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Industry Platforms: A New Mode of Coordination in the Economy

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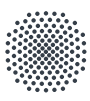
SOI Discussion Paper 2024-02

Industry Platforms

A New Mode of Coordination in the Economy

Ulrich Dolata



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SOI Discussion Paper 2024-02
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Abstract

This discussion paper is a plea for an urgently needed shift in perspective: from the concentration of social science research on the ubiquitous platforms of the consumption- and communication-based internet to the investigation of the platform-oriented reorganization of industrial distribution, production and innovation processes, which has so far received far less attention. The paper focuses on two questions. Firstly, what distinguishes industrial platforms from the platforms that characterize the consumption- and- communication-based internet? Can typical peculiarities and overarching characteristics of platform-based forms of work and organization in industry be identified? And secondly, do platforms represent an independent form of organization and coordination of industrial market, production and innovation processes that is substantially different from organized networks? The paper undertakes an empirical mapping and classification of the little explored field of industrial platforms and discusses from a theoretical-conceptual perspective why platforms should be conceived of as a sui generis form of organization whose dominant mode of coordination can be described as rule-based curation.

Zusammenfassung

Dieses Discussion Paper ist ein Plädoyer für eine dringend notwendige Perspektivverschiebung: Von der Konzentration der sozialwissenschaftlichen Forschung auf die im Alltagsleben allgegenwärtigen Plattformen des konsum- und kommunikationsbasierten Internets hin zur Untersuchung der weit weniger im Fokus der Aufmerksamkeit stehenden plattformorientierten Reorganisation industrieller Distributions-, Produktions- und Innovationsprozesse. Im Zentrum dieses Textes stehen zwei Fragen. Erstens: Was unterscheidet Industrieplattformen von den Plattformen, die das konsum- und kommunikationsorientierte Internet prägen? Lassen sich typische Eigenheiten und übergreifende Charakteristika plattformbasierter Arbeits- und Organisationsformen in der Industrie herausarbeiten? Und zweitens: Schält sich mit Plattformen eine eigenständige Organisations- und Koordinationsform industrieller Markt-, Produktions- und Innovationsprozesse heraus, die sich insbesondere von organisierten Netzwerken substanziell absetzt? Der Text unternimmt eine empirische Kartierung und Einordnung des noch wenig erschlossenen Feldes und erörtert in theoretisch-konzeptioneller Perspektive, warum Plattformen als eine Organisationsform *sui generis* begriffen werden sollten, deren dominierender Koordinationsmodus als regelbasierte Kuratierung bezeichnet werden kann.

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1 Introduction: From networks to platforms?

At the beginning of the 2000s, Hartmut Hirsch-Kreinsen (2002: 106) stated in an article reflecting the debates of the previous decade that the notion of "network" was advancing

> to become a prominent concept in the analysis of economic exchange processes at the most diverse levels. In this way, it is even gaining an extremely high significance for social science diagnoses of the present. Thus, from a social theoretical perspective, it is assumed that the various network forms are the moment of an emerging "network society" and that they have a lasting impact on the forms of regulation of future socio-economic processes. (Our translation)

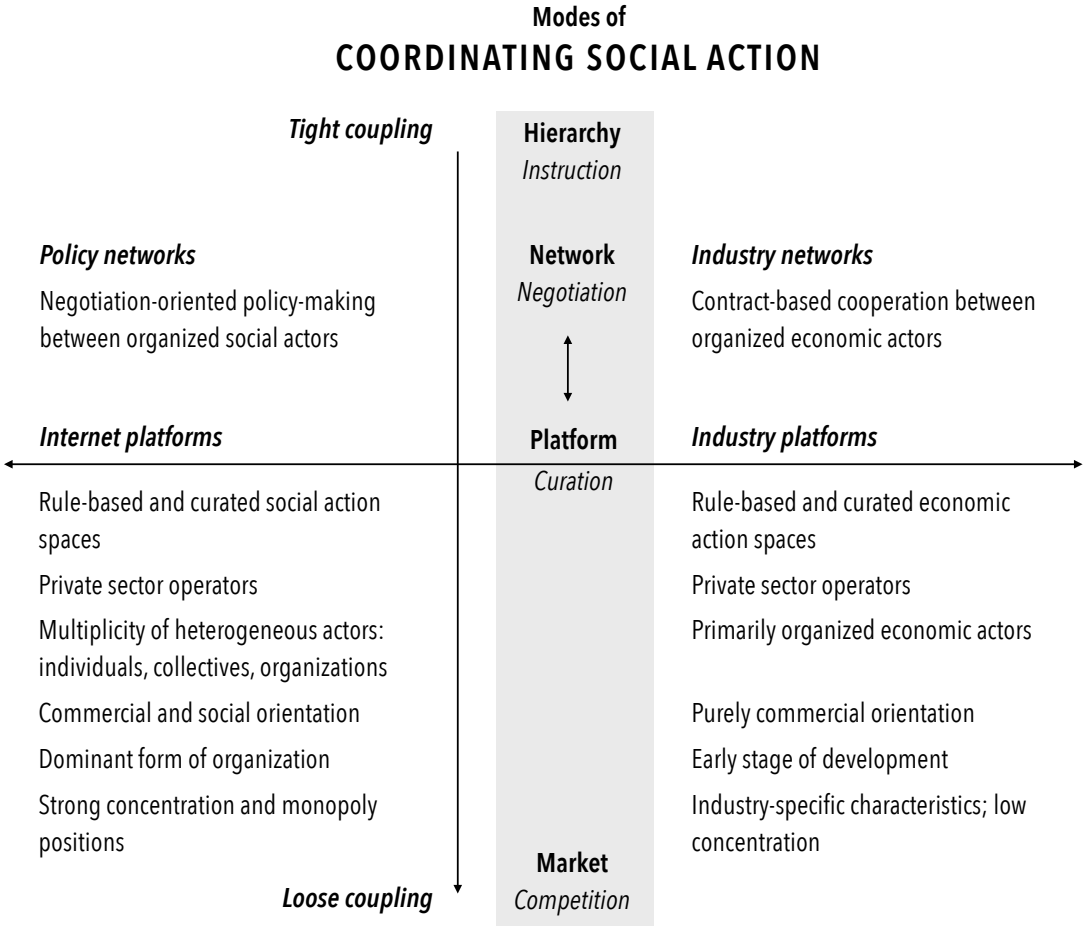
Apart from broad social concepts that were circulating, as they do in every *hype cycle* (*network society*; Castells 1996), the typical characteristics of negotiation-oriented policy-making and coordination processes were henceforth assigned the term "network" (*policy networks*; Marin and Mayntz 1991). Moreover, various forms of economic cooperation across corporate boundaries were being placed under this categorical umbrella. There, they were both empirically investigated and conceptually condensed as strategic (Sydow 1992), industrial (Axelsson and Easton 1992; Grabher 1993), research and innovation-oriented (Freeman 1991), or regional (Saxenian 1990) networks. From an institutionalist perspective, networks have been conceived as a substantially new and distinct mode of interorganizational coordination of action, ideally based primarily on negotiation and cooperation between different, often heterogeneous and usually organized social actors rather than on hierarchical instruction or market-based exchange (Nohria and Eccles 1992; Kenis and Schneider 1996).

If, in the opening quote, the term "network" was replaced with "platform", everything else remaining unchanged, we would have a fairly accurate summary of the discussions about platforms that have been going on in the economic and social science disciplines since around the mid-2010s. More recently, some researchers have been identifying the emergence of a "platform society" that is characterized above all by the platform-based internet and the digital platforms of the leading tech corporations (Van Dijck, Poell and de Waal 2018). Others describe the rise of a platform capitalism (Srnicek 2017) or a platform economy that is significantly transforming value creation processes, economic structures and innovation activities, "all of which are about to undergo their biggest changes in the post-war era" (Kenney et al. 2019: 871; Parker, Van Alstyne and Choudary 2016). Depending on the focus of observation, digital platforms themselves are conceived of as software-based infrastructures (De Reuver, Sörensen and Basole 2018), as multi-sided economic markets (Evans and Schmalensee 2016), as sprawling ecosystems with countless interrelated actors and their own governance structures (Hein et al. 2020; Kretschmer et al. 2020), or as social action spaces created and regulated by the platform-operating companies (Dolata 2022; Dolata and Schrape 2023). Finally, platform companies—and virtually all relevant digital platforms are privately operated commercial offerings—have been elevated by prominent parties to the rank

of a new type of company shaping the digital age and characterized either as the "dominant organizational form of the digital age" (Gawer 2022; also Davis 2016) or as the "21st century ideal type of the firm" (Rahman and Thelen 2019: 198).

I chose to introduce this paper with this stylized comparison of the social science debates on networks and platforms as it is emblematic of the two tracks to be pursued throughout this text, which is exploratory and intended to open up new research perspectives (Figure 1).

Figure 1: Modes of coordinating social action: market, hierarchy, network and platform



Source: Own reflections

The first track concerns the status or perspective of platform-based companies, organizational forms and ecosystems in the economy. If platforms are to be the dominant organizational form of the digital age and the defining type of company of our time—as the above quotes suggest—researchers would do well to empirically examine and identify the typical characteristics and relevance of platform-based organizational patterns in the economy as a whole—in other words, not only in the internet economy but also in leading industrial sectors. However, up until now this has hardly been done.

Instead, economic and social science platform research has focused primarily on the large and small digital platforms of the consumer- and communication-based internet alongside their commercial operators. This includes the leading U.S. tech corporations Alphabet (Google), Amazon, Apple and Meta (Facebook) with their extensive socio-technical ecosystems, the countless more specialized second-tier platform companies such as Uber, Airbnb, Netflix, Spotify and X (Twitter), as well as all the volatile delivery and service offers. In contrast, research on industry platforms or, more precisely, on new platform-based forms of organization in the manufacturing sectors is still in its infancy, having so far spawned relatively few studies to build on. Among the latter are: Pauli, Fielt and Matzner 2021; Jovanovic, Sjödin and Parida 2022; Butollo and Schneidemesser 2021, 2022; Obermaier and Mosch 2019; Lerch et al. 2019; Ziegler 2020; and Hoffmann, Schröder and Pasing 2021.

The second track that is laid out by the opening quote pursues the theoretical-conceptual question of the extent to which platforms are a new, specific mode of coordinating action and how this differs from the other known forms of coordination, especially inter-organizational networks. In the context of industry, the question is: How do platform-like organizational patterns differ from cooperatively designed and contractually framed industrial networks that have been spreading in production, distribution and research and development (R&D) in numerous economic sectors since the 1980s and that have been empirically studied in detail (Hagedoorn 1993, 1996; Hagedoorn and Schakenraad 1991)? To make such a categorical differentiation is far from irrelevant. If the concept of platform is to make sense as a distinct, theoretically robust and empirically manageable sociological category, then the question inevitably arises of whether platforms are a sui generis form of organization, in other words, a specific form of economic activity and social exchange that can be meaningfully classified between hierarchy, market and network—in which case they would have to be based on a distinct, definable mode of coordination. While some studies seek to substantiate this notion (e.g., Stark and Pais 2020 or Kretschmer et al. 2020), hardly any provide systematically developed arguments on this topic.

I analyze these two tracks with two main goals in mind. One is to collect, sort and systematize the empirical and conceptual findings of previous research on industry platforms. On this basis, I discuss typical variants and peculiarities as well as differences to platforms and platform companies on the consumption- and communication-based internet. My intention is to contribute to mapping this still little explored field and to shift the focus of attention to the analysis of platform-like organizational structures in industry. The second goal is to examine the extent to which platforms or platform-based organizational and regulatory structures constitute a new and specific form of coordination and how this could be formulated in terms of action theory. Through this, I will contribute to the theoretical-conceptual grounding and analytical specification of the concept of platform (Section 4). However, before embarking on these two tracks, I will

provide a brief overview of approaches and concepts in economic and social science platform and ecosystem research that are important for the discussion in this context (Section 2) and then briefly summarize what we know for certain about the sociotechnical architectures, variants and regulatory patterns of internet platforms (Section 3).

This paper is not a preprint of a completed study with final results. Instead, it is a discussion paper in the true sense of the word: It comprises the exploration, mapping and classification of a little explored field of research, with all the pitfalls and gaps that this entails.[1] In line with this, the final Section 5 primarily provides an outlook on relevant starting points for further research on the topic.

2 Conceptual starting points: Platforms, ecosystems, social action spaces

The notion of platform is one of those inclusive and vague umbrella terms that can be concretized in a wide range of ways. In the following, I call upon selected conceptual approaches as a way to engage with the topic under discussion in a step-by-step manner.

In a technology-centric perspective, digital platforms are conceptualized as software-based, programmable and algorithmically structuring systems on which countless specific technical applications can be built. Tiwana (2014: 7) defines platforms in this sense as

> extensible codebase of a software-based system that provides core functionality shared by apps that interoperate with it, and the interfaces through which they interoperate.

While writings aligned with this perspective do at times mention the many social (normative, regulative) inscriptions in the software of these technical systems (e.g., Kitchin 2014: 21−26), their overall focus is not on who actually socially constructs and implements the technical systems or on how this is done.

Important in this context is the description of the basic architecture of platforms as an interplay between two constitutive levels: a stable, tightly coupled and code-based core and a variable, flexible and volatile periphery that is coordinated by that core. Both levels are linked by rule-based interfaces. At the end of the 2000s, Baldwin and Woodard (2009: 19) had already characterized corresponding architectural concepts as being typical for platforms in the economy as well, for example, in the form of multi-sided markets or modularly designed and correspondingly easily modifiable product developments:

---

[1] I wish to thank Ann-Kathrin Radig for additional research and stimulating discussions. Of course, she cannot be held liable in any way for what I have made of it.

> The fundamental architecture behind all platforms is essentially the same: the system is partitioned into a set of "core" components with low variety and a complementary set of "peripheral" components with high variety. The low-variety components constitute the platform. They are the long-lived elements of the system and thus implicitly or explicitly establish the system's interfaces, the rules governing interactions among different parts.

This basic notion of the formal architecture or structuring of platforms as consisting of a core, periphery and interfaces implicitly or explicitly forms the essential foundation of economic conceptualizations of commercial platforms and their ecosystems.

In the field of industrial organization in particular, organized two-sided or multi-sided markets were initially conceived as platforms on which the platform operators act as intermediaries or matchmakers bringing together at least two different market actors: sellers and buyers, users and advertisers (Rochet and Tirole 2003; Evans and Schmalensee 2005, 2016). Typical for many of these markets are network effects with concentration-promoting impacts. The more a platform is used and the more active members it has, the more interesting it becomes, and not only for additional users. The number of regularly active users on one side of the market also increases the commercial attractiveness of the platform for advertisers, retailers or other providers on the other side of the market. This basic principle of multi-sided markets is longstanding and has been constitutive for many economic sectors, among them media sectors such as books, music, magazines, radio and television, the wholesale trade, or the travel and ride-share industry, some of which have been fundamentally restructured on a new technical basis during the course of digitalization (Haucap and Stühmeier 2016; Viscusi, Harrington and Sappington 2018: 383−431).

In economics, however, platforms have long ceased to be primarily understood as multi-sided markets (Cusumano 2022). In strategic management research in particular, they are now conceptualized as meta-organizations and ecosystems in which the platform owner has the organizing and rule-setting authority. As such, they are seen to have a stable core around which an extensive network of countless economic actors is grouped who can act and relate to one another relatively independently along the platform rules laid down within the framework of the ecosystem. Among the wealth of literature on this topic, I refer to the articles by Gawer and Cusumano (2013), Kretschmer et al. (2020), Hein et al. (2020), McIntyre et al. (2021) and Kapoor et al. (2021). This new organizational form of larger economic contexts can be succinctly summarized as follows:

> A digital platform ecosystem comprises a platform owner that implements governance mechanisms to facilitate value-creating mechanisms on a digital platform between the platform owner and an ecosystem of autonomous complementors and consumers. (Hein et al. 2020: 90)

The identification of a typical form of action coordination that could characterize platform ecosystems is concretized primarily in distinction to hierarchical organizations on the one hand and markets on the other hand, and is located between these two poles:

> Platforms "are less formal and less hierarchical structures than firms, and yet more closely coupled than traditional markets." And: "Platform ecosystems are characterized by a large collection of relationships that are neither as limited and specific as spot market contracts, nor as enduring and extensive as those within a hierarchical organization. They can be viewed as hybrid structures between organizations and markets, providing a mixture of market-based and hierarchical power, and a mixture of market-based and hierarchical incentives. (Kretschmer et al. 2020: 405, 407)

For sociological platform research, these works are stimulating and useful in several respects. They argue in an actor-centered and institutionalist manner and they present differentiated reflections on the complex socioeconomic architectures, actor figurations and power relations, and coordination, control and governance structures of platform ecosystems. In all of this, they have a focused view on the exploitation-oriented foundations and mechanisms of platforms, which are, after all, usually privately operated. This is a focus which sociological platform research very often lacks. Nonetheless, strategic management research on platforms has some—by no means irrelevant—gaps and fuzziness.

First, the heterogeneity and diversity of commercial platforms tends to be overlooked. Although research offers a number of typifications, it offers virtually no systematic distinction between commercial platforms in the consumer- and communication-based internet and platforms in the manufacturing industry. This is despite the fact that the two areas show a number of substantial differences at first glance even, such as in terms of actor figurations, orientation, reach, structure or institutional framework (Fig. 1). For examples of this shortcoming, see Cusumano (2022), Gawer (2021: Fig. 2) or McIntyre and Srinivisian (2017: 141).

Moreover, the focus in economic platform research on economic (trans)actions and value creation processes is too narrow to adequately capture and classify—both empirically and theoretically—those commercial platforms that go far beyond economic contexts and constitute genuine social structures. While platforms in industry have a purely commercial orientation and, as quasi-market oriented ecosystems, are primarily used by economic actors, many privately organized platforms of the consumption- and communication-based internet are much more than that: they also constitute and regulate non-economic social life, in some cases on a large scale; often exercise quasi-sovereign functions; and are used not only by companies and paying consumers but also by countless individual users, organizations of various kinds and social collectives (such as communities and movements) that often operate on these platforms without any commercial intent (Dolata 2022).

Finally, a gap needs to be identified. When discussing the specific forms of coordination in platform ecosystems, they are usually placed between market and hierarchy (as in the above quotation by Kretschmer et al. 2020). As a result, cooperation-oriented networks, which are based on coordination through negotiation and agreements between different actors, are overlooked as a third ideal-typical basic mode of co-

ordinating action. This is remarkable given a long-standing tradition of intensive research on the characteristics and variants of organized cooperative relationships in industry that could be referred to and built on (from the classical portfolio, e.g., Freeman 1991; Sydow 1992; Axelsson and Easton 1992; Nohria and Eccles 1992; Grabher 1993). If the goal is to identify distinct organizational and coordination patterns of platforms, then the essential question is not where they are to be located between hierarchy and market but rather how they relate to cooperatively designed and contractually framed production, innovation or distribution networks. This is where the decisive difference must be sought if platforms are to be understood and concretized as a specific mode of action coordination.

Research in economic and organizational sociology on platforms as a specific form of organization and coordination of economic and also social action has so far focused on privately operated platforms and ecosystems in the consumption- and communication-based internet (e.g., Van Dijck, Poell and deWaal 2018; Van Dijck 2021; Stark and Pais 2020; Dolata 2022; Dolata and Schrape 2022a, 2023; Kirchner 2023; Ametowobla and Kirchner 2023). Sociological studies of platforms in industry, on the other hand, are almost non-existent, with a few exceptions already mentioned in the introduction.

Unlike economic studies, sociological research does not view commercial internet platforms and their ecosystems as purely economic constellations, instead expanding the scope of vision to include their social or societal dimension, which is neglected in economics. This aspect is particularly evident in the case of the large social media and communication platforms of the internet:

> The platform ecosystem (...) is moored in paradoxes: it looks egalitarian yet is hierarchical; it is almost entirely corporate, but it appears to serve public value; it seems neutral and agnostic, but its architecture carries a particular set of ideological values. (van Dijck, Poell and deWaal 2018: 12)

Although they are privately operated and profit-driven, the actor figurations, patterns of communication and interaction, and structures of order and regulation of commercial internet platforms extend far beyond the organization of economic processes and reach deep into the structuring of social and societal relationships. From this perspective, the operators of many digital platforms not only organize and regulate economic exchange and markets but have also taken on essential social order and regulatory functions on the internet with their rule-setting and curating services. In other words, commercially operated platforms and ecosystems, at least with regard to the consumption- and communication-based internet for which they are now constitutive, are understood not merely as market structures but as broader social and societal structures.

The manner in which the specific sociotechnical architecture and organization of digital platforms has been conceptualized in recent sociological works resembles that of strategic management research: as an interplay between a stable core and a variable

periphery with interfaces linking these two levels (e.g., in Kirchner 2023; Ametowobla and Kirchner 2023). In the works which I have published in recent years, either alone or together with Jan-Felix Schrape (Dolata 2019, 2022; Dolata and Schrape 2022a, 2023), we too adapted these formal notions of architecture and translated them into sociological terms. This has engendered a two-level architecture of commercial internet platforms consisting of the platform-operating companies as organizing cores and their associated platforms. We conceive of these platforms as social action spaces that in part extend far beyond their respective corporate context. These two levels are held together by social rules transformed as comprehensively as possible into technical instructions, which are set and enforced to a decisive extent by the platform operators:

> Internet companies and the platforms they own need to be understood as a new type of enterprise, namely one that consists not only of economic characteristics and market relations between economically relevant actors but, at the same time, of action-orienting social rules, institutional settings and social relations between a great variety of individual, corporate and collective actors that reach well beyond economic contexts and far into society. To this end, we specify the often vaguely used notion of "platforms" in making an analytical distinction between (1) the platform-operating companies as *organizing and structuring cores* whose goal is to operate a profitable business; (2) the platforms belonging to them as more or less extensive, strongly technically mediated *social action spaces* not only for economic but also for genuine social activities; and (3) the institutionalized *coordination, control and exploitation mechanisms* implemented by the platform operators, linking these two constitutive levels of the platform architecture. (Dolata and Schrape 2023: 4)

Finally, the question of whether platforms constitute a specific mode of action coordination and how this can be concretized is answered quite differently in the sociological debate. Whenever this question is raised at all, it has been answered only tentatively rather than with thorough argumentation. David Stark and Ivana Pais, for example, define platforms as a "new form of social organization" (2020: 53) and assign it a specific mode of action coordination, which they call "co-optation":

> Whereas actors in markets *contract*, hierarchies *command*, and networks *collaborate,* platforms *co-opt* assets, resources, and activities that are not part of the firm." (Ibid.: 47) That is, "Platforms leverage physical assets, R&D, workforce, salesforce, market research, and the creative energies of customers not by making or buying but by the Möbius strategy of co-opting. (Ibid. 53)

In contrast, we have argued that internet platforms, and only those we are concerned with here, are difficult to reduce to a single and exclusive mode of coordination. They are instead characterized—similar to how Renate Mayntz (2004) described the fluid organizational forms of new terrorism some twenty years ago—by an asymmetrically constituted combination of hierarchical and participatory coordination features:

> The coordination, control and exploitation mechanisms typical of internet-based platform architectures are characterized by a strong hierarchical orientation in which elements of cooptation and orchestrated participation of users are embedded. (Dolata and Schrape 2023: 14)

Before pursuing these questions in more detail, in Section 3 I express what I see as the typical characteristics and organizational forms of commercial platforms in the

consumption- and communication-based internet, and then use this as a basis for a literature and research-based field exploration of platform-based forms of organization and coordination in industry in Section 4.

3 Concretizations: Commercial platforms on the internet

Today's internet is platform-based.[2] It is characterized by a great variety of mostly commercially operated platforms, such as search, networking, messaging, media, trading, service, crowdsourcing or crowdfunding platforms. The common ground between these platforms is that they can be characterized as digital, data-based and algorithmically structuring sociotechnical infrastructures through which information is exchanged, communication is structured, work and markets are organized, a broad spectrum of services is offered, or digital and non-digital products are distributed.

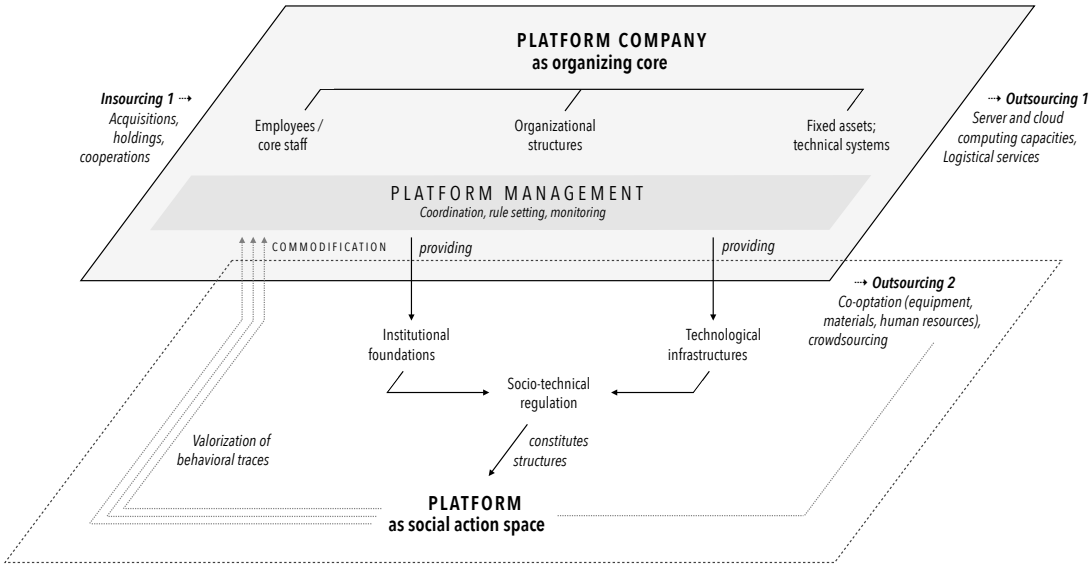
As technical infrastructures, they are based primarily on new possibilities for collecting and processing large volumes of data, the comprehensive digital interconnectivity not only of media, information and communication but also of material things, as well as the sorting and coordination of these processes by learning algorithms. At the same time, all internet platforms are characterized by a strong and action-orienting institutional basis that is shaped by social rules and norms formulated and defined by the platform-operating companies (e.g., terms and conditions, community standards, developer guidelines and market rules) as well as the comprehensive inscription of these rules in the technical foundations of the platforms (e.g., in the form of default settings, technical features and, above all, algorithmic structuring, rating, ranking and monitoring systems).

Beyond this lowest common denominator, the field is structured quite heterogeneously. A rough distinction can be made between two main types of consumption- and communication-oriented internet platforms. The leading internet groups Alphabet, Amazon, Meta and Apple offer a broad spectrum of coordinated and interconnected services and businesses which they have expanded into extensive sociotechnical ecosystems that extend far beyond their traditional field of activity. It is not only countless individual users but also numerous corporative players such as companies, media producers, state institutions and other platform companies who rely on their services. In contrast, many other internet companies offer more specific services on their platforms. As a rule, these are singular and specialized offerings that are either consumption-

[2] This section is based on the research on the political economy of the internet and of platforms conducted by myself and, often, in collaboration with Jan-Felix Schrape at the Department of Organizational and Innovation Sociology at the University of Stuttgart from the mid-2010s: Dolata 2015, 2018, 2019, 2020, 2022; Dolata and Schrape 2018; 2022, 2022a, 2023, 2023a.

based, such as ride services, travel bookings, room agencies, video-on-demand services and shopping portals, or communication-oriented, such as X (Twitter) or TikTok.

Figure 2: Platform companies and platform as a hybrid configuration



Source: Dolata/Schrape 2023

Following the work referred to in Section 2, we have summarized the typical sociotechnical structure of commercial internet platforms (Figure 2) as an interrelated two-level architecture held together by a specific form of action coordination. The organizational core of the architecture here is typically a focal enterprise that owns the platform. At this level, the basic social structures and rules are developed and inscribed in the technical infrastructures that provide a general framework for the activities and interaction possibilities of the users on their platforms—including sanctioning and exclusion options in the event of rule violations. Thus, the platform companies do not simply function as coordinating intermediaries offering neutral technical services, but as rule-setting and rule-enforcing actors. In addition, all interaction and transaction data converge in the companies. This data that initially accrued as raw material through the seamless observation of user behavior on the platforms and is owned by the companies, is converted into a commodifiable form through additional processing in the companies.

The platforms themselves are an elementary component of the companies that own them and without which they could not operate their business. At the same time, however, they clearly extend beyond the platform companies. As social action spaces, they constitute an independent second level of this configuration that is more or less closely linked to their organizing cores and on which social actors of the most diverse provenance can act and relate to one another in specific figurations and, on the basis of the respective platform rules, in a more or less open or narrow manner—not only as economically active actors (sellers, buyers and consumers) but also as individuals,

collectives and organizations who conduct many of their non-economic activities and communications via these platforms.

The various digital platforms can take on very different forms as social action spaces, as Table 1 shows. The countless consumption and service spaces that have been transferred to the internet are not particularly spectacular—they sell and provide services just as their predecessors had done, albeit on a new technical basis. In contrast, the far-reaching social media and messaging platforms operated by leading internet corporations, which constitute no less than the essential foundations of sociality on the internet, as well as the large corporate-owned marketplaces, which can be characterized as privately regulated and sociotechnically constituted market orders on the web, are historically unprecedented.

Table 1: A typology of internet platforms as social action spaces

	Social spaces	**Market spaces**	**Consumption spaces**	**Service spaces**
Examples	*Facebook, Instagram, YouTube, Twitter, TikTok*	*Amazon Marketplace, App Stores;* *Airbnb, Upwork*	*Amazon, Zalando, Otto;* *Netflix, Spotify, Apple Music, Amazon Video*	*Uber, Lyft;* *Just Eat Takeaway, Delivero Hero*
Actors	full spectrum of social actors	customers; co-opted providers	customers; cooperating providers	customers; cooperating providers
Figuration of actors	plural	triangular	bilateral	bilateral or triangular
Access	low-threshold; specific rules for users and commercial providers	low-threshold on the customer side; access or exclusion conditions for commercial providers	customer side low-threshold or dependent on subscriptions; commissioning or licensing of external offers	open on the customer side; low-threshold access for commercial providers
Reach	constitution of social order on the internet	organization and regulation of proprietary markets	organization and structuring of consumption offers	organization and structuring of services
Economic basis	personalized advertising	commissions, sale of own products	trade revenue; subscription; advertising	fees, commissions
	commodification of behavioral traces			

Source: Dolata/Schrape 2023

These two levels are interlinked by a mode of action coordination that I call *rule-based curation*. This mode consists of a specific combination of different coordination mechanisms and encompasses both the interaction of the two levels of the platform architecture described here and the possibilities of action of the highly diverse users on the platforms themselves. The exchange between the two levels takes place primarily via carefully crafted general terms and conditions that regulate in particular users' access

to the platform and the transfer of rights to the platform operators. These terms and conditions are non-negotiable agreements between the platform companies and the users that are set unilaterally by the companies and that must be accepted by the users. This basic foundation, which is characteristic of all internet platforms, is supplemented by specifying rules such as community standards, partner programs, developer guidelines, market and compensation rules, as well as tightly meshed performance control systems. Together, these specifying rules structure and regulate the concrete possibilities for action of the platform users. As elsewhere, they are not typically negotiated between different actors, being instead set and enforced by the platform companies in the form of instructions.

In this configuration, the platform companies have a high degree of structure-giving, rule-making and controlling power. Paradoxically, for all the supposed freedom of access and movement of the users, this mode of rule-based curation exhibits a remarkable renaissance of hierarchically designed regulation and control mechanisms in which elements of orchestrated participation of the participants are merely embedded—for example, in the form of decentrally distributed rating and control systems through which both evaluation and monitoring activities are delegated to the platform participants (users as well as providers).

The general structural pattern of commercial internet platforms outlined here—with a company as the organizing and regulating core and a more or less extensive social sphere of action as a playing field for a variety of activities—differs substantially from networks as organized cooperative structures between a definable number of corporative actors. Industrial production, innovation or distribution networks are characterized by contractually secured cooperative relationships between independent economic organizations whose rules are agreed upon by the participating actors in more or less symmetrically structured negotiations. In contrast, the platform architectures outlined here are more open, the actors involved are more heterogeneous and the platform-specific regulation, control and exploitation mechanisms are significantly more complex. It is not only economic processes in the narrower sense that need to be organized and coordinated here but also social relationships of all kinds. This is not done primarily through formal contractual relationships but through the development and enforcement of generally applicable rules to which users must adhere.

In addition, the structural pattern of commercial internet platforms outlined here also differs significantly from platform-like forms of organization and coordination in industry, as I will explain in the following section.

4 Field exploration: Platforms in industry

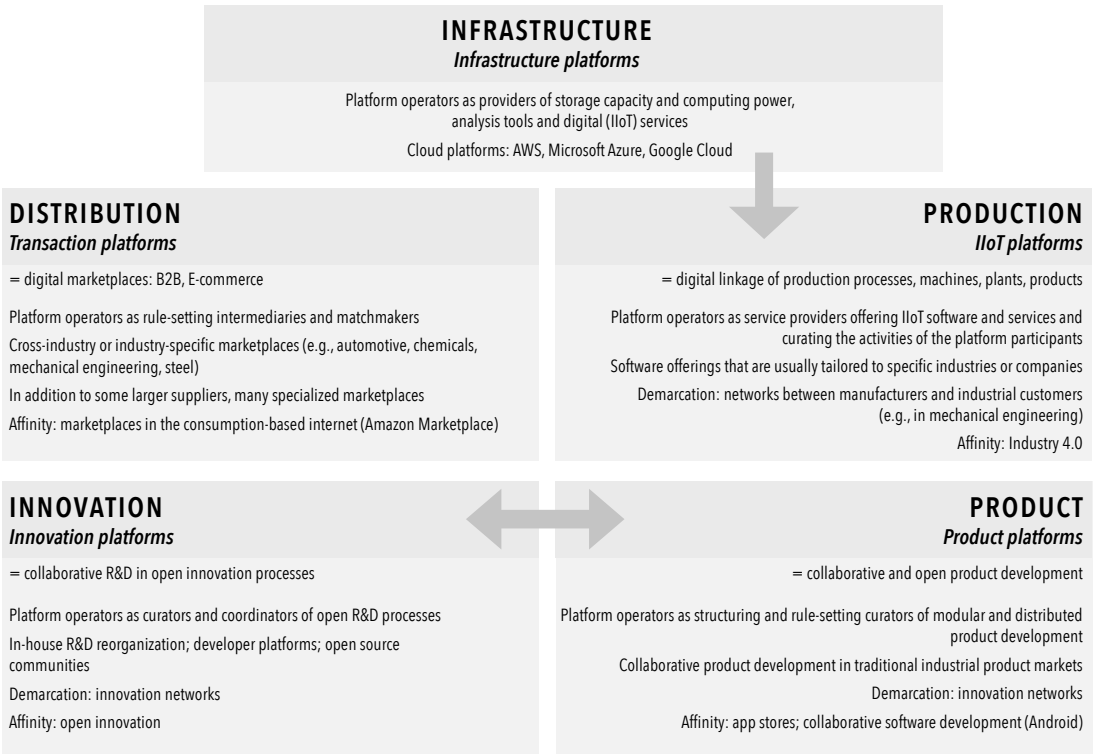
4.1 Research

While platforms on the consumption- and communication-based internet have developed into the central mode of organization and coordination of economic exchange and social action over the course of the 2010s, nothing comparable can be said for the core areas of the manufacturing industry. The few empirical studies that are available on this topic so far show that despite growth dynamics, "the manufacturing sector is still a long way from a platform economy" and, furthermore, that the B2B trading platforms in the corporate sector, which have existed for some time and have been consolidated, "still do not yield the same economic effects as are known from the platform economy in the consumer sector" (Lerch et al. 2019: here 5, 25; our translation. See also Hoffmann, Schröder and Pasing 2021; Fritsch and Lichtblau 2021; EFI 2022: 80−93).

Likewise, research explicitly dealing with the sociotechnical peculiarities, variants, actor figurations and regulatory modes of platforms in industry has been eclipsed by the enormous academic attention which internet platforms have attracted in the past decade. To date, this research has been strongly influenced by economic studies—with all the advantages and weaknesses already mentioned—and is characterized by a correspondingly tailored portfolio. In addition to solid empirical works such as those aforementioned, which give a first impression of the (so far limited) ranges, variants and perspectives of platform-based forms of organization in the manufacturing sector, this portfolio exhibits various, not always coherent attempts at typification and classification (e.g., Obermaier and Mosch 2019; Gerrikagoitia et al. 2019; Haucap, Kehder and Loebert 2020; Hoffmann, Schröder and Pasing 2021; Butollo and Schneidemesser 2021; Sydow and Auschra 2022). In addition, there are considerations on the specific structure and governance of platforms and ecosystems, although these are not always specifically tailored to industry platforms (e.g., Kretschmer et al. 2020; Jovanovic, Sjödin and Parida 2022), and on the relationship between industrial companies as established players in the respective field, start-ups as newcomers, and digital platform companies as challengers (e.g., Pauli et al. 2021). Furthermore, there are reflections on the questions of trust and (data) security that are important in the specific context of industry platforms, on the interplay between cooperation and competition, or on the relationship between openness and control in platform organization and regulation (e.g., Hein et al. 2020; Parker, Van Alstyne and Jiang 2017). Some of these questions have already been raised in the discussions about industry networks in the 1980s and 1990s, as previously alluded to (see, e.g., the overviews in Sydow 2001; Ortmann and Sydow 2003; Dolata 2003: 35−81). However, to date, there is a lack of reconstructive case studies or case comparisons on individual companies or platforms that offer a certain level of substance and sustainability—such as those presented, from an organizational sociological perspective, by Ziegler (2020: 192−283) on the digital and platform-oriented restructuring of the Bosch Group (see also Jovanovic, Sjödin and Parida 2022).

In the following, I turn to the available literature, supplemented by my own initial empirical research, to examine the questions of typical variants and characteristic peculiarities of platform-based forms of organization in industry from a sociological perspective. I am particularly interested in the specific sociotechnical features (or architectures) and institutional framings as well as the actor figurations and power configurations that emerge in the various manifestations of industrial production, distribution or innovation platforms. Looming in the background are also the questions of how industry platforms differ from internet platforms and how platforms differ from networks.[3]

Figure 3: Types of industry platforms



Source: Own reflections

4.2 Types

As in the consumption- and communication-based internet, there is no one-size-fits-all platform model in industry. Instead, there is a broad spectrum of platform-based forms of work and organization which are difficult to clearly distinguish from one another. In addition, many of the developments in this sector are still in their infancy, such that sociotechnical structures and institutional settings are only vaguely recognizable in some cases. This is the background against which I will present an overview

[3] This section has benefited greatly from discussions with Dzifa Ametowobla, Florian Butollo, Felix Gnisa, Gregor Kungl, Ann-Kathrin Radig, David Seibt, Jan-Felix Schrape and Alexander Ziegler during an informal workshop on industrial platforms in 2022 at the University of Stuttgart.

of what I consider to be the main variants and structural patterns of digital platforms in industry as a technically mediated but in its essence social form of organization and coordination and lay out some pathways for further research on this topic (Figure 3).

IT infrastructure: Infrastructure platforms (cloud)

Infrastructure platforms are primarily the cloud offerings of leading technology groups, which, in addition to leasable storage capacity and computing power, now also provide their major business (and other) clients with numerous individually tailored digital services, analysis and development tools with which they can work. Setting up, operating and expanding the material IT infrastructures of cloud platforms is extremely investment- and capital-intensive. As a result, the number of major platform operators in this field is manageable. In this already established and internationally highly concentrated market, the main players in the Western world are Amazon Web Services (AWS), Microsoft Azure and Google Cloud, while they are Huawei and Alibaba in the Chinese market (Table 2).

Table 2: Cloud providers – economic key figures 2022

Group	Revenue IaaS cloud services (in billions of U.S. dollars)	Market share (in %)
Amazon Web Services	48,126	40.0
Microsoft Azure	25,858	21.5
Google Cloud	9,072	7.5
Alibaba Group	9,281	7.7
Huawei Cloud	5,249	4.4
Other	22,746	18.9

Source: Gartner 2023; Annual Reports 2023

Initially, cloud platforms were primarily a means of outsourcing internal IT infrastructures for the companies using them: instead of having to build and expand their own storage and data management capacities at great expense, they could outsource their digital resources on a large scale to external server parks (Infrastructure-as-a-Service: IaaS). In the meantime, the platform operators also offer a wide range of specialized services around this basic service, such as database, management, analysis or development tools. Their paying customers rent these services and use them to continue working independently on the cloud platforms as well as develop, or have developed, applications tailored to their own company—right up to larger technical integration projects such as the digital linkage of production processes, machines and systems (Software-as-a-Service: SaaS). The major cloud providers have thus developed into full-service providers of basic infrastructure services and, building on that, of other specialized IT

services (Platform-as-a-Service: PaaS) (Obermaier and Mosch 2019: 405−407), which are not only used by internet companies such as Netflix, Spotify, Uber or Airbnb but also by numerous large industrial companies such as Volkswagen and Siemens (Ziegler 2020a: 71−78).

Production: Industrial Internet of Things platforms (IIoT)

The companies that operate IIoT platforms basically do what the large cloud platforms now also do. With their IT software and consulting offerings, they support strategies of web-based linkage, control, monitoring and maintenance of industrial production processes, machines and plants. They thus serve strategies that have been known since the emergence of the transformation debates surrounding the Fourth Industrial Revolution (Industry 4.0) narrative (Pfeiffer 2017; Butollo and Schneidemesser 2021a: 541−543). Similar to cloud platforms, the aggregation, processing and integration of machine data or the monitoring, linkage and control of production processes are to take place via these platforms, which basically function as operating systems for the software offered and used there (Krause et al. 2017: 12−21).

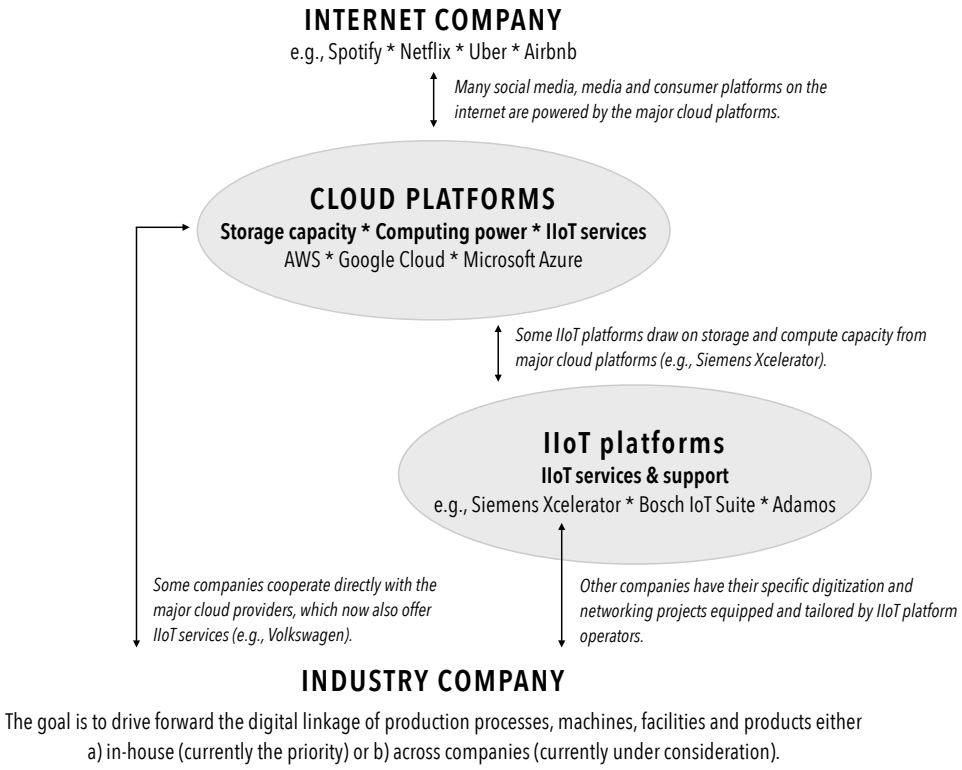
Table 3: Selected IIoT platforms and their offerings

Company	**Area**
AWS IoT	Platform for device software, connectivity and control services, analytic services; AWS Marketplace for third-party providers.
Microsoft Azure IoT	Platform for automated interconnection of devices and systems; remote monitoring of all machines and devices.
Xcelerator (Siemens)	Cross-industry platform for IoT-enabled software and hardware solutions and services; ecosystem for collaboration between customers, Siemens and certified partners.
Bosch IoT Suite	Open software platform for connecting devices and machines (e.g., cars or buildings); part of the Bosch IoT Cloud.
ctrlX Automation (Bosch Rexroth)	Open source-based platform for flexible automation applications (e.g., building automation, goods logistics).
Schaeffler Optime	Automated condition monitoring of industrial plants.
Toii (thyssenkrupp Materials Services)	IIoT platform for machine and production data acquisition and linkage of machines of all generations and manufacturers.
Adamos (consortium of engineering and software companies)	IIoT platform for connecting machines and devices as well as for developing own applications; primarily targeted at small and medium-sized enterprises that cannot build their own platform.
SAP Internet of Things	Platform to support the deployment of connected machines, devices and sensors as Software-as-a-Service via the SAP Cloud; termination of service on July 15, 2022.
Google Cloud IoT	Termination of service on August 16, 2023.
IBM Watson IoT	Termination of service on December 1, 2023.

Source: Own compilation (July 2023)

IIoT platforms and the markets forming around them are still at the beginning of their (potential) careers. The field of platform providers is heterogeneous and far from consolidated. In addition to a number of large players with a broad IoT portfolio, such as Amazon, Microsoft, Siemens or Bosch, it also consists of numerous other companies specializing in more focused solutions (Table 3). However, even larger companies are sometimes finding it extremely difficult to gain a foothold in this market. Siemens, for example, failed with its initial attempt to enter the field with its IoT platform Mindsphere, and is now trying it again with its successor Xcelerator. Google, for its part, completely shut down its IoT cloud with all the software solutions and services offered there in mid-2023 and recommended that its customers migrate to other providers (https://www.heise.de/news/Internet-der-Dinge-Google-schickt-seine-IoT-Cloud-aufs-Abstellgleis-7222369.html?view=print; accessed July 5, 2023). IBM also discontinued its Watson IoT service at the end of 2023, and SAP ended its SAP Internet of Things as early as mid-2022 (https://www.computerwoche.de/a/ibm-wirft-watson-iot-plattform-aus-seiner-cloud,3613237; https://www.computerwoche.de/a/ist-der-internet-of-things-hype-schon-vorbei,3613359; accessed September 13, 2023).

Figure 4: Infrastructure- and production-oriented platforms in industry



Source: Own reflections

Nonetheless, fundamental market, competition and cooperation configurations on this new and volatile playing field of the digital transformation of industrial production have begun to take shape (Figure 4).

On one side of this market there are the industrial companies—so far still large enterprises rather than small and medium-sized companies (Lerch et al. 2019: 22−25)—that are in a process of gradual sociotechnical restructuring and that require individually tailored software services for their digital transformation that they are unable to develop, implement or operate themselves. To obtain these services and solutions, the companies rent individually tailored IT services via leasing contracts (together with corresponding support). As part of this process, they have to transfer sensitive data to the platform operators on a large scale, without which the software-as-a-service offerings running on the platforms would not function. In addition to fundamental difficulties in the large-scale implementation of digital technologies in production (especially in small and medium-sized companies), the latter is a key factor that is slowing down the pace of development in this area.

On the other side of this market are the platform-operating companies that offer IIoT services and networking solutions. On the one hand, these are established IT groups such as Oracle and industrial companies such as Siemens (with Xcelerator), Bosch (with IoT Suite) or Schaeffler, which develop and offer company-specific, industry-wide or cross-industry IIoT solutions for interlinking production processes, machines, facilities or products (BDI 2021: 10−41). Furthermore, there are the previously mentioned major cloud providers (AWS and Microsoft Azure), who now have a similar portfolio of IIoT software solutions, IT support and consulting and who also work directly with a number of industrial companies such as VW on the digital linkage of manufacturing and logistics (Table 3).

Observing the emerging power structures in this market, there is growing evidence that the major U.S. technology groups are gradually working their way into a central position on this playing field as well (Figure 4). With their large cloud platforms, they are growing visibly beyond their traditional domain of the consumption- and communication-based internet while also increasingly serving the growing demand for platform solutions from core areas of industry. In addition, even large IIoT platform operators such as Siemens are also foregoing the construction and operation of their own infrastructure solutions in order to conduct their business, and are instead systematically relying on the storage space and computing capacity of the large cloud platforms:

> Siemens, a leading company in the industrial sector, uses Amazon Web Services (AWS) to make its software tools accessible, scalable and flexible for customers. (https://aws.amazon.com/de/solutions/case-studies/innovators/siemens; accessed July 3, 2023; our translation. See also Obermaier and Mosch 2019: 409f. and Ziegler 2020: 222f.).

Thus, both via their infrastructure platforms and via the software services embedded in them, the leading cloud platforms have now gained a considerable influence on industrial platform strategies.

Levels of action: Cloud and IIoT platforms between market, network and platform

Infrastructure platforms and IIoT platforms are, on one hand, technology-centered platforms that aim to digitally interlink processes and products on a large scale—both within and between companies. On the other hand, they are also constituting (technically mediated) social structures and relationships, which are of particular interest here. At first glance, these platforms are characterized by bilateral provider-customer relationships: platform operators offer storage space, computing power and IT services for rent to industrial customers. In this basic form, this could be considered a market-mediated exchange between two classes of organized economic actors. This basic configuration is not at all sustainable on its own, however, and must be significantly expanded in at least three respects.

Firstly, it must be expanded in the direction of contractually secured social relationships between platform operators, customers and other players who cooperate in larger projects on the platform. An example of this is the intensive cooperation between the Volkswagen Group and AWS, which has been ongoing since 2019. VW's Industrial Cloud, which aims at bringing together the data of all machines, facilities and systems in manufacturing and logistics and is intended to go beyond the group boundaries as an open platform in the future, runs on AWS and also uses many services offered by AWS (Boes and Ziegler 2021: 67−101). Of interest here is that VW does not simply rent the services offered by the platform but rather works together with AWS and other cooperation partners such as Siemens and MHP—a management and IT consulting firm that belongs to Porsche AG—on the development of custom-tailored software. To this end, IT specialists and engineers from AWS and VW work together directly on a project-oriented basis. AWS refers to this as "customer engineering":

> Here, software solutions are created in direct collaboration with the customer, and tailored specifically to them. What is new about this is that the customer is not handed a finished service but that a new service is jointly defined, developed and operated. (https://www.aboutamazon.de/news/amazon-web-services/aws-und-volkswagen-produzieren-die-zukunft; accessed June 28, 2023; our translation)

Siemens, through its Siemens Digital Industries Software division, is collaborating with AWS on the development of its Xcelerator platform in a similar way:

> Specifically, industrial companies are to be supported in accelerating the digital transformation in the cloud. To this end, Siemens and AWS want to jointly drive forward the introduction of "Xcelerator as a Service." (https://www.bigdata-insider.de/siemens-erweitert-zusammenarbeit-mit-amazon-web-services-a-88f919cd82c788a344a4ecaf6696ef27/; accessed July 3, 2023; our translation)

These are organized innovation networks within the framework of the platform. In both of the cases mentioned here (VW and Siemens), comparisons with the networks between manufacturers and industrial customers come to mind, as investigated by Uli Kowol (1998; also Kowol/Krohn 1995) in the second half of the 1990s for special purpose machine construction. There, too, the planning and manufacturing process of specialized

machine tools was characterized by "iterative fine-tuning between manufacturer and customer" (Kowol 1998: 201; our translation) as part of a longer cooperation project, at the end of which a so-called proprietary solution emerged: a product tailored to the specific needs of the company using it with corresponding unique selling points.

Secondly, there are also comparatively open and curated action spaces within the platform ecosystem which are used by a large number of heterogeneous players as third-party providers. In the case of AWS, this is AWS Marketplace, which is structured similarly to Amazon Marketplace and is described by the group itself as a

> curated digital catalog that you can use to find, buy, deploy, and manage third-party software, data, and services that you need to build solutions and run your businesses. (https://docs.aws.amazon.com/marketplace/latest/buyerguide/what-is-marketplace.html; accessed June 28, 2023).

AWS Marketplace thus complements, in a way that is quite comparable to Amazon Marketplace, the software offerings that AWS has in its product portfolio with offerings from third-party providers. The ecosystem of the cloud platform thus includes a transaction platform that functions according to the typical pattern of multi-sided markets and whose rules are set and controlled by the platform operator as an intermediary—in this case, including strict quality control of the offerings sold there. Likewise, the plan is for Siemens' Xcelerator platform to eventually not only offer software from its own company but also function as a digital marketplace that is open to third-party providers (https://www.handelsblatt.com/unternehmen/industrie/siemens-aktie-legt-zu-siemens-auf-dem-weg-zurueck-zu-alter-groesse/29144326.html; accessed July 3, 2023).

Thirdly, there is also the mode of co-opting new members who are selected by the platform operators. For example, Siemens Digital Industries Software is a "Manufacturing and Industrial Competency Partner" of AWS, alongside many others. This means:

> The program recognizes consulting and software partners in the manufacturing industry who have appropriate expertise and offer cloud services. To earn this AWS status, AWS partners must pass rigorous technical validation and provide verified customer references. (https://www.digital-manufacturing-magazin.de/siemens-ist-aws-manufacturing-and-industrial-competency-partner/; accessed July 3, 2023; our translation)

The few examples presented here already show how multifaceted the forms of action and the coordination requirements are that could or actually do emerge within the ecosystems of industry platforms. They range from comparatively open market relationships and spaces for action with a larger number of participating actors to organized networks between selected cooperation partners, to forms of targeted co-optation of new members or complementors by the platform operators.

Distribution: Transaction platforms (B2B)

Web-based digital transaction platforms for trade between companies have been established for some time. As far back as the early 2000s, they were already an important

topic of the emerging research on electronic commerce (Zerdick et al. 2001: 217–243) and were empirically studied as business-to-business (B2B) marketplaces, such as for the mechanical engineering, chemical and automotive industries (Stobbe and Zampieri 2001; Perlitz 2002; Auer and Heymann 2003). Today, transaction platforms are the most widespread and most consolidated platform type in industry (Table 4).

Compared to IIoT platforms, the structures and regulatory patterns of industrial transaction platforms are clear and unambigous. In essence, they are typical and long-established multi-sided markets in which the platform operators act as curating matchmakers who set the rules and bring traders together with customers (Evans and Schmalensee 2005). They thus allow for the trade of a wide variety of industrial goods and services. In its basic form, this may take place either via online stores, where platform operators sell commissioned goods directly from their warehouses to their customers, or via open marketplaces, where suppliers sell their goods to customers requesting them. In the latter case, the platform operator functions primarily as an intermediary providing technical infrastructures and setting the social rules of the exchange. The predominant way in which platform-operating companies generate revenue is by charging commissions for the transactions they broker (Falck and Koenen 2020).

Table 4: Selected transaction platforms (B2B) and their offerings

Company	**Area**
CheMondis	Marketplace for chemical products. Approved suppliers of chemicals and verified buyers (founded by Lanxess; independent)
Circulania Services GmbH	Trading platform for by-products, secondary raw materials and waste as well as related services (purchase, sale, refining)
Metals Hub GmbH	B2B commodity trading and price data platform for the metals industry (start-up)
MoBase	Open marketplace for professional rail products and solutions (Siemens Mobility GmbH)
Schüttfix	Platform for ordering, transporting, delivering and disposing of bulk materials, construction and demolition waste (start-up)
XOM Materials XOM eProcurement	Industry-specific B2B platform for the trade and brokerage of goods, particularly steel, metal and plastic products of all kinds, and the provision of related services (founded by Klöckner & Co SE; independent)
Mercateo	Open cross-industry marketplace where manufacturing companies and suppliers can offer their products
Amazon Business	Cross-industry online marketplace for third-party sales of products and services to business customers

Source: Own compilation (July 2023)

None of this is particularly spectacular or novel. B2B transaction platforms are similar in principle to their much better-known, albeit later launched counterparts from the consumption-based internet (e.g., Amazon, Otto or Zalando) and constitute what I refer to as a web-based market space (Section 3), understood as a curated, rule-based sociotechnical framework within which participants can conduct their business. The market rules and the observance of them are established and controlled in a comparatively hierarchical way, and third-party providers are usually only co-opted following thorough scrutiny.

Nevertheless, there are a number of notable differences to consumption-based retail platforms on the internet. For one, individual consumers do not play a role in the industrial sector and transactions are conducted exclusively between corporative players. In addition, the field of industrial transaction platforms is more fragmented and divided into small segments. Monopolies, as are characteristic of the consumption-based internet, have not yet emerged. It is true that there are also cross-sector trading platforms in industry with a broadly diversified range of standardized products and services (such as Mercateo or Amazon Business). More typical, however, are industry-specific platforms (such as XOM Materials, Metals Hub or Circulania), some of which are operated by industrial groups or their subsidiaries, while others have been founded by start-ups (Table 4; also: Radig 2021). Compared with the consumer-based internet, the degree of concentration is often lower and the competition greater. In addition, the rule-setting power of individual platforms is less pronounced, since their operators have to deal with organized economic players as customers who have considerable purchasing and negotiating power. With the exception of Amazon (and Amazon Business), internet groups have not played a significant role in B2B commerce to date (Falck and Koenen 2020: 22−29; BDI 2021; Lerch et al. 2019: 18−22).

Research and Development (R&D): Innovation platforms

Compared to the well-documented and quite clearly organized transaction platforms, innovation-oriented platforms are much less researched and, where they do become the object of research, are considerably less clearly defined. This is partly due to their early stage of development as well as the fact that platform-based collaborative innovation processes may also take place within the framework of IIoT platforms, for example, making it quite difficult to ascertain clear delineations. In order to sharpen the focus, it makes sense particularly in this area to distinguish, both analytically and empirically, between platforms and networks. The latter have already been established for several decades as a specific form of cooperative and cross-company-organized R&D processes. So what makes the difference?

In very general terms, innovation platforms should “enable companies to develop products and services collaboratively in an open innovation process” (EFI 2022: 84; our translation) and the platforms themselves should serve “as a basis for third parties to

develop complementary technologies, products and services" (Obermaier and Mosch 2019: 383; our translation). When this serves as starting point, then appropriately oriented industrial innovation activities can be traced and examined at various levels (Table 5). For example:

- in the context of service-oriented platforms for digitally supporting the management of innovation processes in companies (e.g., CrowdworX) or for the storage, management and collaborative processing of software development projects (e.g., Github) (Sims and Woodard 2020; Bounegru 2023);

- as decidedly R&D-oriented platforms on which their operators successively open up the innovation-oriented ecosystem for external companies and developer communities, which, as complementors, make independent, often non-commissioned contributions to the further development of products and processes (Parker, Van Alstyne and Jiang 2017; Butollo and Schneidemesser 2022). This takes place, for example, on the Teamplay Digital Health Platform from Siemens Healthineers or, in the future, possibly also as part of the VW Industrial Cloud (Büchel et al. 2022: 91−100; https://www.volkswagen-newsroom.com/de/storys/voll-vernetzt-volkswagen-baut-industrie-cloud-fuer-alle-werke-6965; accessed September 14, 2023);

- as the targeted, intensive, informal and project-oriented involvement of companies on open source platforms, which has long since become part of the repertoire of innovation strategies not only of leading technology groups but also of many industrial enterprises (Germonprez et al. 2013). Such open working and collaboration environments allow these companies to participate beyond formalized and contractually regulated collaborations in a wide range of ideas and knowledge relevant to their own R&D (West and O'Mahoney 2008; Schrape 2015, 2018). An example to be examined in more detail is the participation of, among others, Bosch, Continental and Mercedes Benz in the Software Defined Vehicle Group on the open source platform Eclipse (https://sdv.eclipse.org/index.html#about, accessed July 31, 2023). Another interesting research object in this area could be the Open Manufacturing Platform, which is loosely embedded in the Linux Foundation (https://www.bosch.com/stories/open-manufacturing-platform/; accessed September 14, 2023);

- as platform-like reorganizations of in-house R&D structures, which continue to form an important basis for research-intensive companies in their overall increasingly distributed innovation activities (for Bosch, e.g., Ziegler 2020: 192−294).

Table 5: Selected innovation platforms and their offerings

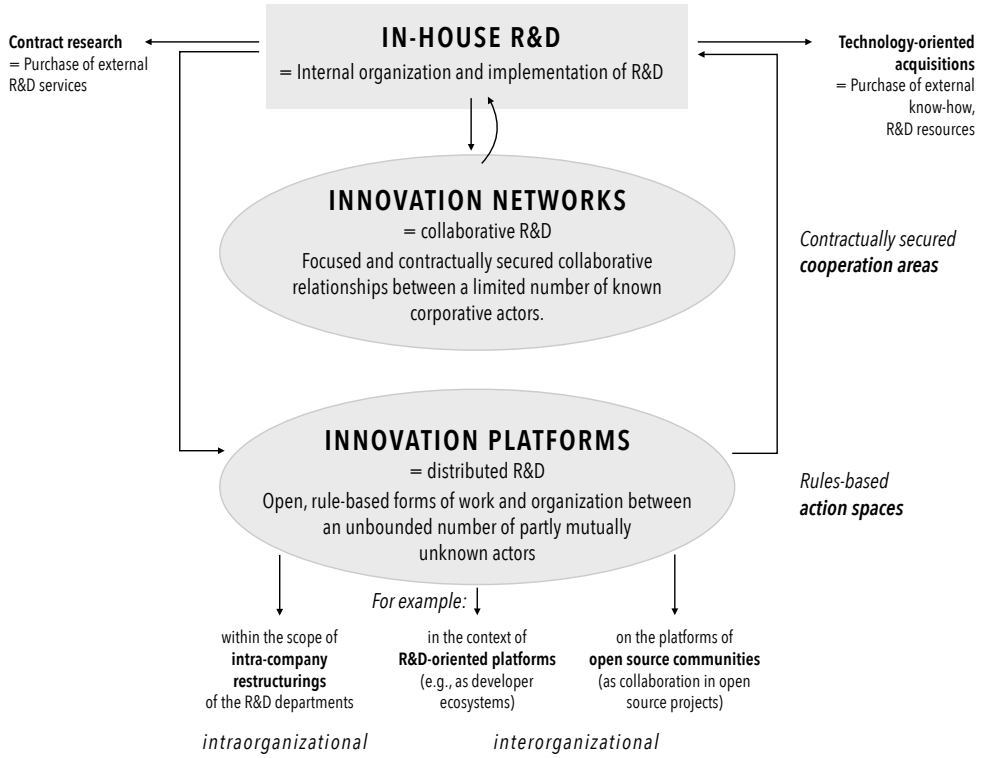
Company	Area
CrowdWorx	Software and consulting service provider for internal innovation management. Software packages for organizing innovation management, idea management, operational suggestion system, open innovation.
Github	Online version management service for open source software development projects. Owned by Microsoft since 2018.
VW Industrial Cloud	Platform aimed at driving digital innovation in the automotive industry and beyond. Prospectively open to external manufacturing, logistics and technology companies as well as software developers. Core players: VW in cooperation with AWS and Siemens.
Eclipse	Open source platform, which serves as the umbrella of the Software Defined Vehicle Group, for example, which focuses on accelerating innovation of automotive software stacks using open source and open specifications.
Open Manufacturing Platform	Platform for manufacturing companies with the goal of cross-industry collaboration, exchange of non-differentiating knowledge and data, and access to new technologies. Founded under the umbrella of the Joint Development Foundation, which in turn is part of the Linux Foundation. Founders: BMW and Microsoft; steering committee members include Anheuser-Busch InBev (AbInBev), Bosch and ZF Friedrichshafen.
Teamplay Digital Health Platform	Open platform for the digital interconnection of the German healthcare system; also designed for third-party offerings that can integrate their own apps and other digital services into the platform. Core players: Siemens Healthineers and IBM.
Bosch Innovation Portal	Platform where external players such as start-ups, university institutions and large companies can submit ideas along the interests of the Group and apply for cooperation with Bosch.

Source: Own compilation (September 2023)

My interpretation is that platform-based forms of work and organization in industrial innovation processes fit into a decades-long process of successive opening and differentiation of industrial R&D both externally and within companies (Figure 5). For a long time, this has included the purchase of external R&D services in the form of contract research as well as the integration of external R&D resources, competencies and knowledge via the acquisition of other companies, especially research-intensive technology firms. Above all, however, it includes systematically pursued and contract-based R&D cooperations, such as between several large companies, between large companies and start-up firms or between companies and public research institutions. This empirically well documented cooperative orientation in business is by no means a phenomenon limited to new high-tech sectors. On the contrary, in recent decades it has also established itself as a previously unknown form of collaborative innovation activity that transcends corporate boundaries, including in core areas of industrial production (such as the automotive or chemical-pharmaceutical industries) (Hagedoorn 2002; Rothaermel 2001; Dolata 2016). This focus on cooperation had already been conceptually condensed in the 1990s, such as with the term “networks of innovators” (Freeman 1991; Powell and Grodal 2005; Pittaway et al. 2004), and has been further investigated

since the early 2000s under terms such as "open innovation" (Chesbrough 2003; Chesbrough and Bogers 2014; Bogers, Zobel et al. 2017).

Figure 5: Contextualization of innovation platforms



Source: Own reflections

Overall, innovation-oriented networks can be understood as interest-driven, goal-oriented and content-focused cooperative relationships between a clearly determinable number of mutually known corporative actors, and in the context of which R&D projects of a certain strategic relevance for the participants are carried out. Collaboration within such networks is marked by confidentiality and a legally secure contractual basis. Negotiation and mutual agreement between the participating actors are the essential mode of coordination, supplemented by the formation of network rules and management structures. In research-oriented collaborations, the relationships of the participants at the working level are usually characterized by forms of informal and trust-based exchange. At the same time, however, they tend to be characterized by more or less pronounced power asymmetries between the actors and the attendant varying possibilities for exerting influence (Sydow 2001; Hirsch-Kreinsen 2002; Dolata 2001; for the chemical-pharmaceutical industry Dolata 1996: 69−128, 2003: 143−303). To put it succinctly:

> By R&D alliances we mean formal agreements between firms that contain arrangements for (joint) R&D. Thus, R&D alliances at once imply a specific legal basis (a contract), objective (R&D), and type of partner (firm). (Frankort and Hagedoorn 2023: 2)

Platform-based forms of work and organization in industrial innovation contexts, such as in the context of open source communities or on R&D-oriented platforms, differ significantly from this. The essential characteristic that distinguishes innovation platforms from innovation networks is that, unlike networks, they are not outwardly closed areas of cooperation but rather constitute significantly more permeably structured and more expansively laid out spaces of action. This means that the relationships are designed to be more inclusive, that the existing or developed knowledge stocks are often of a non-proprietary nature and hence more accessible, and that the actors involved are more heterogeneous. Aside from corporative actors, (sub)communities or individuals acting in a professional capacity have an important role to play here as well. Platform-based innovation activities take place on the basis of shared rules. However, they are not underpinned by strong formal, legal and justiciable contracts between participants where aspects such as cooperation goals, intellectual property rights, exploitation patterns and secrecy and confidentiality rules are defined in detail.

Looking at the actors involved and their relationships with each other, the picture is not really clear. While the participants in project-oriented working groups on open source platforms are comparatively manageable and identifiable, this is no longer the case on developer platforms, with their principally open-ended number of formally independent developers or developer communities. The actors participating here are not only very heterogeneous but also relate to each other in a considerably more loosely coupled, market-like manner, and often do not even know each other. That is:

> Firms must now manage value creation that occurs externally just as carefully as they manage the value they create internally. And, this is not just outsourcing. Firms are relinquishing product specifications to third parties that they do not even know. (Parker et al. 2017: 256)

This has considerable consequences for the way in which companies deal with all the distributed, open-ended, often fleeting and hardly controllable contributions of partly unknown third parties on their product platforms, which have little in common with classic contract research or focused R&D collaborations.

This relates in particular to issues of boundary demarcation and closure, which always exist not only in closed innovation processes but also in more open and distributed innovation processes (Dahlander and Gann 2010). This issue has been prominently addressed both in research on open innovation (Bogers, Zobel et al. 2017: 16−18) and in the network debates of the 1990s and 2000s (Sydow 2001; Ortmann and Sydow 2003). Parker et al. point to two key regulatory decisions which platform operators are called upon to make in this context and, in the case of the dynamic growth of their platform and the actors involved, to adjust promptly:

> (1) how much of the core platform to open in order to spur developer innovation and (2) how long to grant developers the right to benefit from sales on top of the platform before the platform absorbs those innovations into the core. (Parker et al. 2017: 257; also Hein et al. 2020: 92; Jovanovic et al. 2022)

In a different way, boundaries also play an important role in the collaboration of technology or industrial companies on the platforms of open source communities. Here, the main question is what and how much of its own proprietary knowledge a company can disclose and include in the process of platform-based collaboration, which is considerably less protected than collaboration in contract-based networks. In these cases, boundaries are drawn between, on the one hand, strategically relevant R&D and knowledge bases of the companies that make the difference in competition (differentiating parts) and that are carried out as protected projects in-house or as part of contractually secured cooperation networks and, on the other hand, important but competitively less significant innovation projects (non-differentiating parts) that can be worked on collaboratively in open source projects in a creative and cost-effective way (Germonprez et al. 2013). An example of this is Bosch's comments on "Joint development with Bosch and Open Source":

> To make the software-defined vehicle a reality, strong partnerships are essential. Bosch, with its subsidiary ETAS GmbH, joins initiatives such as the Eclipse working group software-defined vehicle, focusing on accelerating innovation of automotive-grade in-car software stacks using open source and open specifications developed by a vibrant community. Bosch, and ETAS together with other leading organizations are joining forces on the non-differentiating parts, thus decreasing time-to-market, sharing best practices, and overcoming the war for talents. (https://www.bosch-mobility.com/en/mobility-topics/collaborative-development-with-bosch/; accessed August 4, 2023)

The question of typical modes of action coordination in platform-based innovation contexts cannot be answered unambiguously either. Concrete working contexts on open source platforms, with their comparatively manageable spectrum of actors and a fairly clear thematic focus, can be coordinated via modes of negotiation, mutual agreement and co-opting of new members that are typical of networks too, and are in some cases also underpinned by robust regulatory structures and supervisory bodies (such as the Software Defined Vehicle Group on the OS platform Eclipse; https://www.eclipse.org/org/workinggroups/sdv-charter.php; accessed on August 4, 2023). In contrast, for R&D-oriented developer platforms, more market-like and more hierarchically controlled forms of coordination seem to be more typical. In these cases, the platform operators as focal actors make the fundamental decisions and formulate the basal rules of action. Questions such as the extent to which this is done with the systematic involvement of and in consultation with platform participants, how power and influence are distributed on the platforms in concrete terms, and when and in what combination various modes of action coordination occur can only be answered through case-specific or comparative reconstructions—something that has barely been done to date.

We still know little about the scope, significance and dynamics of platform-based forms of work and organization in industrial R&D contexts. Nevertheless, it can already be said today that the trend towards opening up industrial innovation processes, which has been briefly outlined here (Figure 5), should not be overestimated. Especially, the trend outlined should not be understood as the successive replacement of

one type of organization with another but rather as a component of a gradual process of differentiation into various forms of industrial innovation activity that coexist and are pursued by companies not alternatively but in parallel. In-house research and (semi-)closed innovation processes are by no means discontinued models of the industrial organization of R&D. The specific interplay of different organizational forms of industrial innovation as well as the specific weight of platform-based forms of innovation in the overall ensemble of industrial innovation patterns are, in turn, a case for further empirical research.

4.3 Peculiarities

Following the tracks laid out in the introduction, two sets of questions emerge. Firstly, what distinguishes industry platforms from the platforms that characterize the consumption- and communication-based internet? Can typical peculiarities or overarching characteristics of platform-based forms of work and organization in industry be identified from the field explorations undertaken here? Secondly, do platforms represent an independent, distinct mode of organization and coordination of industrial market, production and innovation processes that is substantially different from networks?

Heterogeneity, fragmentation, gradual transformation: Industrial and internet platforms in comparison

First of all, it should be noted that platform-based forms of organization have not yet become established on a large scale in industry. While digital platforms have become established on a broad front in the consumption- and communication-based internet over the past decade and have solidified themselves as a central structural and organizational principle of the web, corresponding processes of platformization in the industrial sector are at an early stage of development and characterized by tentative and erratic search processes. It is not yet clear if, when, where and how platform-based forms of organization can actually gain a foothold on a larger scale. For the time being, we are not yet witnessing a platform capitalism or platform economy in industry. Rather, instead of disruptive breaks, gradual transformation processes (Dolata 2013: 94−120) dominate the development of this field.

However, a distinction must be made here. While IIoT and R&D-oriented platforms are still at the beginning of their potential but by no means certain career, digital transaction platforms have long since established themselves as two- or multi-sided markets for commerce between companies (B2B) and have achieved economically relevant orders of magnitude. Pure B2B internet commerce by manufacturers and wholesalers with their customers, which is conducted via online stores but increasingly also via digital marketplaces, has generated sales of €352 billion in Germany in 2021—with a clear upward trend. By way of comparison, in the same year, consumption-based internet commerce

(B2C) comprised only one quarter of B2B sales in Germany, at €87 billion. Amazon, as a central player in this field, achieved sales of €37.3 billion (ECC 2022: 9; Amazon 2023: 67). B2C is thus a rather modest economic segment compared to B2B. This has received little attention over the years, despite being known for a long time:

> While the Internet economy is generally thought of as enterprises selling to consumers, the vast majority of e-commerce is actually comprised of businesses selling to other businesses. In 2007, roughly 90 percent of global e-commerce was B2B. (Atkinson et al. 2010: 22)

In addition, industry platforms and their offerings are considerably more presuppositional than those of the consumption-based internet and have a significantly higher organizational complexity, as Pauli et al. (2021: 184) emphasize:

> Marketing and sales to business customers, such as industrial organizations, is significantly different from the processes in the B2C domain. As it interacts with the customer's buying process, selling products and services is usually more complex and may involve detailed technical proposals, extensive negotiation, and long-term relationship building. The purchase of a predictive maintenance solution, for example, (...) will require cross-functional decision making involving, among others, purchasing, finance, administration and engineering functions. This indicates that purchasing industrial platform-based solutions will not be as straight forward as downloading an app from an app store, for example.

Furthermore, the field is quite heterogeneously structured and, in some cases, highly fragmented. There is no one-size-fits-all model of industry platforms but rather distinct variants that differ significantly from one another. So far, there are also no industry platforms with a monopoly-like significance, as is typical for the consumption- and communication-based internet. Instead, industry-specific and in some cases highly specialized platforms dominate the scene with their offerings.

It is not only in terms of their stage of development, complexity and fragmentation that platform-based forms of work and organization in industry differ significantly from the familiar internet platforms. Industry platforms also have a purely economic orientation. On the surface, this sentiment may sound banal. However, it means that they do not span such expansive social action spaces as the large social media, networking and messaging platforms of the internet (see Section 3), serving instead, in a much narrower sense, to coordinate organized economic actors and processes. The provision of playing fields and offerings for countless individual users or collectives with primarily non-economic interests and activity profiles, which are constitutive of the relevant platforms of the consumption- and communication-based internet, play no role in the industrial sector. Nor, for that matter, does advertising revenue as a supporting business model.

The spectrum of actors we are dealing with here is correspondingly different too. It primarily comprises corporative actors from the business sector, who can be roughly divided into four groups across platforms (Tables 2−5; Hoffmann et al. 2021: 17f.; Obermaier and Mosch 2019: 403).

The first group consists of established industrial companies such as Siemens, Bosch, the automotive manufacturers VW, BMW and Mercedes, or Klöckner and Schaeffler. These companies have well-established contacts, business and cooperation relationships in key industrial sectors, have long been actively involved in shaping digital restructuring activities, for example in manufacturing or logistics, and can leverage their domain knowledge accordingly. They shape the establishment and operation of digital marketplaces (transaction platforms) and also play an important role in the considerably more preconditioned establishment of production- and innovation-oriented platforms. However, this requires industrial companies that operate platforms to further open up their corporate boundaries well beyond the comparatively clear cooperation and regulatory frameworks of production or innovation networks, and also to maintain a close cooperation with technology groups that are likewise positioning themselves as serious competitors, particularly in the area of the Industrial Internet of Things (IIoT).

These leading U.S. technology companies form the second relevant group of players. They have not yet achieved the same central position in the industrial sector as they have in the consumption- and communication-based internet, which they shape and control almost like monopolies with their platforms. In the fragmented, industry-specific and often highly specialized segment of B2B transaction platforms, Amazon (with Amazon Business) in particular plays a role, albeit not as an all-dominant player as in consumer-oriented internet commerce but as a competitor alongside others. The situation is different in the IIoT sector. Here, Amazon (with AWS) and Microsoft (with Azure) could particularly gain significant influence in the coming years on the basis of their already existing infrastructural dominance as cloud operators—above all because they have long since provided not only storage space and computing capacity for their industrial customers but also integrated IIoT services. This is likely to give them a substantial competitive advantage in this emerging market compared with pure IIoT platform operators.

In addition, there are two other groups of actors. One group is comprised of start-up companies that have developed their own platforms and also operate them themselves in specialized areas (e.g., Schüttfix or Metals Hub), organize platforms as spin-offs of large industrial companies (e.g., XOM Materials or CheMondis) or have meanwhile been taken over by large companies (e.g., GitHub by Microsoft). The other group is comprised of communities as a specific type of collective actor: developer communities and open source communities, which have become indispensable as a decentralized creative resource of primarily software-based innovation processes for both technology and industrial companies.

Rule-based curation: Platforms as a distinct mode of organization and coordination

The sociotechnical structuring of industry platforms can be conceptualized in its basic form as a rule-based, two-level architecture similar to that of the platforms of the

consumption-and communication-based internet (Section 3 and Figure 2). Here, too, all platforms consist of a coordinating core with a focal actor (or a group of actors) and are based as spaces for action on a more or less broadly designed ecosystem of primarily organized actors (complementors). These are held together and made capable of action and interaction by platform-specific social rules, incentives and regulatory structures that are inscribed as far as possible in the technical infrastructures.

The concept of platforms as rule-based action spaces can also be applied to platforms in industry, provided some differences be taken into account and incorporated. These differences concern primarily their social reach, something I had commented on as follows concerning the leading social media and communication platforms on the internet:

> The large platforms, with their own rule-setting, structuring, selection, monitoring, and sanctioning activities, constitute no less than the institutional foundations of a *private-sector sociality on the internet,* which have, over the past two decades, evolved largely decoupled from democratic institutions and state influence. (Dolata 2022: 468f; see also Van Dijck, Poell and de Waal 2018)

This cannot be said for industry platforms. Although they also open up spaces for action—an essential signature of this form of organization across all variants—their spaces are comparatively focused and decidedly economically oriented. They take the form of market, production or innovation spaces whose social or societal scope remains comparatively manageable.

Likewise in contrast to the consumer- and communication-based internet, where low-threshold access options, strong network effects and high user numbers are virtually constitutive for the success of platforms, platforms in industry are generally more exclusive in design and are equipped with serious entry barriers for new complementors. They often start as rather closed in-house platforms that are opened up to selected new participants over time. What Jovanovic et al. (2022: 3) emphasize in the following quote with regard to transaction platforms also applies, by and large, to the other types of industry platforms:

> In contrast to the B2C digital marketplaces, complementors cannot join based on self-selection. Subsequently, the platform sponsor gradually opens the industrial digital platform through the selective promotion of complementors. However, the platform sponsor needs to make careful strategic decisions about how many and what type of complementors it wants to induce to join the platform.

Platforms are usually expanded successively, in a controlled manner, and after thorough examination of new participants, who are then primarily accepted in the mode of co-optation. This is not surprising: data security, safeguarding of property rights, quality and reliability of the complementors, as well as the dangers of uncontrolled knowledge outflows or competitive conflicts play a much more prominent role in the context of industry platforms than, for example, on the social media platforms of the internet (Pauli et al. 2021: 185−188). They also require regular adjustments of the extremely sensitive relationship between openness and boundary setting as well as

between collaborative interaction and competitive dynamics (Kretschmer et al. 2020: 411−416). These challenges were already discussed as essential tasks of network management in the network debates of the 1990s (Sydow 2001) and have been addressed in the more recent research on open innovation whenever the discussion moved from intra-organizational to inter-organizational aspects of distributed innovation processes (Bogers, Zobel et al. 2017: 16−18).

With all this in mind, are platforms a sui generis form of organization, characterized by a specific mode of coordinating action, which substantially distinguishes them from the classical variants hierarchy (instruction), network (negotiation) and market (competition)? As I have already argued (in Section 2), when seeking an answer to this question from a sociological perspective, conceiving of platforms as hybrid structures between organizations and markets (as is done, for example, in strategic management research; Kretschmer et al. 2020: 407) is less helpful than situating platforms in the intermediate field of organized networks and markets and to work out their indisputable status as an independent mode of organization and coordination especially in comparison to networks.

To recapitulate, networks in industry in the sense understood here denote forms of negotiation- and contract-based cooperation between a limited number of independent and usually corporative actors. The dominant mode of coordination is the negotiation of the concrete conditions of interorganizational cooperation and—based on this—the goal-oriented cooperation of the network actors. Embedded in this ideal-typical mode of coordination are, of course: power asymmetries; the emergence of focal actors and their attendant forms of hierarchical coordination and control (e.g., in the context of network management); but also scope for informal coordination patterns (especially in research networks) and market-like interactions (especially as competition between network participants). In principle, however, relationships in networks are negotiation-oriented and cooperative, more loosely coupled than in the context of organizations and more tightly coupled than in markets. Industry networks constitute contract-based cooperation areas that are anything but open to the outside world. When new members join, they are usually co-opted in a controlled manner.

This stylization does not fit industry platforms (and certainly not platforms of the consumer- and communication-based internet). Platforms offer a broader spectrum of possibilities for action and interaction for a significantly more indeterminate number of heterogeneous actors, who may relate to one another in various ways or may have nothing to do with one another at all. The spectrum of action ranges from competitively oriented relationships in marketplaces for third-party suppliers, to more openly designed collaborative product development and innovation activities not tied to formal cooperation agreements, to opportunities to establish more organized cooperative relationships or networks with selected participants independently and decentrally within the platform's framework of action. Relationships of indifference, in other

words, the unrelated and disinterested coexistence of participants who need not even know each other, are also possible here—and anything but unusual. In a stylized distinction to networks, platforms can be understood as rule-based spaces of action that are clearly more broadly defined and more flexibly structured than areas of cooperation and, in some cases, offer the participating actors considerable decentralized possibilities for independent activities of various kinds. The general framework for action is not defined here by detailed and individually tailored contracts between all participating actors but by a set of basic rules of action that apply to everyone and for which the platform operators are ultimately responsible. The dominant mode of coordination on which all action there is ultimately based is rule-based curation. What is meant by this is the development, setting and enforcement of order-creating rules that are under constant tension and that can be adjusted to changing conditions at any time. These rules hold the platform together as a social structure. Speaking in Giddens' sense, they do not simply restrict the possibilities of the widely distributed decentralized action there but make it possible in the first place.

Curation is, of course, also to be understood as an ideal-typical mode of coordination, in which both strong hierarchical and substantial negotiation-oriented mechanisms can be embedded. For the large platforms of the consumption- and communication-based internet, I have argued that the operating corporations have a high degree of structure-giving, rule-setting and also controlling power into which elements of a rather selective and decentralized participation of the users (e.g., via rating systems) are embedded. Rule-making and regulation there are characterized by a strong bias in favor of the platform operators: this is curation as an essentially hierarchically designed and executed mode of coordination in which traces of an operator-controlled participation of the users are merely integrated (Dolata 2022; Dolata and Schrape 2023, 2023a).

The same cannot so readily be said for the very heterogeneously structured and considerably more fragmented field of industry platforms. In stimulating contrast and with some plausibility, Butollo and Schneidemesser (2021: 15) argue:

> The platforms need to negotiate and cooperate with their complementors on an equal footing, at least as long as the platform landscape remains fragmented and no single platform emerges as a dominant channel through which software applications are distributed.

In fact, platform operators in the industrial domain are dealing with a fundamentally different field of participants compared to internet platforms populated by countless individual users. Above all, this includes resource-rich and assertive economic players who, as platform users, can assert their own interests with considerably greater negotiating power—especially since industry platforms (with the important exception of cloud offerings) are not yet characterized by consolidated monopoly positions. Platform operators in this environment cannot easily set and enforce rules of any kind in a top-down manner, being instead obliged to often do so in close exchange with their industrial customers. This is curation as a substantially negotiation-based

process. Here, too, it is the platform operators who are ultimately responsible for establishing and enforcing platform-specific rules. However, curation would not work here without an accompanying institutionalization of negotiation- and coordination-oriented regulatory structures in which relevant platform participants are systematically involved.

5 Outlook: Open questions and research perspectives

In terms of research strategy, this text can be read as a plea for an urgently needed shift in perspective: from concentrating on the platforms of the consumption- and communication-based internet—ubiquitous, well-known and by now very well researched—to a more in-depth investigation of the platform-oriented reorganization of industrial distribution, production and innovation, which is far less in the crosshairs of public and academic attention. Without a corresponding readjustment in the direction of industry platforms, no serious judgment can be made either about the scope and substance of a platform economy or platform capitalism or about the role and significance of platform companies as the supposedly signature type of company of our time. From a sociological perspective, such a shift in perspective is above all a task for research in the sociology of organization, industry and technology.

In terms of research pragmatics, this text aims to provide pointers for further empirical research and the theoretical classification of industry platforms. Based on the existing literature and on additional research of my own, I have provided a basic structuring of this still rather fragmented field, as well as initial theoretical-conceptual considerations on the structuring, coordination of action and regulation of industry platforms, which further research in this field can build on. However, much of what I developed in Section 4 and summarized in Section 4.3 naturally requires further intensive investigation. I see two complementary starting points for future research on the topic: case studies at the micro level of the platform or firm, and more precise field surveys and mapping of the industrial platform economy at the meso level of business sectors and the macro level of the overall economy.

For one, there is an urgent need for detailed reconstructions of the emergence, institutionalization and functioning, and of the problems and failures, of both concrete industry platforms and platform projects and platform-related reorganization strategies in and between companies. In contrast to the platforms and platform companies of the internet—one need only think of the countless studies on Uber alone—we know very little about this.

In a structure-oriented perspective, this means working out the concrete sociotechnical architectures, rule-making, coordination and regulation mechanisms, either in indivi-

dual or comparative case studies. In a process-oriented perspective, we need to examine: how rules, curation approaches and regulatory structures gradually emerge and consolidate; who is involved and with what resources and influence; what potential power and negotiating leeway the participating actors have vis-à-vis the platform's organizing core actors; which forms and focal points of a platform management emerge; how the relationship between decentralized possibilities for action and decision-making on the one hand and central coordination and control functions on the other develops; and, overall, how all of this can be depicted and causally condensed over time as the gradual institutionalization (or de-institutionalization, discontinuation and failure) of a platform. With few exceptions, there is a lack of both detailed individual and comparative case studies that do just that.

Furthermore, it remains an important task to map the field, which is quite heterogeneously structured and not yet entirely consolidated, as a whole much more precisely than has been done so far. In other words, the task is to observe the field over time with all its developmental dynamics, dead ends and aberrations and, on this basis, to assess its organizational, sectoral and macroeconomic formative power in an empirically comprehensible way.

This means not only looking at the development and diffusion of the various platform-based markets, work and organizational contexts and their sectoral or macroeconomic significance in the overall context, and examining all of this empirically in more detail. It is equally important to systematically identify new platform-based organizational forms on a sector- or platform-specific basis in order to be able to use this as a basis for comparative analysis of characteristic features and differences, institutionalization dynamics as well as development limits of industrial platform projects. This also applies in a similar way to the actor figurations that characterize these processes as well as the collaborative and competitive positions that emerge.

Only on this basis will it be possible to make a reliable assessment of, firstly, how platform-based reorganization strategies and processes relate to established organizational and network structures and, secondly, the status they occupy in the overall structure of (inter)organizational transformation dynamics in industry, which are far more multifaceted.

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