights, or benefits to compliance with specific environmental sustainability requirements. In this context, it refers to connecting certain data sharing rights, obligations, and incentives to tangible contributions to environmental sustainability to ensure that data sharing advances both dimensions of the twin transition rather than favouring the digital over the green aspect. Accordingly, rather than treating environmental sustainability as an incidental factor in data regulation, future reforms should better ensure that data sharing demonstrably contributes to the green transition alongside digital competitiveness.

Potential measures may include prioritising or simplifying access to data where the intended use supports environmental sustainability objectives, such as climate change mitigation and adaptation, resource efficiency, biodiversity protection, circular economy, or transition to renewable energy sources. Building on the existing initiatives, such as the ODD's concept of high-value datasets, the EU can identify categories of environmentally relevant data, such as data on emissions, energy, mobility, and biodiversity, and subject them to enhanced interoperability and sharing measures that can foster their easier exchange and reuse. Furthermore, regulation can be used to incentivise the reuse of existing datasets before new data

is collected, thereby reducing unnecessary duplication of data and reinforcing the circular use of data as an economic resource.

This green conditionality approach could extend to data infrastructure and governance to address the ecological impact of data sharing, which could significantly limit the environmental gains it can deliver. As an example, large-scale data sharing operations and the use of data ecosystems such as the CEDS can be accompanied by environmental impact assessment requirements, encompassing energy consumption, carbon emissions, resource use, and potential rebound effects associated with increased data sharing.

The introduction of environmental performance standards for data sharing infrastructures, including requirements regarding resource efficiency, renewable energy use, and environmental impact reporting, may further ensure that the expansion of data sharing does not disproportionately heighten the ecological footprint of digitalisation. While the precise design and implementation of such measures would necessitate further legal and policy analysis, incorporating green conditionality into the EU data regulation may help rebalance the current emphasis on digital competitiveness and strengthen the capacity of the EU data strategy to facilitate a more Pareto-efficient twin transition.

5. Conclusion and outlook

Despite recognising the distributional function data sharing can play in data-driven value creation, the EU does not include the European twin transition as one of its priority areas to leverage this function for. While the EU's current approach to data may serve the twin transition to some degree through environmental efficiency gains, it also bears the possibility of undermining it by disproportionately increasing digital innovation at the cost of the environment. The latter may intensify the already existing imbalance between green and digital transitions and make achieving a Pareto-efficient twin transition virtually impossible, even from a theoretical point of view. On top of these, the lack of a strategic link and the existence of interoperability issues among the legal instruments that lay down the rules and limits of data sharing in the EU lead to a patchwork data regulation framework and curtail the potential of data sharing as a redistribution mechanism towards the twin transition.

The EU acknowledges this regulatory fragmentation and introduces several amendments through its Digital Omnibus proposal to coordinate some overlapping aspects of the data sharing regulatory framework. From a twin transition viewpoint, a closely relevant proposal of the Digital Omnibus is to merge the DGA's provisions on the reuse of protected data and the rules of the ODD in a single framework on data reuse under the DA. The Digital Omnibus further proposes to turn the regime for the data intermediaries under the DGA into a voluntary one and reduce the provider obligations, as well as to repeal the reporting and transparency obligations for data altruism organisations. While the reduced compliance requirements and streamlined rules may incentivise data intermediation services and data altruism, and thereby data sharing, they risk worsening the trade-off between data sharing and data protection by removing some important procedural safeguards, which may have a discouraging effect on these practices in a paradoxical way. On top of that, the Digital Omnibus proposes to narrow down the scope of the exceptional need mechanism under Article 14 of the DA to only "public emergencies," which may considerably restrict the functionality of one of the most critical provisions of the DA in terms of fostering the twin transition through data sharing.

The Digital Omnibus also does not fully address the uncertainty arising from the overlap between the GDPR and the data sharing frameworks of the DGA and the DA. Although it acknowledges the legislative fragmentation of the EU data regulation framework, its proposed solution appears to be limited to consolidating the rules on data reuse within the DA. This approach neither resolves the issues regarding the treatment of personal data in data sharing and reuse nor clarifies the interaction between the GDPR and the broader data sharing framework. Moreover, the proposal does not reconcile the differing terminology and legal concepts employed in these frameworks. As a result, an entity may continue to qualify simultaneously as a data controller or processor under the GDPR and as a data holder or user under the DGA and the DA, reflecting the distinct regulatory objectives pursued by each instrument. Overall, the

Digital Omnibus appears to amalgamate the data sharing framework rather than eliminate the conceptual ambiguity stemming from the coexistence of different legislations with occasionally competing objectives.

That said, these amendments are still at the proposal stage, and thus it is too early to foresee the impact of the Digital Omnibus on the distributional function of data sharing in the twin transition context. In any event, the possibility of a mutually reinforcing twin transition is conditional on filtering the EU's approach to data sharing through an environmentally conscious lens to balance the digital dimension with the green aspect in a Pareto-efficient-like manner.

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