Spiekermann, Markus

Article

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Markus Spiekermann

Data Marketplaces: Trends and Monetisation of Data Goods

In today's digital economy, data and information are the most important resources for businesses and society.[1] New technological developments, such as mobile computing and the Internet of Things (IoT) lead to a continuous increase in IT applications that create enormous potential for companies' added value by generating unstructured data.[2] As the raw material for the acquisition of information, data is considered to be of great importance for the (sustainable) economic success of a company.

1 F. Stahl, F. Schomm, G. Vossen: The data marketplace survey revisited, ERCIS Working Papers 18, University of Münster, European Research Center for Information Systems (ERCIS), 2014.

Markus Spiekermann, Fraunhofer Institute for Software and Systems Engineering, Dortmund, Germany.

2 S.A. Fricker, Y.V. Maksimov: Pricing of Data Products in Data Marketplaces, in: A. Ojala, H. Holmström Olsson, K. Werder (eds.), International Conference of Software Business, 2017, pp. 49-66.

They represent the foundation that leverages the creation of new digital services and even new business models.[3] As a strategic resource for companies, data is considered an asset that, like any other material good, has a financial value and whose management generates costs. Data created, collected or used in individual business processes can be sold to other organisations as raw or processed data, so that it no longer serves as an enabler of products, but is the product itself.[4] This leads to the paradigm that data assets can be monetised by exchanging and trading data between organisations.

Against this background, numerous digital platforms have emerged in recent years whose primary business model comprises the trading of raw and processed data and the provision of data-related services.[5] Data marketplaces, which will be considered in more detail in this article, are becoming increasingly popular in theory and practice. In general, the platforms offer an infrastructure for data exchange by acting as intermediaries that create a link between data providers and data buyers.[6]

However, data has different characteristics compared to tangible products that prevent the direct transfer of established processes and rules of trading goods, especially in terms of pricing mechanisms.[7] In trading data, there is less willingness to pay. For example, data buyers often do not recognise the potential value of data items because it cannot be fully disclosed prior to purchase (known as the 'Arrow paradox').[8] In addition, there is often a lack of notion that the creation, processing, storage and distribution of high-quality data is a major cost factor for the data provider. Another obstacle is the lack of trust and security causing potential data providers to fear that competitors could benefit from disclosure of in-house data.[9]

Considering the urgent interest in data marketplaces as trading platforms for data goods, this article aims to provide an overview of the concepts of data marketplaces, current trends and the possibilities for organisations to monetise their data goods. The key questions addressed in this article are the economic and technological characteristics of data marketplaces and how currently existing or rising platforms could be classified.

Data marketplaces

Digital platforms act as intermediaries which connect two or more market participants via the platform and simplify their interaction. By linking several actor groups via the marketplace, a more efficient interaction is made possible through standardised interfaces and services. If a market is determined by a digital platform, these platforms constitute a data-driven overall system that handles all market transactions.[10]

A market is a meeting place for suppliers and consumers who exchange goods among themselves.[11] According to the 'one-sided' view, this exchange (interaction) takes place directly between two distinguishable user groups (market sides). In multilateral markets, on the other hand, the interactions between the market sides are made possible by platforms (intermediaries) which themselves are not involved in the 'direct' interaction.[12]

Despite the large number of academic contributions, there is no uniform definition of data marketplaces.[13] However, different data marketplaces may vary from each other in terms of their underlying business model, type of data offered, functionality, market mechanisms, etc. This means that a clear distinction between the terms 'data marketplace' and 'data provider' (often also referred to as 'data broker', 'data supplier' or 'data vendor') often is not

3 B. Otto, H. Österle: Corporate Data Quality – Prerequisite for Successful Business Models, Berlin 2015.

4 M. Spiekermann, D. Tebernum, S. Wenzel, B. Otto: A metadata model for data goods, in: P. Drews, B. Funk, P. Niemeyer, L. Xie (eds.), Multikonferenz Wirtschaftsinformatik (MKWI), 2018, pp. 326-337.

5 A. Muschalle, F. Stahl, A. Löser, G. Vossen: Pricing Approaches for Data Markets, in: M. Castellanos, U. Dayal, E.A. Rundensteiner (eds.): Enabling Real-Time Business Intelligence, 2012, pp. 129-144.

6 P. Koutroumpis, A. Leiponen, L. Thomas: The (Unfulfilled) Potential of Data Marketplaces, Working Paper No. 53, The Research Institute of the Finnish Economy, 2017.

7 M. Spiekermann, S. Wenzel, B. Otto: A conceptual model of benchmarking data and its implications for data mapping in the data economy, in: P. Drews, B. Funk, P. Niemeyer, L. Xie (eds.), Multikonferenz Wirtschaftsinformatik (MKWI), 2018, pp. 314-325; D. Moody, P. Walsh: Measuring the Value of Information: An Asset Valuation Approach, in: J. Pries-Heje, C. Ciborra, K. Kautz, J. Valor, E. Christiansen, D. Avison et al. (eds.), Proceedings of the 7th European Conference on Information Systems, 1999, pp. 496-512.

8 K.J. Arrow: Economic welfare and the allocation of resources for invention, National Bureau of Economic Research, Princeton 1962, Princeton University Press, S. 609-626; F. Stahl, F. Schomm, L. Vomfell, G. Vossen: Marketplaces for Digital Data: Quo Vadis?, in: Computer and Information Science, Vol. 10, No. 4, 2017, pp. 22-37.

9 P. Miller: Nurturing the market for Data Markets, 2012, available at https://www.cloudave.com/16572/nurturing-the-market-for-data-markets/.

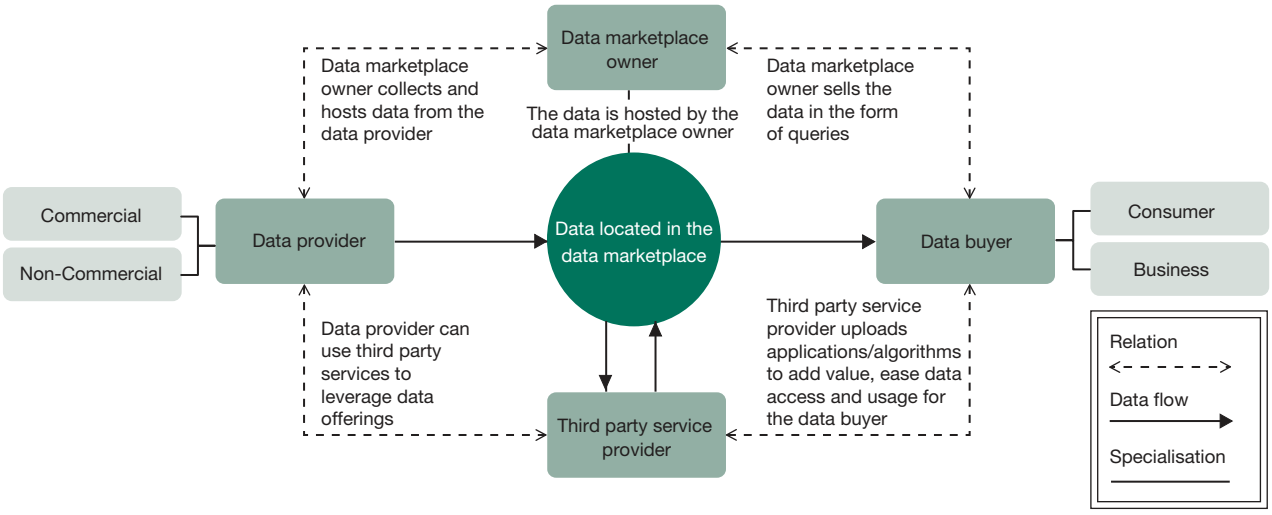
10 S. von Engelhardt, L. Wangler, S. Wischmann: Eigenschaften und Erfolgsfaktoren digitaler Plattformen, iit-Institut für Innovation und Technik in der VDI/VDE Innovation+ Technik GmbH, Berlin 2017.

11 R. Kampmann, J. Walter: Mikroökonomie. Markt, Wirtschaftsordnung, Wettbewerb, First Edition, München 2010.

12 R. Clement, D. Schreiber: Internetökonomie. Grundlagen und Fallbeispiele der vernetzten Wirtschaft, Third Edition, Heidelberg 2016.

13 F. Stahl, F. Schomm, G. Vossen, L. Vomfell: A classification framework for data marketplaces, in: Vietnam Journal of Computer Science, Vol. 3, No. 3, 2016, pp. 137-144.

Figure 1
Role model of data marketplace ecosystems



Source: Own illustration.

made in the literature.[14] In order to form a common understanding of the differences and how data marketplaces are considered in this article, it is therefore necessary to define these concepts.

A data marketplace can be understood as a digital platform on which data products are traded.[15] These platforms must act like a neutral intermediary and allow anyone (or at least a large number of potentially registered customers) to upload and sell their data products. Data marketplaces can provide both static data or (dynamic) data streams and allow access via various access types, such as individual file downloads, APIs or customised web interfaces.[16] Therefore, data marketplaces provide standardised licensing models, as well as regulations regarding data access and usage.

A data provider is an organisation or individual that 'owns'[17] data and offers it to others, either for a fee or free of charge. However, it is important to note that a data provider can make its data available not only in neutral data marketplaces, but also on proprietary closed platforms in bilateral exchange.[18]

For clarification, the relationship between data marketplace operators and data providers as well as other players is explained in more detail in Figure 1.

In recent years, the data market has been dominated mainly by commercial and privately-managed trading platforms that operate within closed systems and sell their data primarily through bilateral exchange relationships.

This dominance is weakening as some multilateral and open data marketplaces have emerged (and continue to emerge) in recent years. Table 1 provides a list of the identified data marketplaces used for further analysis.

Classification of data marketplaces

At the strategy level, the reference focuses on describing the business model of a data marketplace. In order to answer the leading research question, namely to enable the classification of data marketplaces in the context of data economics, a taxonomy is developed that clearly presents the essential elements of the business model in the form of a morphological box and makes the existing solutions comparable on the basis of defined dimensions.

14 One example is the three-year study by F. Stahl, F. Schomm, G. Vossen: Marketplaces for data: An initial survey, ERCIS Working Papers 14, University of Münster, European Research Center for Information Systems (ERCIS), 2012, which uses the term "data marketplace" as a subtype of a "data provider"; F. Stahl et al.: A classification framework..., op. cit.

15 S.A. Fricker, Y.V. Maksimov, op. cit.; P. Koutroumpis et al., op. cit.; J. Lange, F. Stahl, G. Vossen: Datenmarktplätze in verschiedenen Forschungsdisziplinen: Eine Übersicht, in: Informatik Spektrum, Vol. 41, No. 3, 2018, pp. 170-180.

16 S.A. Fricker, Y.V. Maksimov, op. cit.

17 It is important to note that as of today there are no ownership rights in data. The current discussion sees an increasing need for contractual arrangements in the data goods trade, see H. Richter, P.R. Slowinski: The Data Sharing Economy: On the Emergence of New Intermediaries, in: IIC-International Review of Intellectual Property and Competition Law, Vol. 50, No. 1, 2019, pp. 4-29.

18 F. Stahl, F. Schomm, G. Vossen: Marketplaces for data..., op. cit.

Table 1
List of identified data marketplaces

Data marketplace	Company	Country	Source[1]
Advaneo	Advaneo GmbH	GER	https://www.advaneo.de/de/data-marketplace https://www.crunchbase.com/organization/advaneo-gmbh https://www.internationaldataspaces.org/use-case-01-advaneo/
DAWEX	Dawex Systems SAS	USA	https://www.dawex.com/en/ https://www.crunchbase.com/organization/dawex https://www.linkedin.com/company/dawex
Caruso	Caruso GmbH	GER	https://www.caruso-dataplace.com/ https://www.linkedin.com/company/carusodataplace https://www.tecalliance.net/en/official-green-light-for-the-caruso-data-marketplace/
DIH	Deutsche Telekom	GER	https://dih.telekom.net/en/
Streamr	Streamr Network AG	CH	https://www.streamr.com/ https://www.crunchbase.com/organization/streamr https://www.streamr.com/whitepaper https://coinmarketcap.com/currencies/streamr-datacoin/
Qlik DataMarket	Qlik Technologies	USA	https://www.qlik.com/us/products/qlik-data-market https://www.crunchbase.com/organization/qlik-technologies
xDayta	xDayta	USA	http://www.xdayta.com/ https://www.crunchbase.com/organization/xdayta
Kasabi	Kasabi	GBR	https://www.crunchbase.com/organization/kasabi https://www.slideshare.net/ldodds/kasabi-linked-data-marketplace https://gigaom.com/2012/07/09/kasabi-shuts-down-says-data-marketplace-too-slow/
InfoChimps	Infochimps Inc.	USA	https://www.crunchbase.com/organization/infochimps http://radar.oreilly.com/2012/03/data-markets-survey.html http://cloudofdata.com/2013/02/is-infochimps-running-from-the-data-market-business/
IOTA	The IOTA Foundation	GER	https://www.iota.org/ https://data.iota.org https://blog.iota.org/part-1-iota-data-marketplace-update-5f6a8ce96d05
Databroker DAO	SettleMint NV	BEL	https://databrokerdao.com/ https://www.crunchbase.com/organization/databroker-dao https://www.linkedin.com/company/databroker-dao
Microsoft Azure Data Market	Microsoft Corp.	USA	https://msdn.microsoft.com/en-us/magazine/gg309173.aspx https://adtmag.com/articles/2016/11/18/azure-datamarket-shutdown.aspx http://radar.oreilly.com/2012/03/data-markets-survey.html
Otonomo	Otonomo	ISR	https://otonomo.io/platform/ https://www.crunchbase.com/organization/otonomo https://europe.autonews.com/article/20180220/ANE/180229998/israeli-startup-takes-on-google-in-rush-to-process-car-data
Datafairplay	Data Fairplay GmbH	GER	http://www.datafairplay.com/ https://www.handelsblatt.com/technik/it-internet/cebit2014/neue-plattform-data-fairplay-geld-her-fuer-meine-daten/9565908.html

Note: [1] The list presented here is an excerpt of the documents that were used during the literature review.

Source: Own representation.

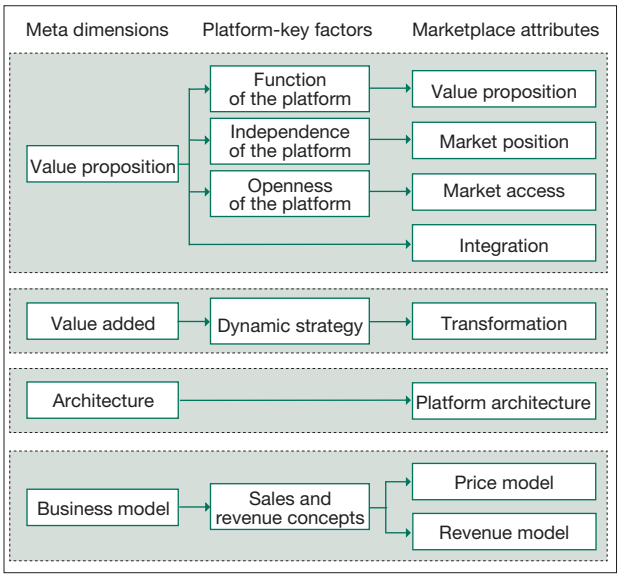
In the following subsections, the development process of the taxonomy, including modelling techniques and design decisions, is described in detail and summarised.

Taxonomy development

Since the taxonomy to be developed should cover all possible business models of the data marketplaces, it must be designed in such a way that it covers the entire bandwidth of the observation framework.[19] Accordingly, Gassmann et al.'s widely accepted concept of the description of business models was chosen as the start-

19 See A. Hanelt, B. Hildebrandt, J. Polier: Uncovering the Role of IS in Business Model Innovation – A Taxonomy-Driven Approach to Structure the Field In: Proceedings of the 23rd European Conference on Information Systems, 2015; R.L. Glass, I. Vessey: Contemporary Application-Domain Taxonomies, in: IEEE Software, Vol. 12, No. 4, 1995, pp. 63-76.

Figure 2
Dimensions of classification scheme



Source: Author's illustration.

Figure 3
Morphological box for the classification of data marketplaces

Attribute	Characteristic				
Value proposition	Transaction-centric	Data-centric			
Market positioning	Data supplier	Neutral			
Market access	Closed	Hybrid	Open		
Integration	Domain-specific	Domain-unspecific			
Transformation	Raw data	Normalisation	Aggregation	Quality assurance	
Architecture	Central	Hybrid	Decentral		
Price model	Free	Fixed price/ subscription	Package	Pay-per-use	Progressive price
Revenue model	Free	Freemium	Flat rate	Fee	
	Listing fee	Transaction fee /commission	Service fee	Storage fee	

Source: Author's illustration.

ing point for the dimension determination.[20] As such, the three elements known as value offer, value creation and value yield represent the meta dimensions of taxonomy development. Furthermore, with regards to the technological infrastructure of a digital trading platform, value architecture was added as an additional meta dimension, which originates from the V4 framework for business modelling of Al-Debei et al.[21] Value architecture is the technological and organisational infrastructure used to deliver products and services to customers.[22]

On this basis, scholarly publications addressing conceptual analysis of data marketplaces and marketplace instances were considered according to sector-specific economic differentiation characteristics. To add another perspective, the key factors for setting up successful digital trading platforms according to von Engelhardt et al. were used to identify the dimensions and correlated with the generally applicable industry-independent business model dimensions.[23] Figure 2 shows the development of the dimensions used in this paper.

20 O. Gassmann, K. Frankenberger, M. Csik: Geschäftsmodelle entwickeln. 55 innovative Konzepte mit dem St. Gallener Business Model Navigator, München 2013.
21 M.M. Al-Debei, R. El-Haddadeh, D. Avison: Defining the Business Model in the New World of Digital Business, Proceedings of the 14th Americas Conference on Information Systems, 2008.
22 M.M. Al-Debei, D. Avison: Developing a Unified Framework of the Business Model Concept, in: European Journal of Information Systems, Vol. 19, No. 3, 2010, pp. 359-376.
23 S. von Engelhardt et al., op. cit.

As illustrated in Figure 2, the meta dimensions served as a general frame of reference and conceptual starting point for the creation of taxonomies. By including the platform key factors, a total of eight final dimensions (or data marketplace characteristics) were derived in the course of the conceptual-empirical procedure that characterise the business model of a data marketplace and differentiate the various solutions.

This section presents the final taxonomy, which consists of eight differentiation attributes and the corresponding characteristic values (see Figure 3). The classification scheme developed is represented in the form of a morphological box, which provides an intuitive insight into the model structure.[24] The development of the classification scheme for the classification of data marketplaces addresses leading research questions.

Identified data marketplace characteristics

The value proposition indicates which core offer the data marketplace provides in order to instil added value for platform users. Here, a distinction is made between transaction-centred and data-centred trading platforms. The former focuses on the switching function of data goods and data services, i.e. the platform brings two parties together,

24 See T. Ritchey: Problem Structuring Using Computer-Aided Morphological Analysis, in: Journal of the Operational Research Society, Vol. 47, No. 7, 2006, pp. 792-801.

either by providing the necessary infrastructure or by direct switching. The data-centric marketplace also provides tools for data analysis, visualisation and preparation within the platform infrastructure in order to gain new insights from the data goods. IOTA, Streamr, and DAWEX are examples of transaction-centric marketplaces. In contrast, the Telekom Data Intelligence Hub, Advaneo, and Caruso are exemplary data-centred trading platforms.

The characteristic market positioning provides information about the independence of the platform. A distinction is made as to whether data marketplaces are operated by the same actors that are also involved in direct data trading (data providers), or whether the marketplace operator is neither on the supplier side nor on the buyer side (neutral).[25] As a rule, large companies in particular operate their own data platforms to manage regular data interactions with third parties, while smaller companies tend to exchange data via neutral platforms.

The degree of openness of a platform is defined by market access. Closed marketplaces regulate access to their platform and are thus limited to cooperation with selected partners. Open marketplaces, on the other hand, are aimed at a broad and unknown group of participants, which increases the activities on the platform through a larger target group, but reduces control over the quality and use of the data products on that marketplace. Mixed forms enable the exchange between selected actors while simultaneously opening a part of their platform for newcomers – if they fulfil certain requirements.

The degree of integration determines the domain spectrum of the data types traded on the marketplace.[26] On the one hand, a data marketplace can have a broad and rather general data offering that extends across several industries or sectors. Yet on the other hand, there are marketplaces that specialise in trading within a particular data domain. The DAWEX Data Marketplace is a prominent example of a cross-domain data marketplace while the Caruso Marketplace is an example of a domain-specific data marketplace.

The characteristic data transformation differentiates the degree to which the data in the marketplace is syntactically or semantically checked and prepared. Thus, the value-added services in raw data trading are limited only to the forwarding of data packages or data streams in the unprocessed form. Within the framework of data normalisation, data is compared with a standardised data model and converted into a syntactically uniform format. In data aggregation, data is collected by the marketplace operator in a report-based, aggregated format, presented and organised into logical packages to prepare combined data sets for further analysis. Quality assurance guarantees the high or constant quality of the data traded on the data marketplace through consistency and quality checks.

With regard to the platform architecture, a distinction can be made between the centralised and decentralised approach.[27] In the former, the data products are offered by different providers via a central location (e.g. a cloud infrastructure), which enables the immediate processing of data within the platform and better access control. In addition, data providers do not need to establish technical and organisational measures to provide data to other actors. With decentralised platform architecture, however, content data remains with the provider. This approach favours the preservation of data sovereignty, but makes the exercise of data processing and data storage more difficult for the actors. Hybrid platform architectures combine both approaches by making decentralised data trading possible and by providing supplementary technical infrastructure support the central approach.

The price model specifies the composition of the final price paid by the data buyer for the data product. Six basic variants can be distinguished.[28] Data from public authorities or non-profit organisations is often available free of charge. Such free data offers help the data marketplace, for example, to attract new users to the platform. In the fixed-price or subscription price model, data is made available for a certain period of use. In the case of package prices, differently staggered packages are offered at a fixed price for a certain period of use and quantity, so that larger packages are more expensive, but relatively cheaper per unit. The pay-per-use model sets a price for each unit consumed and measures the final price based on the units consumed. The progressive price is based on the demand for the data products. Accordingly, the price increases the more customers purchase a license to use the data set. This price model is used if, for example, the dissemination of data products is to be restricted.

The revenue model refers to the specific pattern of turnover generation, i.e. it explains how the marketplace operator earns money. Marketplaces usually calculate a commission for each data transaction. Fees are also charged for data marketplace membership, listing of data products, storage space or use of data services. With Freemium revenue models, the platform user must pay a fee for an extended or full range of functions, while basic functions

25 H. Richter, P.R. Slowinski, op. cit.
26 J. Lange et al., op. cit.
27 P. Koutroumpis et al., op. cit.
28 F. Stahl, A. Löser, G. Vossen: Preismodelle für Datenmarktplätze, in: Informatik-Spektrum, Vol. 38, No. 2, 2015, pp. 133-141.

can be used free of charge. In the flat rate tariff, customers pay a lump sum irrespective of the scope of use of the service. There are also marketplaces (particularly those of the public authorities and non-profit organisations) which make their platforms available free of charge and without restrictions.

Challenges and trends

There is currently a clear trend towards the development of new trading platforms specialising in the commercial exchange of data.[29] Data as an economic asset is a high priority in the aforementioned development of a data economy, which has a significant influence on business models and the overall efficiency of business processes.[30] In 2015, about 70% of large companies bought data and it is expected that this will rise to 100% in 2019. Simultaneously, a growing number of companies are beginning to make money selling their data.[31]

Therefore, data marketplaces, which were identified by a review of different scholarly as well as practitioner's publications during a heuristic web search, are analysed by their characteristics to provide an overview of the current meta of data marketplace approaches (see Table 2). The selection is limited to data marketplaces with a commercial focus and therefore does not take into account the multitude of available platforms on which data can be made available for non-commercial purposes, often referred to as open data.

Challenges

As illustrated in the market analysis, data are still rarely traded in practice via multilateral data marketplaces.[32] Thus, it appears difficult to establish data marketplaces permanently on the market. The challenges of data trading and cross-company data exchange are reflected in the abundance of data marketplaces that have failed in recent years. Prominent examples are Microsoft's Azure Data Marketplace, which withdrew from business in 2017 due to a lack of demand after some years of operation, as well as xDayta or Kasabi. Other marketplaces such as InfoChimps or Data Market have deviated from their original business model and no longer represent data marketplaces in terms of the article's definition.

A major obstacle in data sharing is the lack of trust and security. Data owners fear the loss of control over their data if it is reused by third parties.[33] In addition, companies worry that their data could be useful to other stakeholders and in such be harmful to their own business interests. Another reason for the failure of data marketplaces can be attributed to the fact that many customers are not prepared to pay the required price for the data. This is partly because they do not recognise the value of the data before purchasing it and partly because the costs associated with ensuring data quality are not understood.[34] As a matter of fact, there is a need for clear valuation procedures, which are not yet available, mainly because data has fundamentally different characteristics than material goods.[35]

Furthermore, the absence of legal frameworks restricts the advancement of data marketplaces, which leads to considerable legal uncertainty with regard to trading data. For instance, data as such is currently not protected by intellectual property rights.[36] Thus, there are no clear liability rules that could be asserted in the event of violations of the terms of use. In order to solve this problem effectively, changes to the applicable law are to be expected by 2025 in order to specify both the concept of data ownership and exploitation claims more precisely.[37]

Despite the mentioned obstacles, the analysis of the current data market shows a clear trend towards the development of new trading platforms specialising in the commercial exchange of data.[38] Due to the rapid and agile development of data economics, providers of data marketplaces see increasing potential – as acceptance by customers grows over time.

These challenges are addressed by the emergence of data marketplaces that offer multilateral platforms with minimal entry barriers and thus reach non-technical companies and users (e.g. Dawex, IOTA, Databroker DAO and Streamr).[39] The literature and market research has shown that the current data marketplace concepts vary greatly depending on the data available and the strategic business interest. The focus, however, is increasingly on the emerging IoT and AI

29 J. Lange et al., op. cit.
30 B. Otto, H. Österle, op. cit.
31 IDC: FutureScape for Big Data and Analytics, 2015, available at https://www.businesswire.com/news/home/20141211005981/en/IDC-Reveals-Worldwide-Big-Data-Analytics-Predictions (22.7.2019).
32 P. Koutroumpis et al., op. cit.
33 P. Miller, op. cit.
34 P. Miller, op. cit.; F. Stahl et al.: Marketplaces for data..., op. cit.
35 D. Moody, P. Walsh, op. cit.
36 H. Richter, P.R. Slowinski, op. cit.
37 B. Benders, C. Burkard, J. Küfen, Y. Ostad: Wirtschaftliche Verwertungsmöglichkeiten für Mobilitäts- und Infrastrukturdaten, IKT für Elektromobilität, Berlin 2018.
38 J. Lange et al., op. cit.
39 P. Koutroumpis et al., op. cit.; F. Stahl et al.: Marketplaces for data..., op. cit.

Table 2
Classification of data marketplaces

Data marketplace	Value proposition	Market positioning	Market access	Integration	Data transformation	Platform architecture	Price model	Revenue model	Status	Founded	Closed
Dawex	Transaction	Neutral	Hybrid	Unspecific	Raw Data	Centralised	Fixed-price	Freemium	Active	2015	
IOTA	Transaction	Neutral	Hybrid	Specific	Raw Data	Decentralised	Progressive	Transaction Fee	Beta	2017	
Databroker DAO	Transaction	Neutral	Hybrid	Specific	Raw Data	Decentralised	Progressive	n/a	Beta	2017	
Streamr	Transaction	Neutral	Hybrid	Unspecific	Aggregation	Decentralised	Progressive	n/a	Active	2017	
Data Intelligence Hub	Data	Neutral	Hybrid	Unspecific	Raw Data	Centralised	Multiple	Transaction Fee	Active	2018	
Advaneo	Data	Neutral	Hybrid	Unspecific	Raw Data	Centralised	Fixed-price	Transaction Fee	Active	2018	
Otonomo	Data	Neutral	Hybrid	Specific	Aggregation	Centralised	Fixed-price	Transaction Fee	Active	2015	
Datafairplay	Transaction	Neutral	Hybrid	Specific	Normalisation	Centralised	Progressive	Transaction Fee	Withdrew	2014	2018
InfoChimps	Transaction	Neutral	Hybrid	Unspecific	Raw Data	Centralised	Fixed-price	Transaction Fee	Withdrew	2009	2013
Qlik	Data	Provider	Hybrid	Unspecific	Raw Data	Centralised	Package	Freemium	Active	2017	
xDayta	Transaction	Neutral	Open	Unspecific	Raw Data	Centralised	Fixed-price	n/a	Withdrew	2013	2015
Kasabi	Transaction	Neutral	Open	Unspecific	Normalisation	Centralised	Fixed-price	Freemium	Withdrew	2010	2012
Here OLP	Data	Provider	Hybrid	Specific	Aggregation	Centralised	Multiple	Freemium	Active	2018	
Azure Data Marketplace	Transaction	Neutral	Hybrid	Unspecific	Raw Data	Centralised	Fixed-price	Transaction Fee	Withdrew	2010	2017
International Data Spaces	Data	Neutral	Hybrid	Unspecific	Raw Data	Decentralised	Multiple	Transaction Fee	PoC	2016	
Caruso Dataplace	Data	Neutral	Hybrid	Specific	Aggregation	Centralised	Multiple	Membership Fee	Active	2017	

Source: Own representation.

sectors.[40] The development is additionally fuelled by the widespread use of blockchain technology, whose integration into the marketplace infrastructure supports the execution of independent transactions via smart contracts and thus promotes a high level of transaction integrity and data sovereignty.

Trends

A large number of such platforms are currently in their conceptual phase.[41] Therefore, at this stage, it is only possible to outline probable development scenarios in which the findings from conventional platform development can be applied to a certain extent, taking into account their core functions and the specific characteristics of the data.

With regard to the matching function, data marketplaces benefit from network and scale effects as long as they can maintain the trust of their users.[42] If a trading platform is not geared to a specific domain but to a cross-industry data market, growth is to be expected. Hence, it can be assumed that sooner or later the economy for data exchange will consolidate if market participants are able to build and maintain the trust required for large-scale data exchange.[43] Currently, however, the challenge appears to

40 T.D. Cao, T.V. Pham, Q.H. Vu, H.L. Truong, D.H. Le, S. Dustdar: MARSA: A marketplace for realtime human sensing data, in: ACM Transactions on Internet Technology (TOIT), Vol. 16, No. 3, 2016, pp. 16-37; P. Gupta, S.S. Kanhere, R. Jurdak: A Decentralized IoT Data Marketplace, Proceedings of the 3rd symposium on Distributed Ledger Technology, 2018.
41 J. Lange et al., op. cit.
42 B. Otto et al., op. cit.
43 H. Richter, P.R. Slowinski, op. cit.

be greater than the critical mass of users (also known as the chicken-and-egg problem).

At the same time, the provision of value-adding data-related services beyond the core functions of a data marketplace appears to be a key success factor.[44] One example is the recently opened Data Intelligence Hub, an independent trading platform specialising in data exchange between companies and simultaneously providing an environment for data analytics. The decisive factor is how such synergies drive the markets and how data providers are encouraged to offer their data.

Finally, the future development of markets and interdependencies between companies depends to a large extent on technical interoperability standards that enable extensive data exchange.[45] The crucial question will be how proprietary these standards are and how they are defined. For example, platform competition can lead to different standards, while at the same time a dominant platform can set a de facto standard.[46]

Conclusion

Data trading is establishing itself as an increasingly important business segment in which data marketplaces play a key role as digital trading platforms. Such platforms are moving to the center of the data economy by providing an infrastructure for trading data and data-related services, thereby increasing the willingness to exchange data. Furthermore, they enable access to large, high-quality data sets and create the capacity to monetise a company's own database. Despite growing awareness of the data market, most data marketplaces are still in their infancy. Due to the enormous interest in the data economy and data monetisation, this is astonishing to both the theoretical and practitioner communities.

As data and information are getting more important for creating business value and generating money, the concept of data marketplaces makes perfect sense. However, differences can be identified due to specific characteristics of data when transferring the characteristics of existing markets for tangible products and their marketplace structures. These differences were confirmed by the review of the academic and practitioners' literature on data marketplaces. Various attributes and distinguishing features of data marketplaces were identified. In order to work out these differences and to enable a structured classification, a morphological box was developed and presented.

The results help to structure the field and, by emphasising the current challenges and trends, give guidance for further research. Because of the rising interest in monetising data resources, data marketplaces are expected to advance to the center of the data economy by forming a neutral, scalable and systematic structure for the trading of data goods of various kinds.

44 B. Otto et al., op. cit.
45 B. Benders et al., op. cit.
46 H. Richter, P.R. Slowinski, op. cit.