Value Capturing from Tokenized Asset Histories

Ingrid Bauer[a, *] *and Gerhard Schwabe*[a]

Summary: Digital tokens have sparked the interest of many businesses as they enable them to attribute value to digital objects and create novel ways for handling these. In the context of the used car trade, creating a unique representation of a car's history (i.e., a tokenized car history) can help reduce information asymmetry and offer potential for businesses aiming to monetize their so far unutilized data resources. Having reached sufficient maturity, businesses developing tokenized asset histories are more and more questioning how they will best capture these newly created values. Applying design science research methods, we (1) propose two designs for offering and pricing tokenized asset histories and (2) evaluate their business implications for its providers through an experimental market game with 102 participants. The results indicate that users can be granted control over the offering and pricing tokenized asset histories without sacrificing its value but significantly increasing its trade and revenue.

Keywords: Token Economy; Tokenized Asset Histories; Value Capturing; Blockchain Technology; Information Asymmetry.

Wertschöpfung aus tokenisierten Historien von Vermögensgegenständen

Digitale Token haben das Interesse vieler Unternehmen geweckt, da sie ermöglichen, digitalen Objekten einen Wert zuzuschreiben und dadurch neue Wege für deren Handel zu schaffen. Im Gebrauchtwagenhandel bietet die Erstellung einer nachvollziehbaren, einmaligen Dokumentation der Fahrzeughistorien, oder besser gesagt der tokenisierten Autohistorien, grosses Potenzial. Zum einen erlauben diese, Informationsasymmetrien zwischen Käufern und Verkäufern zu verringern, und zum anderen ermöglichen sie Unternehmen aus dem Fahrzeugökosystem ihre bislang ungenutzten Datenressourcen zu monetisieren. Da die Entwicklung solcher tokenisierter Historien von Vermögensgegenständen eine ausreichende Reife erreicht hat, stellen sich Unternehmen zunehmend die Frage, wie sie diese neu geschaffenen Werte am besten abschöpfen können. Unter Anwendung gestaltungsorientierter Forschungsmethoden schlagen wir (1) zwei Designs für das Angebot und die Preisgestaltung von tokenisierten Vermögenshistorien vor, und (2) bewerten die geschäftlichen Auswirkungen für die Anbieter durch ein Planspiel mit 102 Teilnehmern. Die Ergebnisse zeigen, dass der Handel und die Einnahmen mit tokenisierten Vermögenshistorien erheblich gesteigert werden, wenn den Nutzern die Kontrolle zum Angebot und zur Preisgestaltung überlassen wird.

a Department of Informatics, University of Zurich, Zürich, Switzerland.
* Corresponding author.

Stichworte: Token-Wirtschaft; Tokenisierte Vermögensgegenstände; Wertschöpfung; Blockchain; Informationsasymmetrie

1. Introduction

Tokenization sparks the interests of the art business (Franceschet et al., 2021), the music industry (Chalmers et al., 2021), tourism (Treiblmaier, 2020), and many other areas. Digital tokens are defined as the unique, digital representation of something (Oliveira et al., 2018). They allow attributing value to digital objects that were difficult to evaluate before and to handle these objects in ways not possible before (Miscione et al., 2020). One important sub-area is the tokenization of data. Tokenized data is special in that it may have a higher trading value than data that can be copied without costs (Mazzei et al., 2020). Further it can allow greater transparency and increase trust about the data. But how should the trade of tokenized data be organized? This is the question that was raised in the Carfile consortium[1], which strives to create a comprehensive digital history of a car using a blockchain platform. Such a 'car history certificate', has significant value if a car is traded: Car buyers can use it to verify the state of the car. As creating and running the platform is expensive, the Carfile consortium searched for a way to capture the value of the stored data. The interesting trait of this stored car history is that it loses its value if moved outside the platform: Only the Carfile platform assures that the data is correct, complete, and up-to-date. Outside the Carfile platform, it is just an unsubstantiated and largely worthless claim. So, a car history certificate, drawn from the Carfile platform, is a unique representation of a car's history, i.e., a tokenized car history.

Like in the case of the Carfile consortium, the interest in tokens has been triggered by the rise of blockchain technologies in many areas like the music, the art or the jewellery business. However, increasingly practitioners have become aware that tokens can also be realized using centralized platforms. For example, the European Central Bank plans to issue the digital Euro using a centralized platform (European Central Bank, 2021). The choice between a centralized and a decentralized approach depends on economic criteria, such as the feasibility and the desirability of a central platform (Bauer, Parra-Moyano, et al., 2022; Zavolokina, Ziolkowski, et al., 2020). In the case of the Carfile, the members were afraid that a centralized platform provider might become too powerful, and they did not trust any consortium member to take over this role. Thus, they opted for a decentralized approach using a distributed ledger. However, it is conceivable that car manufacturers use their economic power and their direct access to the car to provide a car history. Or that digital giants like Google gain access to car histories. Either way, any of them will face the issue of how to best capture the value of a tokenized car history. While value creation is vital for satisfying customer needs, creating adequate revenue streams to turn the newly created value into profits (i.e., capture the value) are just as critical to businesses (Chesbrough, 2002; Osterwalder et al., 2005). And this issue is faced not only by the car ecosystem aiming to tokenize car histories (Bauer et al., 2020; Bauer, Zavolokina, Leisibach, et al., 2019) but also by many other projects aiming to tokenize histories of buildings (Gupta et al., 2020) or precious stones (Mohanty, 2019) for example.

The key issue in any offer is the pricing. Most prior research on pricing information (e.g., digital newspapers) looked at prizing only from the perspective of central informa-

1 Anonymized.

tion providers to information consumers (Varian, 1995). Here the production cost of the producer and the utility of the consumer determine pricing models. However, more recent research (Parra-Moyano et al., 2020) indicates that pricing a tokenized asset history (such as the Carfile) could follow more sophisticated rules by granting users more control of their own data resources. But how can a platform make use of this insight to increase its revenues? And how can this be implemented? In this study we use the 'instance problem' (Lee et al., 2011) of the Carfile consortium to more tangibly demonstrate our case however with the overarching goal of studying the abstract problem of value capture from tokenized asset histories (in the following referred to as TAHs). Therefore, we ask the following research question:

RQ: *How can tokenized asset histories be offered and prized to advance trade and revenue for its providers?*

Applying Design Science Research (DSR) methods, in this study, we substantiate prior suggestions for the pricing and offering of TAHs and evaluate its effectiveness through an experimental market game. We suggest that users can be granted control over the offering and pricing of TAHs. Thus they could be offered as tools for sellers to further support their ability to signal product quality (Stahl & Strausz, 2017). To evaluate and contrast the impact of this approach against established modes of pricing and offering of TAHs on business success, we conducted an experimental market game with 102 users. Applying a between-subject design, the market game simulated the used-car market and employed one of the two modes of TAH pricing and offering (i.e., platform- vs. seller-controlled). The results show that by applying a seller-controlled pricing and offering mode, both trade with TAHs and revenue from TAH purchases for its providers significantly increases.

2. Related Work

Tokenized information can be used for documenting and managing real-world assets to increase transparency in markets that struggle with information asymmetries (Notheisen et al., 2017). The used-car market is probably the predominant example of a market struggling with information asymmetries between buyers and sellers and has been termed as the “market for lemons” by Akerlof (1970). The lack of information about product quality on the buyer’s side and the inability of sellers to prove product quality leads to enormous inefficiencies and a loss of social welfare (Clemons & Thatcher, 1997), even today (European Parliament, 2018; The Economist, 2019). Businesses in the car ecosystem (e.g., car manufacturers, car insurers, or used-car dealers) aim to address the problems of information asymmetries through the use of blockchain technology (Bauer, Parra-Moyano, et al., 2022). Zavolokina et al. (2020) argued that in the car ecosystem, blockchain technology enables multiple businesses to develop an inter-organizational information system that decentralizes market power and avoids yet another Google or Facebook for car data. Similarly, Bauer, Ziolkowski, et al. (2022) studying 19 blockchain consortia from different domains, show that the use of blockchain is not only a matter of technical feasibility but a complex decision including a variety of different motives that address many socio-technical aspects. Thus, following regulatory demands for decentralizing the power of platforms (Schallbruch et al., 2021), car businesses see an opportunity to finally monetize the increasingly available car-related data by building on blockchain technology and offering novel data-driven products and services (Bauer et al., 2020; Bauer, Zavolokina, Leisibach, et al., 2019). Drawing on the data sources of many different stakeholders will allow them to document the whole life cycle of a car and offer tokenized car histories (i.e., unique digital representations of a car) to buyers and sellers in the used car market (Zavolokina, Miscione, et al., 2020).

Initial exploratory studies indicate that TAHs, could indeed offer valuable information products in the form of verified data entries or analysis and increase the value of used cars by approximately 7 % (Bauer, Zavolokina, & Schwabe, 2019). While the results are promising, open questions remain regarding how the platform providers should offer such TAHs to increase trade among users and revenue for its providers that will finance its operation.

While car history certification, in general, is not novel, TAHs provide immutable proof of the origin of the record history (Koutroumpis et al., 2020) and allow to establish uniqueness and scarcity in terms of ownership of it (Miscione et al., 2020). Consequently, providers of TAHs have the potential to provide more control over the use (e.g. in terms of offering and pricing) to the actual owners of the physical cars and thus their digital twins (Parra-Moyano et al., 2020; Subramanian, 2018). Such power shifts from data cooperatives to individuals are increasingly demanded from a legal point of view (Schallbruch et al., 2021). While this sounds promising, empirical analysis of how this can be applied and on the effects on its provider's business success does not yet exist.

Analysing prior work on existing designs for the offering and pricing of certification in opaque markets in similar context (i.e. without building on DLT), Stahl and Strausz (2017) propose two essential business models for providers of certificates that differ in their effect on the market. "Buyer certification" and "seller certification," as they term them, differ regarding whom certification is offered to and who eventually pays for it. In the "buyer certification" model, the buyer can buy certification from a third-party certifier and use it for inspection. In the "seller certification" model, certification is offered to sellers who pay for it and use it to signal product quality. The researchers argue that seller certification, by its nature, is more informative than buyer certification. While in the case of buyer certification, a lack of certification reveals nothing about a product's quality, in the case of seller certification, no disclosure of certification indicates that the seller has something to hide (Stahl & Strausz, 2017). While seller certification serves both buyers and sellers in opaque markets, buyer certification is only useful to buyers; it does not enable sellers to signal product quality (Stahl & Strausz, 2017). Apart from this theoretical analysis by Stahl & Strausz (2017), literature that investigates different modes of offering and pricing certification is rare. A paper proposed by Durbin (1999), for example, compares the sale of guidebooks to buyers privately to selling certificates to sellers that publicly certify the quality of their goods. Research proposed by Fasten & Hofmann (2010) examines two-sided certification for rating agencies. However, neither of these proposals analyses empirically the effects as well as their impact on the certifier's revenue.

3. Methods

Originating from computer and engineering science, DSR is aimed at solving practical problems with the design of new IT artifacts that extend the current capabilities of individuals and organizations (Hevner et al., 2004; March & Smith, 1995). The problem at hand that we aim to address with this research is the lack of design knowledge concerning the pricing and offering of TAHs and their effects on its provider's success. We observed these problems in a real-world blockchain project called Carfile, which we will introduce in the following section. Thus, the rationale for a design science approach is the design and development-centered initiation aimed at designing and evaluating instantiations of pricing and offering schemes of TAHs (Peffers et al., 2007). As part of the design cycle (Beck et al., 2013), the goal is to address the lack of both academic and practical knowledge of how different pricing and offering modes affect the artifact use and profits. Following the three cycles of relevance, design, and rigor proposed by Hevner (2007), we first identified the problems both in related works and in the application domain (rigor and relevance). Next, we built on the concepts introduced in the related work section and designed instantiations of the artifact (design). We then applied experimental techniques, through the use of a market game, in order the evaluate the two designs (evaluate). Finally, through the means of this paper, we report on our findings, position them in the context of prior work, and provide important design insights for practitioners (rigor and relevance).

In the following sections, we first elaborate on the problem field from a practical perspective by introducing the Carfile project. We then explain the artifact design. Thereafter, we introduce how the experiment was set up and conducted and how the resulting data was analysed.

3.1 The Carfile Project as exemplary use case

Carfile is a real-world blockchain project where several car-related businesses have formed a consortium to develop a decentralized car ledger to monetize their data resources. The consortium utilizes the technical mechanisms of blockchain as they allow the involved businesses to decentralize system governance. It also allows them to tokenize data events, thus ensuring transparency and traceability over data provenance. Offering TAHs – in the form of verified car data entries and analysis services in different information categories – to buyers and sellers in the used car market that are currently suffering from information asymmetries, the initiators hope for novel business potential. Initial innovation funding and the current membership fees were sufficient for the first prototyping phase, but now the consortium is questioning how tokenized car histories could be offered and priced to achieve long-term sustainable revenue for their use. Estimates provided by car retailers that are members of the consortium indicate that each car history certificate may be worth approximately CHF 100. As around 800,000 used cars are sold each year in the regional market that Carfile is targeting, the potential market volume of TAHs in the region – if, on average, one certification is sold per traded used car – is about CHF 80 Million. If we assume that buyers investigate more than one car, this number is even higher. Yet, these are only estimates based on comparisons with current existing solutions (such as Carfax or Eurotax). However, the consortium is questioning whether novel seller-controlled approaches, enabled by TAHs, are a successful alternative from a business perspective.

3.2 Artefact Design

For the design of the offering and pricing functions of TAHs, we drew on the earlier works introduced above, as well as insights gained from the Carfile project. Based on these insights, for two years, two dominant modes of offering and pricing TAH were designed and implemented: platform- and seller-controlled offering and pricing. While offering refers to what information is offered in the Carfile, pricing builds on the offering and describes who sets the prices for the offerings.

In *platform-controlled* (PC) design, all information included in a Carfile is offered and priced by the platform. The offering is available to all interested parties if they paid for it the set price. The platform sets all prices, and the seller receives a fixed share of the revenue. This revenue share rewards the seller's "data ownership" and incentives to share data. In the *seller-controlled* (SC) design, the seller decides which information is offered to the buyer by setting prices respectively. He can, in fact, refuse any request for information by charging an astronomical price for it. In the seller-controlled design, the platform decides only its own price for the data sale. The seller has the opportunity to determine its own return on data trading via a markup or markdown on the platform price. This yield can also be negative (i.e., he can subsidize the data purchase by the buyer). In this way, building on Stahl & Strausz, (2017), he can potentially signal the high quality of the car. All in all, as mentioned, the platform-controlled mode represents the "as is" situation, where a platform (i.e., a third-party certifier like Carfax or Eurotax) offers tokenized car histories to both buyers and sellers of used cars. Whereas the seller-controlled mode emerged as a further development and instantiation of the proposals of prior works (Parra-Moyano et al., 2020; Stahl & Strausz, 2017)), and ideas from the collaboration with Carfile.

The designs were iteratively developed over the course of a year and constantly evaluated through workshops with members of the Carfile consortium. These workshop participants were mainly car importer and retailer, owners of online market places for used-cars as well as mobility services providers. The workshops with the partners took place at about every fourth month once a new design emerged. Initially, the researchers developed conceptual models and sequence flows of potential pricing and offering functions. Building on the feedback of partners from the Carfile project, these were refined and presented as mock-ups. After another workshop iteration with project partners, the designs were again refined and finally implemented. The final artifact design was then tested with managers and employees of the businesses involved in the Carfile project before the final experimental evaluation.

Following prior research, the offered *TAH types* included both data and analysis (Bauer, Zavolokina, & Schwabe, 2019; Zavolokina, Miscione, et al., 2020). While data is produced by the individual stakeholder in the consortium (e.g., road-traffic authorities, insurers, importers and, potentially, private users), analysis is considered as an extra service provided by Carfile and assumed to incur additional costs. Table 1 below summarizes the different TAH types, explains how they are generated, and gives an example for each.

TAH Types	Explanation and Example
Data	Data is provided by the individual stakeholders and shows a verified data entry. Example: *Mileage wear: "250,000 km"*
Analysis	Analysis for each car is a service additionally provided by industry experts. It represented an evaluation and a recommendation of the verified data entry. Example: *Mileage wear: "250,000 km indicates a high mileage wear, leading to a 10 % deduction of the market prices"*

Table 1 – TAH Types

Besides that, TAHs provided in the form of data and analysis are offered in three information categories: *(1) general car usage, (2) repair and service, and (3) driver dynamics*. The information categories were discussed and designed in collaboration with industry experts who are part of the Carfile consortium. As mentioned, in the platform-controlled instance, Carfile controlled and preset the prices of the TAH types in all information categories and offered these equally to both buyers and sellers, with one exemption, namely that sellers were granted free access to the data about their own car. This was done to account for their information advantage, as it was their task to put themselves in the role of truly selling "their own" car. However, the sellers could not release this information to their counterparties in a secure manner supported by the Carfile TAH application. Only in the seller-controlled instance were they able to do so. In case they decided not to make any changes, by default, the same prices as in the PC instance were displayed. These ranged between CHF 15 and CHF 20 for data and between CHF 20 and CHF 25 for analysis, dependent on the information category. For revenue distribution, both the PC and SC pricing and offering modes follow the same basic idea of dividing the achieved revenue generated from TAH purchases fairly according to where costs are incurred. In collaboration with Carfile, the following rules were applied: *Data sale:* A 70:30 distribution is applied, where used-car sellers receive 70 % of the revenue from the data sales and its providers receive 30 % of the revenue. In the case of SC pricing, if sellers decide to publish their data freely, no revenue is generated. Hence, nobody receives any revenue. *Analysis Sale:* 100 % of the revenue goes to the platform operators since this is a service provided jointly by the experts from the Carfile consortium. Table 2 summarizes the two modes and describes the sellers' level of control for each TAH type. Additionally, Figure 1 shows how sellers in the SC instance could study their data, purchase analysis, and manage prices per information category.

Instance	Description
PC: Platform-Controlled	**Carfile has central control over pricing and offering TAH types.** **Data:** Sellers are granted free access to their data in all categories to account for their information advantage. Buyers have to pay a fixed fee per data category that is the same for all cars on the market. Sellers have no option to release the data to buyers in a secure Carfile App-supported manner. **Analysis:** Both buyers and sellers have to pay the same fixed fee for analysis that is the same for all cars on the market and only slightly varies per information category.
SC: Seller-Controlled	**Sellers have individual control over pricing and offering TAH types.** **Data:** Sellers are granted free access to their data to account for their information advantage. Further, sellers of used cars can set the prices for their data themselves. They can set a price between CHF 0 and CHF 100,000. If they choose to set the price to CHF 0, they offer their data free of charge to all interested buyers on their car advertisement page. If they set a price, buyers have to pay this price to view the respective data. **Analysis:** Sellers can buy the analysis themselves for a fixed price. Additionally, they have three options to manage the release of analysis to potential buyers (per information category): (1) they can opt to not take over any costs for potential buyers interested in their analysis; (2) they can opt to split costs with potential buyers and take over a certain percentage (1 %-99 %); and (3) they can opt to take over 100 % of the costs.

Table 2 – Modes of Pricing and Offering TAHs types

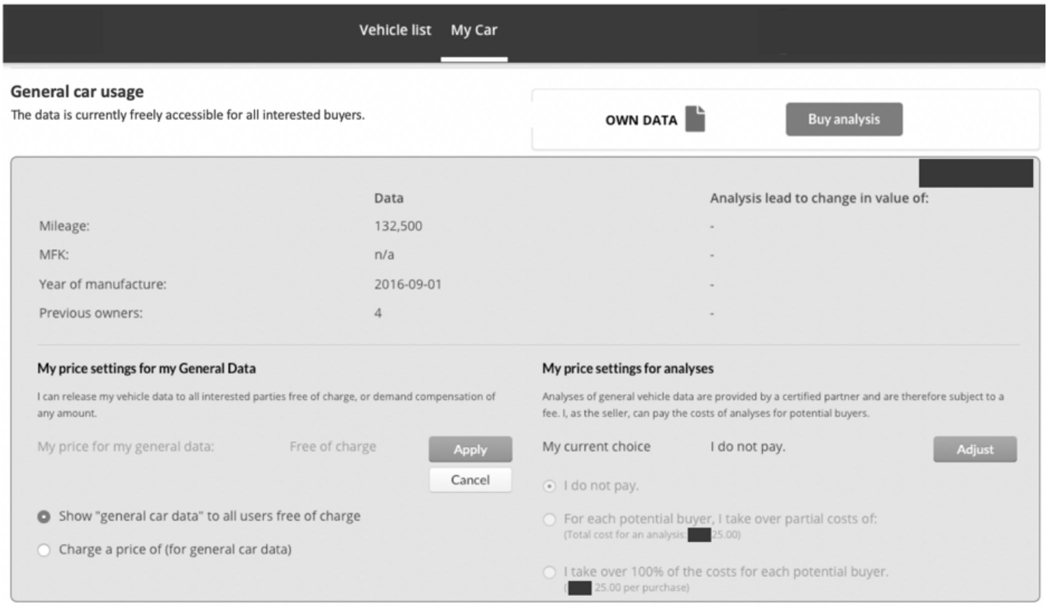

Figure 1 – SC instance: Sellers' options for offering and pricing TAHs

3.3 Evaluation

To evaluate the two designs for offering and pricing TAH, we applied experimental techniques through the use of a market game. This market game (called CarMarket) simulated the used-car market and allowed us to embed TAHs. According to Stebbins (2001), besides serving the validation of theoretical models, experimental techniques are a well-suited method to discover and describe phenomena and their correlations in the course of exploratory research. Further, experimental techniques within DSR enable the designer to measure whether the outcome that they want to achieve with the IT artifact has been achieved (Briggs & Schwabe, 2011). Finally, they enable the designer to explore market dynamics and agents' behavior, and hence, inform early the design of novel systems (Roth, 2002).

CarMarket was designed and implemented as a rebuild of the currently existing and well-established used-car market platform AutoScout24. For this, we were granted access to all relevant information by AutoScout24. While AutoScout24 offers a variety of additional services, next to buying and selling used cars, for our study we minimized the rebuilt platform to the core functionalities relevant for testing the IT artifact TAH. These included the registration of users and cars, and the core marketplace functions of offering and searching for used cars. In addition to AutoScout24's functions, we included the possibility for users to negotiate via a simple chat function and the possibility to close a deal online via CarMarket. Besides that, the ability to offer and buy TAHs was embedded into the CarMarket rebuild, and the administrator of the system could switch between the two modes of offering and pricing TAHs (i.e., platform- vs. seller-controlled). For the experiment, CarMarket was installed on two different servers and made accessible for users via two different URLs (installing one of two different pricing and offering modes). To account for external validity, we discussed and developed CarMarket iteratively in collaboration with AutoScout24 for the online used-car market setting, and with experts from the Carfile consortium to integrate TAHs. For the experiment, AutoScout24 also granted access to real used cars currently available on the used-car market. We ensured that a certain portion of cars that had below-average quality and a certain portion of cars that had above-average quality were included in the sample, following current research (Blundell et al., 2019; European Parliament, 2018; The Economist, 2019). The additional novel data used for simulating TAHs was created in collaboration with Carfile based on their expertise and expectations of future data availabilities.

Prior to the main experiment, we conducted multiple smaller tests of the experiment with both experts from Carfile and with students. In the experiment with experts from the Carfile consortium 10–15 participants form three partner companies participated. Drawing on the experts' views, we ensured the validity and accuracy of the experimental market game setting in relation to reality. The test performed with a smaller student group (20–30 participants) enabled us to test the understandability and internal validity of the experiment with non-experts.

After smaller pretests, we conducted the large-scale experiment with 102 students from a master's program in Business Administration at the local university. The students were strongly incentivized to act in a realistic manner by the opportunity to earn bonus points for their final exam. The number of bonus points they received depended on the results achieved from the used car sale, including their information costs spent on and earned from trades with TAHs. Approximately 70 of the 130 students enrolled in this class normally attend the sessions. For this experiment session, 105 students signed up and participated, thus indicating that the incentives of earning bonus points for the final exam indeed worked. The objective of all players was to maximize their relative revenues. We chose the relative revenue as a measure of success, to account for the fact that the values of the cars slightly differed from each other. In other words, it did not matter whether a student bought a rather expensive or a rather cheap car. The relative revenue was calculated based on the actual value[2] of the car compared to the sales price, plus accounting for the participants' expenditures and revenues from TAH sales and purchases. Using students as study objects can yield results that are just as reliable as using actual customers if they have sufficient knowledge about the study environment (Höst et al., 2000). Hence, to account for sufficient background knowledge, we purposefully selected an economics class where the students have just learned about the market for lemons problems along the used-car market example theorized by Akerlof (1970). Finally, also a proper introduction of the Carfile project and blockchain was provided. All relevant information was communicated and explained to the students twice. First, a week in advance, preparation material in the form of a written document and a screencast was sent out. Second, at the beginning of the lecture, a vocal explanation and a live walk-through of the system were provided.

Just before the start of the game, the participating students were divided into two groups, and each group was instructed to use a separate instance that employed one of the two pricing modes. To ensure internal validity, we accounted for a random but equal distribution of the students between the two game instances (List et al., 2010), and applied a between-subject design (Qureshi & Compeau, 2009). Out of the 105 students who signed up for the experiment, one student had technical issues at the beginning of the game and ceased participation. Two other students sold their cars immediately after it was published for CHF 1 and CHF 10 as the participants had wrongly placed a decimal separator. Hence, in the end, we had 102 participants who seriously participated, of whom 49 participated in the platform-controlled (PC) instance, and 53 participated in the seller-controlled (SC) instance. Each group had exactly 60 minutes for the market game.

After the experiment was conducted, we analysed the log files and focused in particular on data trade and revenue to evaluate the effects of the two pricing and offering modes of TAHs. As each student participated in both roles (buyer and seller), in total, on the PC market, 49 cars were offered and on the SC market, 53 cars were offered. Of these 49 and 53 cars, 32 and 34 cars, respectively, were finally sold. The remaining sellers of cars did not reach a final agreement during the given 60 minutes. Hence 17 cars in the PC instance and 19 cars in the SC instance were not sold. In real life, these sellers would probably continue their sales and potentially generate additional revenue from TAH sales, so for the analysis, only the achieved results per sold used car were considered.

4. Effects of TAH Offering and Pricing Modes

To evaluate the effects of the above introduced two pricing and offering modes on data trade and revenue for its providers, we conducted an experimental market game where the

2 We acknowledge that no such thing as a universal actual value exists. However, to evaluate the cars and approximate their actual values, we used a standard assessment table that was provided to us by one of the leading used-car retailers in the country.

participants had the chance to offer and buy TAHs during used-car sales. The following sections present the overall results for TAH trade and TAH revenue per sold car, which shows how its providers can optimize their revenue. We then analyse in more detail trade and revenue per TAH type, and how sellers made use of their ability to control pricing and offering, to understand why the SC mode advances trade and revenue.

4.1 TAH Trade and Revenue

The analysis of the average number of TAH purchases and the average revenue from TAH purchases for the 32 and 34 sold used cars (Table 3) shows that overall, both the average purchase of TAHs per sold used car and the average revenue from TAH sales per sold used car greatly increased in the SC instance.

Instance	(1) TAH Trade	(2) TAH Revenue (in CHF)		
	Avg. number of purchases per sold car	Avg. revenue per sold car	Avg. revenue for sellers per sold car	Avg. revenue for Carfile per sold car
PC	2.25	56.22	22.73	33.49
SC	4.03	136.18	38.95	97.22

Table 3 – Effects of Offering and Pricing Mode on Trade and Revenue of TAHs

The results concerning TAH trade (1) show that the average number of purchased TAHs almost doubled in the SC instance, compared to the PC instance. While on the market that employed PC pricing and offering only 2.25 TAHs were purchased, on average, per sold used car, on the market where sellers had control over TAH offering and pricing, 4.03 TAHs were purchased, on average, per sold used car (Table 3, column 1). These figures include purchased TAHs of all types and categories. To test whether the average number of purchased TAHs per sold car is significantly different between the instances, we conduct a two-population t-test for the difference between the two means. The resulting t-statistics show a standard deviation of 1.93 for the average number of traded TAHs in the PC instance and 3.20 for the average number of traded TAHs in the SC instance. The resulting p-value of 0.0096 of a two-sided t-test shows that the difference between the two samples is statistically significant.

Looking at the achieved revenue from TAHs (2), the results show that the average revenue of TAH purchases more than doubled on the market that employed a SC offering and pricing mode, compared to the market that employed PC offering and pricing. While in the PC instance an average revenue per sold used car of CHF 56.22 was generated, in the SC instance, an average revenue per sold used car of CHF 136.18 was generated (Table 3, column 2). Splitting this up into the shares for sellers (Table 3, column 3) and the shares for Carfile (Table 3, column 4), the results show that the large share of the average revenue increase is accounted to Carfile. While the average revenue for sellers increased from CHF 27.73 in the PC instance, to CHF 38.95 in the SC instance, the average revenue for its providers increased almost by a factor of three from CHF 33.49 in the PC instance, to CHF 97.22 in the SC instance per sold used car. The resulting t-statistics for the average revenues achieved from TAH sales per sold used car show a standard deviation of 43.0394 for the average number of traded TAHs in the PC instance and 146.7679 for the average number of traded TAHs in the SC instance. The results of a two-sided t-test showed that the difference in revenue was statistically significant, with a p-value of 0.0107.

4.2 Trade and Revenue Distribution per TAH Type

Next, to understand how this increase in revenue for Carfile compared to the rather small revenue increase for sellers came about, we take a deep dive into the achieved trade and revenue per TAH type. Remember, the revenue that was achieved from TAH data sales was distributed to 70 % to the car sellers (i.e., owners), and 30 % to Carfile. The revenue achieved from TAH analysis was 100 % accounted to Carfile. Table 4 below gives an overview of the distribution of average TAH data and analysis purchases per sold used car and shows that a large share of the significant revenue increase, can be attributed to the increase in the number of TAH analysis purchases.

Instance	Avg. TAH Trade and Revenue per sold used car			
	(1) Data		(2) Analysis	
	Trade	Revenue ($)	Trade	Revenue ($)
PC	1.41	33.07	0.84	23.15
SC	1.18	59.40	2.85	76.78

Table 4 – Effects of Offering and Pricing Modes on Trade and Revenue per TAH Type

While purchases of TAH data (1) slightly decreased, from an average of 1.41 purchased TAH data offerings per sold car in the PC instance to an average of only 1.18 purchased TAH data offerings per sold used car in the SC instance (Table 4, column 2), analysis (2) purchases increased by a factor of 3.4 from an average of 0.84 purchased TAH analyses per sold used car in the PC instance, to an average of 2.85 purchased TAH analyses per sold used car in the SC instance (Table 4, column 4). Surprisingly, however, while data trade decreased, the average revenue achieved from TAH data (1) purchases nearly doubled from an average of CHF 33.07 per sold used car in the SC instance to an average of CHF 59.40 per sold used car in the PC instance (Table 4, column 3). The average revenue achieved for TAH analysis (2) trade followed the trend shown by the average number of trades. The average revenue achieved from TAH analysis purchases per sold used car increased by a factor of more than three from CHF 23.15 in the PC instance to CHF 76.78 in the PC instance (Table 4, column 5). Hence, we conclude that the significant difference in revenue increase, between sellers and Carfile can be explained by the fact that much more TAH analysis was traded in the SC than in the PC instance.

4.3 The Use of Seller-Controlled Pricing and Offering of TAHs

To understand why the average revenue from TAH data purchases increased despite the decrease in the average number of purchases, and why many more analyses were sold in the SC instance, we again take a deeper dive and analyze how sellers used their ability to manage the prices per TAH type. Table 5 summarizes these results and shows the distribution of the selected options by the sellers, per TAH type.

Use of SC offering and pricing	(1) Data				(2) Analysis		
	Free Publishing	Price Reduction	No Price Change (Default)	Price Increase	Full Takeover	Partial Takeover	No Takeover (Default)
Sum	65.69 %	8.82 %	8.82 %	16.67 %	33.33 %	11.67 %	54.90 %

Table 5 – Use of Seller-controlled Offering and Pricing

The results for pricing of TAH data (1) show that 65.69 % of the sellers who sold their cars had published their data freely on the advertisement page of their cars. In other words, all interested buyers could freely view the verified TAH data. Another 8.82 % reduced the prices for TAH data and offered it at marginal prices that ranged between CHF 2 and CHF15 per information category. The same percentage of sellers did not change the data price settings, instead opting for the default prices. The remaining 16.67 % of sellers decided to increase prices for TAH data offerings, ranging between CHF 25 and CHF 400 (up to 20 times higher than the default price). Thus, the decrease in data purchases in the SC instance can be explained by the great willingness of sellers to make their data available to potential buyers free of charge. Furthermore, the prices of up to CHF 400 explain why the average revenue from TAH data sales increased despite the decreased number of purchases.

The results for pricing of TAH analysis (2) show that almost half of the sellers made use of the option to fully (33.33 %), or at least partially (11.67 %) takeover costs for the analysis. The remaining 54.90 % of the sellers decided not to take over any costs for buyers. Hence, buyers had to bear the full cost of analysis if they were interested in viewing it. Thus, the great increase in analysis sales can be explained by the fact that sellers subsidized the analysis purchases, motivating more buyers to purchase and view the analysis. All in all, this analysis shows that seller-controlled pricing and offering resulted in a significant increase of trade with and revenue from TAH sales.

5. Discussion

This study asked *how to offer and price TAHs to advance data trade and revenue for its providers*. Drawing on prior works, we proposed a design scheme and evaluated its effects on trade and revenue for its providers against current approaches. This offers valuable insights, not only for academics but also for practitioners who aim to achieve high gains and acceptance of novel TAHs.

5.1 Pricing and Offering TAHs

The use of certificates to mitigate the impact of information asymmetries is not new. Current solutions that have been established include Carfax or Eurotax, for example. However, neither have they achieved widespread adoption, nor large-scale positive effects (The Economist, 2019). The introduction of blockchain gives rise to a novel approach to address the problems of information asymmetries by decentralizing system governance (Du et al., 2020; Zavolokina, Ziolkowski, et al., 2020) and hence enabling the collaboration of multiple stakeholders towards more comprehensive and trusted car histories (Bauer, Zavolokina, & Schwabe, 2019). However, a single trusted third-party (e.g., the car manufacturer) could provide legitimate and reliable information to the same amount and degree. In any case, tokenizing it makes it possible to *rethink how these novel data products can be used (i.e. offered and priced)*. Tokenization creates traceable data entries and dedicated ownership (Miscione et al., 2018, 2020), enabling users to trust record history. In other words, while calls for giving customers more control over their data have been around for a long time, in line with Koutroumpis et al. (2020), we argue that tokenization now also offers a way to do so without losing trust in data quality of those who eventually obtain the data, and we show how this can be instantiated in the case of tokenized car histories. Although this approach is in line with prior works that call for more pricing power of individuals (Parra-Moyano et al., 2020), and although it might sound reasonable from a user, legal, and IT perspective, it might seem counterintuitive from a business perspective. Businesses could fear handing over control of key product functions, like pricing and offering, as they do not know *how this can be done and how this will impact their business,* which would explain why such concepts have not yet been established.

Our proposed design for a seller-controlled pricing and offering mode, however, shows how this can be implemented into an existing used-car market platform. Building on Stahl & Strausz (2017) – who argue that if certification is offered to sellers, it enables them to signal product quality and thus increase market transparency and revenue for certification providers – we take the concept further and not only *offer* TAH to sellers but also *grant the sellers control over pricing and offering* TAHs (in the SC instance) of these. Consequently, TAHs are no longer offered as platform information products to sellers (and/or buyers) as they are currently, but rather offered as a *signalling tool* for sellers. We do this not only for the TAH type data, where self-control by the co-producer of the data seems obvious, but also for analyses which are the services of businesses. Based on the natural assumption that the seller of a car at least partially co-produces the data, for example, by registering, driving, and servicing the car (and the companies take over the rest of the tasks, such as storing and processing), handing over control of the data to the sellers may be increasingly demanded in the future simply from a legal point of view (Schallbruch et al., 2021). However, analytics, meaning the preparation and contextualization of the data, are services that are carried out by companies, where companies may indeed be concerned about whether seller-controlled pricing can achieve sufficient returns.

The results from the market game in the used-car market, however, show that there are no grounds for such fears. In fact, decentralizing the pricing and offering of TAHs – by granting sellers control over offering and pricing – can prove beneficial for platforms offering TAHs. First, in terms of revenue for its providers and second in terms of use (i.e., data trade). As sellers reduced the prices for their data offerings, or even published them for free, this sparked buyers' interest to purchase more analysis offerings. Sometimes sellers even promoted the sale of analysis offerings by subsidizing them. Consequently, this largely benefited the businesses operators in terms of achieved revenue. Besides direct financial benefits for businesses, the increase in trade, and hence, the usage of TAHs, can even foster the project's long-term success. As private users directly experience the benefits, it might motivate them to cooperate with the providers by granting businesses access to their data. This, in turn, can help such providers to stand out and succeed against currently existing third-party certifiers, by increasing the TAHs comprehensive.

5.2 Practical Implications for Carfile and Similar Projects

Looking at the instance problem at hand, the results indicate that a seller-controlled pricing and offering mode can indeed increase revenue for Carfile. Offering TAHs not only as information products but rather as tools for sellers to signal product quality (Stahl & Strausz, 2017), can multiply data trade by a factor of almost two and the total revenue for the Carfile consortium by a factor of more than two. If the experiment results hold up to further empirical tests, for the regional market that the Carfile consortium aims to address (with approximately 800,000 used cars sold every year), this would mean an increase in revenue of more than CHF 160 million per year. This is more than one order of magnitude higher than the current annual budget of the Carfile consortium, which can be a core component for solving the instance financing problem of Carfile. However, this is only possible if the TAHs are embedded in a carefully crafted artifact design that involves attractive information, fair sharing of costs, and revenues between private users and businesses.

Finally, some of the insights can be transferred to other similar tokenization projects that span the application area of the car ecosystem but cover the life cycle of high-value assets (Risius & Spohrer, 2017). Examples could include life cycles of pieces of art, jewellery, houses, or even the health information of humans and animals. In these cases tokenized asset histories might not only be used for reducing information asymmetries but also for greater efficiency and effective treatments. Giving the control over them to the individual data owners and letting them decided whom to grant access to and to which data might foster their engagement and adoption. In other words, as users experience greater control over their data, their willingness to collaborate in such initiatives could increase. Thus, we suggest that corporates aiming to create transparency and trust through product life cycle documentations of high value assets should not only look after short term monetary data-returns but also incorporate the value of trust and customer engagement in the creation of such novel data assets into their business calculations. Lastly, direct engagement and experience with the application and use of its products by end users might lead to an increase in trust towards the decentralized system. This is of special importance not only in the area of high value goods (e.g. cars, houses or jewellery) but even more in domains that use sensitive personal data (e.g. health care). Finally, our study confirms prior debates on higher value of tokenized digital goods (Miscione et al., 2020) as tokenized data allows for increased trust about the data and thereby allows attributing value to digital objects that were difficult to evaluate before.

6. Conclusion

This paper studies how tokenized asset histories can be priced and offered to best leverage their potential for its providers. Thereby we shed light into decentralized ecosystems and the challenges of how to attribute value to data. More specifically, our results show that granting users control over the offering and pricing of TAHs for their products significantly increases both the use of TAHs and the revenue achieved from the sale of TAHs for the network of operators. These insights are highly relevant and valuable for both academics and practitioners, as they unfold how the use and value of blockchain-based applications can be increased through different designs of its core functions. Hence, this study helps to get a step closer to the realization of tokenization projects. From an academic perspective, we take prior works on the application of blockchain for tokenized assets, especially in the used-car market (Notheisen et al., 2017; Zavolokina, Ziolkowski, et al., 2020), but also in the art business (Franceschet et al., 2021), the music industry (Chalmers et al., 2021), and tourism (Treiblmaier, 2020), a step closer to realization by proposing a design for value capturing.

From a practitioner's perspective, our study gives well-founded insights that help direct development efforts early on for decentralized data market designs. Even more, our analysis allows an approximation of potential market acceptance and expected profits of tokenized asset histories, which are essential for blockchain consortia that struggle with increasing development costs and thus question whether their investments will be worthwhile.

Yet, this study is not without limitations which open avenues for future research. First, this study relies on experiments conducted in one geographical location. While this provides great insights about market dynamics and user preferences in one area, it also motivates to repeat the experiment in other countries to test if the results still hold true. Second, despite our efforts to employ as realistic lab settings as possible, experimenting with real-world users would give even more reliability to the results. Besides these methodological limitations, we also want to call to attention that in this study, we did not consider privacy aspects and regulatory demands with regards to data ownership. However, we encourage practitioners and academics working on such projects to consider and evaluate these aspects carefully. Further, for future researchers we propose to repeat our experiments with a larger number of participants and thereby not only to validate our findings but also to go more into depth and study if a detailed subdivision into user groups provides even more insights. Besides that, while our study provides indications that seller-controlled pricing and offering power could increase trust in the system, we encourage further investigation to deepen the insights. Finally, for a thorough cost-benefit analysis future practitioners and/or research it would be interesting to deep-dive the efforts such technologies require in terms of implementation and contracting costs with the benefits and revenues achieved through the ability to decentralize trust and control.

While designing and experimenting with the Carfile systems we noticed how sensitive users are not only to the economic market design but also to the information, communication and interaction design of the platform. Abstracting these insights into design principles could be an interesting outcome from future studies. This would deepen our insights how to design future markets for tokenized asset histories that create value both for platform owners and their users.

List of References

Akerlof, G. (1970). The market for 'lemons': Quality uncertainty and the market mechanism. *The Quarterly Journal of Economics*, *84*, 488–500.

Bauer, I., Parra-Moyano, J., Schmedders, K., & Schwabe, G. (2022). Multi-party Certification on Blockchain and Its Impact in the Market for Lemons. *Journal of Management Information Systems*, *39*(02), 395–425. https://doi.org/10.1080/07421222.2022.2063555

Bauer, I., Zavolokina, L., Leisibach, F., & Schwabe, G. (2019). Exploring Blockchain Value Creation: The Case of the Car Ecosystem. *Proceedings of the 52nd Annual Hawaii International Conference on System Sciences*, 10.

Bauer, I., Zavolokina, L., Leisibach, F., & Schwabe, G. (2020). Value Creation from a Decentralized Car Ledger. *Frontiers in Blockchain*, *2*. https://doi.org/10.3389/fbloc.2019.00030

Bauer, I., Zavolokina, L., & Schwabe, G. (2019). Is there a market for trusted car data? *Electronic Markets*, *30*(2), 211–225. https://doi.org/10.1007/s12525-019-00368-5

Bauer, I., Ziolkowski, R., Hacker, J., & Schwabe, G. (2022). Why Blockchain: A Socio-technical Perspective on the Motives of Business Consortia Members to Engage with Blockchain Technology. *Distributed Ledger Technologies: Research and Practice*, 3573893. https://doi.org/10.1145/3573893

Beck, R., Weber, S., & Gregory, R. W. (2013). Theory-generating design science research. *Information Systems Frontiers*, *15*(4), 637–651. https://doi.org/10.1007/s10796-012-9342-4

Blundell, R., Gu, R., Leth-Petersen, S., Low, H., & Meghir, C. (2019). Durables and Lemons: Private Information and the Market for Cars. *US National Bureau of Economic Research, Working Paper Series*, *26281*. https://doi.org/10.3386/w26281

Briggs, R. O., & Schwabe, G. (2011). On Expanding the Scope of Design Science in IS Research. In H. Jain, A. P. Sinha, & P. Vitharana (Eds.), *Service-Oriented Perspectives in Design Science Research* (Vol. 6629, pp. 92–106). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-20633-7_7

Chalmers, D., Matthews, R., & Hyslop, A. (2021). Blockchain as an external enabler of new venture ideas: Digital entrepreneurs and the disintermediation of the global music industry. *Journal of Business Research*, *125*, 577–591. https://doi.org/10.1016/j.jbusres.2019.09.002

Chesbrough, H. (2002). The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change*, *11*(3), 529–555. https://doi.org/10.1093/icc/11.3.529

Clemons, E. K., & Thatcher, M. E. (1997). Evaluating Alternative Information Regimes in the Private Health Insurance Industry: Managing the Social Cost of Private Information. *Journal of Management Information Systems*, *14*(2), 9–31. https://doi.org/10.1080/07421222.1997.11518163

Du, M., Chen, Q., Xiao, J., Yang, H., & Ma, X. (2020). Supply Chain Finance Innovation Using Blockchain. *IEEE Transactions on Engineering Management*, *67*(4), 1045–1058. https://doi.org/10.1109/TEM.2020.2971858

Durbin, E. (1999). McDonald's or the Michelin Guide? Revealing Quality Through Private-sector Certification. *Mimeo, Olin School of Business, Washington University*, 47.

European Central Bank. (2021). *Eurosystem launches digital euro project*. https://www.ecb.europa.eu/press/pr/date/2021/html/ecb.pr210714~d99198ea23.en.html

European Parliament. (2018, May 29). *Fighting mileage fraud on used cars*. News European Parliament. http://www.europarl.europa.eu/news/en/headlines/society/20180525STO04312/fighting-mileage-fraud-on-used-cars

Fasten, E. R., & Hofmann, D. (2010). *Two-sided Certification: The market for Rating Agencies*. 44.

Franceschet, M., Colavizza, G., Smith, T., Finucane, B., Ostachowski, M. L., Scalet, S., Perkins, J., Morgan, J., & Hernández, S. (2021). Crypto Art: A Decentralized View. *Leonardo*, *54*(4), 402–405. https://doi.org/10.1162/leon_a_02003

Gupta, A., Rathod, J., Patel, D., Bothra, J., Shanbhag, S., & Bhalerao, T. (2020). Tokenization of Real Estate Using Blockchain Technology. In J. Zhou, M. Conti, C. M. Ahmed, M. H. Au, L. Batina, Z. Li, J. Lin, E. Losiouk, B. Luo, S. Majumdar, W. Meng, M. Ochoa, S. Picek,

G. Portokalidis, C. Wang, & K. Zhang (Eds.), *Applied Cryptography and Network Security Workshops* (pp. 77–90). Springer International Publishing.

Hevner, A. R. (2007). A Three Cycle View of Design Science Research. *Scandinavian Journal of Information Systems*, *19*(2), 7.

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design Science in Information Systems Research. *MIS Quarterly*, *No. 1*(28), 75–105.

Höst, M., Regnell, B., & Wholin, C. (2000). Using Students as Subjects—A Comparative Study of Students and Professionals in Lead-Time Impact Assessment. *Empirical Software Engineering: An International Journal*, *5*(3), 201–214.

Koutroumpis, P., Leiponen, A., & Thomas, L. D. W. (2020). Markets for data. *Industrial and Corporate Change*, *29*(3), 645–660. https://doi.org/10.1093/icc/dtaa002

Lee, J. S., Pries-Heje, J., & Baskerville, R. (2011). Theorizing in Design Science Research. In H. Jain, A. P. Sinha, & P. Vitharana (Eds.), *Token* (pp. 1–16). Springer Berlin Heidelberg.

List, J., Sadoff, S., & Wagner, M. (2010). So you want to run an experiment, now what? Some simple rules of thumb for optimal experimental design. *VOX, CEPR Policy Portal*. https://voxeu.org/article/simple-rules-designing-economic-experiments

March, S. T., & Smith, G. F. (1995). Design and natural science research on information technology. *Decision Support Systems*, *15*(4), 251–266.

Mazzei, D., Baldi, G., Fantoni, G., Montelisciani, G., Pitasi, A., Ricci, L., & Rizzello, L. (2020). A Blockchain Tokenizer for Industrial IOT trustless applications. *Future Generation Computer Systems*, *105*, 432–445. https://doi.org/10.1016/j.future.2019.12.020

Miscione, G., Richter, C., & Ziolkowski, R. (2020). Authenticating deeds/organizing society: Considerations for Blockchain-based Land Registries. In W. De Vries (Ed.), *Responsible and Smart Land Management Interventions: An African Context* (pp. 133–147). CRC Press: Taylor & Francis.

Miscione, G., Ziolkowski, R., Zavolokina, L., & Schwabe, G. (2018). Tribal Governance: The Business of Blockchain Authentication. *Proceedings of the 51st Hawaii International Conference on System Sciences*. https://doi.org/10.24251/HICSS. 2018.566

Mohanty, D. (2019). Supply Chain—Gold Tokenization. In D. Mohanty (Ed.), *R3 Corda for Architects and Developers: With Case Studies in Finance, Insurance, Healthcare, Travel, Telecom, and Agriculture* (pp. 193–198). Apress. https://doi.org/10.1007/978-1-4842-4529-3_11

Notheisen, B., Cholewa, J. B., & Shanmugam, A. P. (2017). Trading Real-World Assets on Blockchain: An Application of Trust-Free Transaction Systems in the Market for Lemons. *Business & Information Systems Engineering*, *59*(6), 425–440. https://doi.org/10.1007/s12599-017-0499-8

Oliveira, L., Zavolokina, L., Bauer, I., & Schwabe, G. (2018). To Token or not to Token: Tools for Understanding Blockchain Tokens. *Proceedings of the 39th International Conference on Information Systems*. https://doi.org/10.5167/uzh-157908

Osterwalder, A., Pigneur, Y., & Tucci, C. L. (2005). Clarifying Business Models: Origins, Present, and Future of the Concept. *Communications of the Association for Information Systems*, *16*, 28. https://doi.org/10.17705/1CAIS. 01601

Parra-Moyano, J., Schmedders, K., & Pentland, A. (2020). What managers need to know about data exchanges. *MIT Sloan Management Review*, *61*(4), 39–44.

Peffers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A Design Science Research Methodology for Information Systems Research. *Journal of Management Information Systems*, *24*(3), 45–77. https://doi.org/10.2753/MIS0742-1222240302

Qureshi, I., & Compeau, D. (2009). Assessing Between-Group Differences in Information Systems Research: A Comparison of Covariance- and Component-Based SEM. *MIS Quarterly*, *33*(1), 197–214. https://doi.org/10.2307/20650285

Risius, M., & Spohrer, K. (2017). A Blockchain Research Framework: What We (don't) Know, Where We Go from Here, and How We Will Get There. *Business & Information Systems Engineering*, *59*(6), 385–409. https://doi.org/10.1007/s12599-017-0506-0

Roth, A. E. (2002). The Economist as Engineer: Game Theory, Experimentation, and Computation as Tools for Design Economics. *Econometrica*, *70*(4), 1341–1378. https://doi.org/10.1111/1468-0262.00335

Schallbruch, M., Schweitzer, H., & Wambach, A. (2021, February 26). Europa stutzt die Digitalkonzerne. *Frankfurter Allgemeine Zeitung (FAZ)*. https://www.faz.net/aktuell/wirtschaft/europa-stutzt-die-digitalkonzerne-kampf-gegen-monopolstellungen-17158280.html

Stahl, K., & Strausz, R. (2017). Certification and Market Transparency. *Review of Economic Studies*, *84*, 1842–1868. https://doi.org/10.1093/restud/rdw064

Stebbins, R. (2001). *Exploratory research in the social sciences*. Sage Publications, Inc. https://www.researchgate.net/deref/http%3A%2F%2Fdx.doi.org%2F10.4135%2F9781412984249

Subramanian, H. (2018). Decentralized Blockchain-based Electronic Marketplaces. *Commun. ACM*, *61*(1), 78–84. https://doi.org/10.1145/3158333

The Economist. (2019). The juicy market for lemons. Can you buy a good second-hand car? *The Economist*. https://www.economist.com/finance-and-economics/2019/09/26/can-you-buy-a-good-second-hand-car

Treiblmaier, H. (2020). Blockchain and Tourism. In Z. Xiang, M. Fuchs, U. Gretzel, & W. Höpken (Eds.), *Handbook of e-Tourism* (pp. 1–21). Springer International Publishing. https://doi.org/10.1007/978-3-030-05324-6_28-2

Varian, H. R. (1995). *Pricing Information Goods* (p. 8). University of Michigan.

Zavolokina, L., Miscione, G., & Schwabe, G. (2020). Buyers of 'lemons': How can a blockchain platform address buyers' needs in the market for 'lemons'? *Electronic Markets*, *30*(June), 227–239. https://doi.org/10.1007/s12525-019-00380-9

Zavolokina, L., Ziolkowski, R., Bauer, I., & Schwabe, G. (2020). Management, Governance, and Value Creation in a Blockchain Consortium. *MIS Quarterly Executive*, *19*(1), 1–17. https://doi.org/10.17705/2msqe.00022

Acknowledgements

We would like to especially thank AutoScout24 for allowing us to use the design of their marketplace for our simulations, as well as for their time and their valuable inputs. We would also like to thank Andreas Engelmann, who strongly supported in the development of the simulation game.

Ingrid Bauer, Dr., is a post-doctoral research at the Information Management Research Group of the University of Zurich. Her research focuses on blockchain platforms, data markets, and token systems. Ingrid led the industry collaboration for this project.

Address: Information Management Research Group, Department of Informatics, University of Zurich, Binzmühlestrasse 14, CH-8050 Zurich, Switzerland, E-Mail: bauer@ifi.uzh.ch, Mobile: +41 78 656 40 80

Gerhard Schwabe, Prof. Dr., is a professor in the Department of Informatics at the University of Zurich, where he leads the Information Management research group. He researches at the intersection of collaborative technologies and information management.

Address: Department of Informatics, University of Zurich, Binzmühlestrasse 14, CH-8050 Zürich, Switzerland, E-Mail: schwabe@ifi.uzh.ch, Tel: +41–44–63–5 43 05