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Towards a serious game on data sharing in business ecosystems

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Abstract. In this paper we develop design principles for a serious game on data sharing in business ecosystems. Even though data has been said to be the new fuel of the economy, we have not seen much large-scale data trading in industrial settings. The purpose of the game is to experimentally study the dynamics of data trading in simulated business ecosystems, particularly under different kinds of governance structures: in centralized and decentralized ecosystems. The objective of the game is also to support the learning of MBA and university students. Through the game, the students can experience the risks and benefits of sharing data in ecosystems, an emerging and increasingly important topic in business life.

Keywords: data sharing, business ecosystems, simulation, teaching game, design principles.

1 Introduction

Over the past couple of decades, there has been an increasing interest in different streams of literature towards 'ecosystems'. Ecosystems are a heterogeneous set of actors that are organized around a shared goal, such as a customer-facing value proposition, core technology, or another important strategic goal shared by the actors. By specializing in compatible offerings to deliver the shared goal, ecosystem participants bind themselves together through interdependencies. Together they co-create an ecosystem-level value offering while ensuring ecosystem benefits for each stakeholder [1,2]. To reach the shared goal in ecosystems, data sharing has become an essential part of value co-creation. However, even though the value of data sharing is in principle widely understood in different ecosystem contexts, we do not see datasets openly and transparently traded on a large scale in praxis [3].

Indeed, sharing organizational data is one of the key challenges for established industrial firms in their transition towards platforms and ecosystems [3]. Organizations strive to tightly control their proprietary data, as they are afraid of losing ownership and the potential benefits from their own data. However, research has shown that openness in data sharing fosters generativity in value creation in ecosystems [4]. Thus, industrial organizations need to find a balance between openness and control of their proprietary data.

There are two different types of governance structures that guide the sharing of data between ecosystem actors: centralized and decentralized ecosystem governance models. Extant ecosystem research has focused mostly on centralized ecosystems, where a central ecosystem orchestrator also determines the rules for data sharing [5,6]. These ecosystem orchestrators, or "hub" firms, actively promote and guide the direction of the ecosystem to enhance their own competitive advantage [7]. Research has paid less attention to understanding governance dynamics in decentralized ecosystems, where the ecosystem actors share data without the governance of a central hub.

We are developing a data sharing game to empirically study, albeit in a simulated game setting, the decision making dynamics of data sharing in centralized versus decentralized ecosystems. Through concrete experience in the ecosystem simulation game, we aim to improve the game participant's understanding of the risks and benefits of their data sharing decisions in a simulated case ecosystem. The aim of the game is to improve the awareness of the participants concerning the transparency and openness of data trading in business ecosystems, in general, and to sensitize the participants to the differences of data sharing in centralized versus decentralized ecosystems, in particular.

Our game aims to give to the participants first-hand experience on data sharing in an ecosystem. At the same time, we collect data from the participants' decisions in the game to study the dynamics of data sharing in the simulated ecosystem. The game thus serves two synergistic objectives:

1) Educational objective: Developing the participants' understanding about the risks and benefits of sharing data in centralized versus decentralized ecosystems.
2) Research objective: Developing through empirical simulation-based research a theoretical interpretation of the dynamics of data sharing in ecosystems and of the impact of the ecosystem governance structure on this data sharing dynamics.

In this paper we explore the suitable game design principles that would meet the educational and research objectives set for the game.

2 Data sharing in business ecosystems

In this chapter, we describe the characteristics of centralized and decentralized ecosystems, and examine the underlying risks and benefits of data sharing.

2.1 Centralized and decentralized business ecosystems

Business ecosystems are usually structured around some kind of platform, often a technological architecture that ensures interoperability and modularity of different ecosystem members [4]. Ecosystem researchers have mostly considered centralized ecosystems, where a hub-firm owns the platform where the ecosystem operates [1,2,8,9]. The ecosystem hub can determine who can access the platform and the

principles of how the data is shared in the ecosystem. We call data sharing ecosystems that operate under centralized governance as data monopolies.

An alternative model for ecosystem coordination is a decentralized governance structure, where the decision making for platform structure and data sharing is jointly operated by the ecosystem participants [3]. However, no decentralized platforms have yet emerged in industrial settings. Koutrompis and al. [3] believe that the reason for this is the difficulty to collectively design technical and contractual structures that would guide appropriate behavior in the ecosystem.

Nevertheless, distributed ledger technologies (DLTs) could open up possibilities to collective data trading without a centralized intermediary [3]. DLTs are distributed databases that automatically track transactions in a data trading system and provide a reliable record for the origins, i.e. provenance, of the traded data. The blockchain that underlies cryptocurrency Bitcoin is one of the most known DLT. A decentralized context can also be a collective marketplace, a data collective, where the ecosystem participants establish clear rules through different contracts and bylaws. The data collective should have transparent procedures to collectively change the rules, and to monitor and audit data trading in the ecosystem [3].

We are curious to explore the opportunities of decentralized governance systems for data trade in an industrial context. Since there are no existing decentralized ecosystems for data trading, we see this game as a great opportunity to study data sharing dynamics experimentally in simulated ecosystems with different governance structures [10].

2.2 **Benefits and risks of data sharing in ecosystems**

Data are rarely valuable alone. In order to become final goods and useful for ecosystem actors, data need to be shared, further processed and combined with analytics [3]. Thus, data are intermediate goods that are produced to be combined and transformed to become information goods [3]. The more data are shared in an ecosystem, the more possibilities there are to combine available data, which increases the generativity of the ecosystem. The increasing volume of data sharing also attracts new members to the ecosystem where data are shared, thus creating positive network effects [11].

By nature, data are experience goods. This means that the value and quality of data is only observable after data has been consumed. Hence, the quality assessment of data is difficult, which can lead to an increase of low-quality goods in the market [3,12]. Data sharing ecosystems can be thus vulnerable to opportunism and free riding [13]. In addition, data appropriability is weak. The copyright of databases usually protects the empty shell of the structure and the organization of the database, not the data itself. Thus, the provenance of data becomes an important aspect for assessing data quality. High quality data need to have detailed metadata on its origin, characteristics, and history.[3]

The difficulty in evaluating the value of data creates barriers for data sharing in ecosystems. Ecosystem actors need to learn how to appropriately evaluate the value of

data they wish to sell and buy. They need to understand the kind of data they have in order to protect the core of their business. Furthermore, the actors need to trust the ecosystem governance structure for providing correct information on data provenance. The data sharing game provides an excellent opportunity to study these behaviors and dynamics of data sharing in ecosystems.

3 Translating educational and research objectives into game design

In this section we explain the background of the game and elaborate educational and research objectives based on the reviewed literature above. We also explain how these objectives are translated to the game design decisions, and how we can analyze the data generated in the game for the purpose of research.

3.1 Background of the game

The game will be built upon a paper-based data sharing game we created and piloted together with Cornell University in 2017. In the paper-based game, data creation, ownership, and trading was modeled in a hypothetical dyadic data market in a workshop setting. A simulation of data buying and -selling was done through a "text-scraping" exercise. Players could trade and exploit text-based data during the workshop. We found out that sellers (who could see the full sentences with all words) showed slightly higher valuations of open source data than buyers (who only saw the "scraped" sentences). These initial findings of the game were interesting. However, the game model with English language sentences, and data as words, was perceived as confusing by the participants. Thus, in the new version of the game we focus to increase the approachability of the data sharing game through developing a more intuitive business ecosystem case. Furthermore, in the new version, we explore different governance systems of data ecosystems.

3.2 Educational objectives

Given the unfolding nature of the topic, our target audience for the game is twofold. First, the game is intended for industry experts, for example in MBA programs, that are currently struggling with decisions related to data sharing. For this audience, the game provides a sandbox where they can test their understanding of data sharing dynamics, and how they are affected by governance structures. The game should also enable profiling of the players, providing them with insight on their behavior (e.g. risk aversiveness / benefit optimism), which would be of personal benefit to the players.

Second, the game is also intended for university students for supporting learning in courses that relate to the ecosystem / platform economy. The game would provide students with an environment where they can test the theories that are being taught and get to experience the effects of their decisions first-hand [14]. Considering this target audience, a modular game structure, or preset scenarios would be important. Also in-game tips and explanations could be added to support the students' in their independent study.

3.3 **Research objectives**

Our research objectives are to develop a theoretical interpretation of the dynamics of data sharing in ecosystems and of the impact of the ecosystem governance structure on these dynamics. We analyze the data valuation and trading behavior of the players in an ecosystem context: how valuable they see their own data, and for what price the other players are prepared to buy the data in question. The basis for this analysis is the "bidding data" that is generated by the players when they agree upon compensation for gaining access to the data. We are also interested in the effects of different types of available data [3], which we could study e.g. through varying the amount of publicly available data between games.

One of our research interests is to study the data sharing behavior in centralized and decentralized ecosystem governance structures. Centralized ecosystem in this game means that there is a hub firm in the ecosystem that creates the rules and opportunities for data trading for other ecosystem members; this would create a data monopoly. Decentralized ecosystem in this game could mean that the platform is operated through distributed ledger technologies (DLTs) that would ensure the collective trading of data.

We have two alternatives for how to study and analyze this contextual difference on data sharing behavior. In the first alternative, the ecosystem governance structure is given to the player in the beginning of the game. At first the players trade data in a centralized ecosystem, and after the first game they play the same game again in a decentralized ecosystem. In the second alternative, players choose their data trading mechanisms by themselves, and we see whether a centralized or decentralized ecosystem emerges during the game. Analyzing the results from the first scenario would be easier from a research perspective, whereas the second scenario would better support the learning of the player, as the player would have first-hand experience of the rationale behind joining/proposing either a centralized or a decentralized ecosystem.

Over time, the game accumulates information about the overall value created by ecosystems during game rounds, and how the co-created value is captured by each ecosystem player. We want to analyze how ecosystem governance affects co-creation and capture of value; do ecosystems create more value under centralized or decentralized governance, and how do differences in governance structures affect sharing of co-created value? After each game round, we also feed some of the results from the game analytics for the players to support their learning from the game. We also plan to run a debriefing with the players after they have finished the game. Debriefing topics are e.g. the perceived fairness of value capture in the ecosystem, and the satisfaction of the players towards their individual results and their ecosystem's results.

Implications for game design

In providing the players with a reflective learning experience, the game should embody an experiential learning cycle of experiencing, reflecting, thinking and acting [15]. In terms of game progression this means that a turn-based game with discrete time would probably be advantageous compared to a continuous, real-time game clock. In terms of organizing game sessions, discrete time would allow asynchronous decision making during the game, which may be advantageous considering the target audience of the game, as it would relax requirements on finding a time that suits potentially busy and geographically dispersed players. Asynchronous games could also enable bigger games, which would in the best case enable emergence of several competing ecosystems.

This leads us to the great question of whether ecosystem emergence is achievable in a game setting. If implementable, the players would get to experience the emergence of an ecosystem first-hand, understanding the rationale of the emergence from the perspective of their ecosystem roles. Implementing this in the game, however, would require an approachable operationalization and flexible implementation of the ecosystem governance mechanisms. Further, allowing ecosystem emergence could benefit from an open game source code. The other alternative, where the ecosystem and its governance mechanisms would be given, and the player would play subsequent games in centralized and decentralized ecosystems, is probably easier to implement. However, it would not offer data nor learning effects on the emergence of ecosystems. Based on the focal phenomena identified in literature, we propose the following game design principles:

Table 1. Game design principles derived from the focal phenomena

Phenome-non	Educational objective	Research objective	Game design principle
Data valuation	1. Understand own cognitive biases related to the valuation of data. 2. Reflect upon what affects own perception of data value, both as a seller and a buyer.	1. Understand how risk aversiveness and benefit estimation affects perception of the counterpart's risk/benefit 2. Understand the effect of behavioral aspects on ecosystem formation	- The price of data/access should be determined based on negotiation /bidding - There should be data/decision uncertainty - Data should be related to both cost and profit - All playable positions can both buy and sell data

Types of data	1. Become aware of how she evaluates different types of data. 2. Understand how the availability of different types of data affects ecosystem formation.	1. Understand how the existence of different forms of data affects the formation of data ecosystems	- There should be different types of data in the game, e.g. private, public, and open data - There should be both substituting and complementing data
Data sharing mechanism	1. Be able to relate the data sharing mechanism to issues such as trust and valuation.	1. Understand how distributed ledger technology affects governance structures of sharing	- There should be different options for how data is shared (1st tier), e.g. inclusive, exclusive. - It should be possible to control access to data.
Governance structures of sharing	1. Understand how different governance structures are evaluated by stakeholders	1. Understand how different governance structures emerge 2. Comparing competitive performance of different governance structures	- The governance structures in the game should be malleable to some extent - Ideally governance structures should emerge within the game, initiated by a player.

4 A tentative game design in the context of gold mining

In order to simulate an ecosystem, and perhaps even its emergence, we need to have at least three different, but co-dependent roles in the game. Each role signifies a type of economic actor of which there can exist multiple playable instances that compete and cooperate with each other. Together the different players are expected to maximize the ecosystem-level value offering (i.e. pursue the shared goal), while each player needs to ensure their own value capture.

The game roles are Equipment Manufacturers, Gold Miners, Surveyors and Environmental Consultants. There could also be other possible roles such as Gold Brokers and Key Component Suppliers. We also might want to include a number of non-profit (non-playable) organizations, such as an environmental agency, and some sort of land registrar. Each game role has a focal decision concerning the mining for gold. This decision has a degree of uncertainty and is directly tied to their economic

outcome. The decision-related uncertainty can be reduced by having access to other player's data, either within the same role, or from another role. The game world consists of a large number of mineable terrain grids, that have different properties (making them more tempting to some miners, compared to other miners) and mining them will produce different payoffs. A table of the actor's focal decisions are included below.

Table 2. Game roles and associated focal decisions

Role	Focal decision	Uncertainty	Data needs
Gold miners	Which grid(s) to mine	Expected grid payoff?	Survey data Environmental impact data
Equipment manufacturers	What equipment capability to develop	What direction do the miners prefer?	Data from mining operations
Surveyors	Which grid(s) to survey	What type of grids are the miners interested in?	Environmental knowledge
Environmental consultants	Which grid type competence to develop	What type of grids are the miners interested in?	Equipment capability data

When making the focal decision, the impact of having information is visible to the player - e.g. through displaying a probability distribution of the expected outcome with and without a given piece of information, providing the player with an idea of what the benefit of having information is. Further, each player has access to options of being dishonest (e.g. selling the information to other players, ignoring agreed terms), along with likelihoods of being caught in the act. Together, these two aspects serve as the basis for the players perception of risk and benefit in data negotiations.

Both bidding and forming of ecosystem governance structures would have to be at least semi-structured processes to ensure fluent gameplay. The former is realized through giving ballpark alternatives for starting bids, and limited options for bargaining. The latter is presented as a configuration task, where the player (in case of emergent ecosystems) or the game facilitator (in case of given ecosystems) chooses the preferred alternatives on issues such as conditions for joining the ecosystem, contribution requirements, methods for enforcing rules and procedures for changing them, etc. For the less versed player, implications of the different options would be available as expandable info-boxes.

The game is round-based, where the mining-season is interrupted by winter, when the ground freezes over, making mining impossible. This creates a natural rhythm for experiential learning [15], where players make their decisions, observe the outcomes of these decisions, which in turn affects their next season decisions. Each round would

have two types of decisions - the focal business decision, which is linked to actor profitability, and the data market decisions, which result in extra profits when selling data, and presumably improved focal decision (and of course additional cost) when buying data. After each season the players would see their financial result, and every five(?) seasons there is a bidecadal industry conference, where players get to see their performance relative to other players and the whole ecosystem.

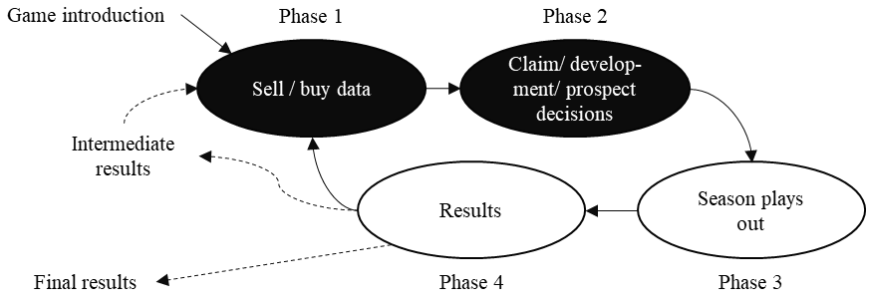

Fig. 1. Each game round consists of four phases, including two types of decisions.

Being a business game, the ultimate measure of success is financial performance. Comparability of performance creates competition, which in turn (along with the built-in possibility of being dishonest - e.g. through allowing arbitrage [16]) would create player emotional engagement, which is beneficial for learning [17]. However, in order to create variance in player behavior, there are predefined player competences (e.g. a miner might be specialized on one type of grid, and thus be able to extract more from this type of grids) and additional incentives (e.g. a prestigious and lucrative environmental award at every industry conference). At the game conclusion, there is a thorough run-through and recap of game events, which secures learning objectives.

5 Conclusions and next development steps

In this paper we develop design principles for a serious game on data sharing in business ecosystems. Once materialized, the simulation game would create a fruitful opportunity to study data sharing in a business context, something which has been proven to be difficult in real life. The game would also serve the educational purpose of increasing understanding of the challenges and opportunities of data sharing among students and industry professionals. As highlighted by prior research, there is a need for understanding the different governance models for such data ecosystems [3], to which our game would be able to contribute to.

We expect that our paper will serve as a starting point for other game developers as well as researchers that are interested in data sharing in business ecosystems as a complex decision making problem, but approachable through serious games. After finalizing the game design principles, we start building a minimum viable version (MVP) of the game together with a software company partner. Then we proceed into piloting, and iteratively develop the research game based on user experiences and

recorded game behavior. After piloting, we start intensive promotion of the game and launch the game to the public.

Our vision is that the game will establish itself as a platform for research related to data ecosystems, forming a link between researchers and practitioners. As a boundary object, we see that the game would be able to connect fellow academics and industry professionals to think and discuss the dynamics of data sharing and explore opportunities for successful and fair data sharing in business ecosystems.

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