The Role of Prosumers in the Evolution of a Software Ecosystem
Case Steam

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Abstract. This paper examines two questions: what is the role of active users or *prosumers*—i.e. users who consume as well as produce—in the transformation of a software ecosystem during its lifespan, and how does a digital marketplace transform into an ecosystem. This approach departs from the extant literature where consumers of an ecosystem are often treated only as passive participants. In this study, the role of prosumers is studied by portraying the transformation of *Steam*, by Valve Corporation, and discussed how it fits in the current field of software ecosystem research as well as what has been the impact of prosumers in its transformation process. The results from this case highlight the importance of users' active role in the evolution. Besides the discussion on the status of prosumers and the ecosystem evolution, the inner structure of this ecosystem is highlighted in the findings.

Keywords: Software ecosystem, Steam, prosumers, ecosystem evolution, ecosystem of sub-ecosystems, marketplace-driven ecosystem

1 Introduction

As the recent literature has often emphasised, different kinds of ecosystems have become the most discussed conceptualisation for understanding and explaining how the modern networked business world works. In the software industry, the 'software ecosystem' concepts and their descendants have become a liveable research field. Software ecosystem research seems to diverge into a few main groups [13, 40]; the absence of stability seems to be a common character for all kinds of ecosystems.

As pointed out already in the seminal paper by Moore [34], ecosystems—both natural and artificial—are not stable and they evolve through distinct phases over time. Therefore, it is not a surprise that ecosystem evolution has become a growing theme in the research of software ecosystems of all kinds. Yet, the number of studies assessing evolution of ecosystems remains low.

The previous work has addressed, e.g., evolution of open-source ecosystems [33, 37, 56], co-evolution of competing ecosystems [45, 58], as well as the transformation of a software product line into an ecosystem [2, 10]. To the authors' best knowledge, only Hanssen [10] has addressed how a system is transformed into an ecosystem with an empirical case.

Thus, this study answers the call of more empirical studies on this area and focuses, firstly, on the following research question:

RQ1 How does a digital marketplace transform into a software ecosystem?

In addition, the role of consumers in an ecosystem is often neglected. While their presence is acknowledged [12, 27, 29], they are often treated only as *'plankton'* [18] or as a source of consumer reviews and ratings [14]. Thus, there is a lack of studies on how the consumers are presented in these ecosystems. The driving research hypothesis for this study is that consumers are not passive entities in an ecosystem; in contrast, they might have a critical role in the evolution of an ecosystem.

Therefore, secondly, we address the following research question:

RQ2 What is the role of users in an evolution of a software ecosystem?

To answer the presented questions, we use a qualitative analysis of multivocal literature [c.f. 36] regarding *Steam* and its evolution. We document the birth and evolution of Steam, a digital distribution platform developed and operated by Valve Corporation (in the following 'Valve'). Valve was established in 1996 by Gabe Newell and Mike Harrington as a videogame enterprise. Since its initial inception Steam has evolved from an update tool for a few games to 'digital distribution platform' which at any given time has over 10 million concurrent users [49]. Valve does not reveal all the data, but figures used to estimate Steam's market share on the downloadable PC games market are usually around 50 to 70% [e.g. 9], market with an estimated value of around 27.1 billion dollars [1].

This study aims to answer to the request of more empirical analyses of different kinds of ecosystems and their evolution [e.g. 10, 17]. Based on the literature analysis of the software ecosystem literature by Manikas [27], Steam has until now remained a largely unstudied and unexplored software ecosystem. Furthermore, while marketplace-centred ecosystems, such as Google Play and Apple's AppStore for iOS devices, and their evolution have been researched previously, there is a lack of diversity in the research of this kind of ecosystems.

We attempt to show how it was not a single decision to become an ecosystem, but a series of conscious decisions, changes and afterthoughts in Steam and other factors around it that led to its current status as a definitive marketplace-driven ecosystem for PC gaming. As an example, along the way we will see how Steam itself and its components, not once but in several occasions, started their lives as specific tools for some purpose but have been expanded to more ambitious purposes later in their lives. In addition, this shows the role of consumers—or to be more exact, prosumers—in this evolution. The results contribute to the literature of software ecosystem evolution and diversification of the research by presenting an empirical analysis of a certain ecosystem and by bringing to light a previously underrepresented actor of the ecosystem.

The remaining of this paper is structured as follows. Section 2 discusses shortly on related work and the motivation behind this study. Section 3 presents details on the research approach used in this study and the rich description of the case subject is given in Section 4. It is followed by a discussion in Section 5. Finally, Section 6 concludes the study with some proposals for the directions of future work.

2   Background and Motivation

As the recent literature surveys have shown [e.g 27, 40], software ecosystems have become an active research topic in the computing discipline with hundreds of studies. While there are a dozen definitions of what constitutes an ecosystem [29], in this study we follow one of the most used and a classic definition by Jansen et al. [20]. According to this definition [20]:

> *"A software ecosystem is is a set of actors functioning as a unit and interacting with a shared market for software and services, together with the relationships among them. These relationships are frequently underpinned by a common technological platform or market and operate through the exchange of information, resources and artifacts."*

As observed by several authors independently [19, 29], three repeating themes appear in most software ecosystem definitions—as well as in the aforementioned one. These are *i)* actors, *ii)* cooperation or business ecosystem, and *iii)* software. In our research subject, Steam, these requirements are fulfilled: *i)* Steam involves various actors, *ii)* there are relationships between the actors through the marketplace, and *iii)* Steam, naturally, involves shared software platforms and tools.

As pointed out by Manikas [27], the research field of software ecosystems is maturing and the research interests are diversifying. A research stream has arose to understand how software ecosystem emerge, evolve and transform. For example, Hanssen [10] presented a longitudinal case study on how a closed organisation with product line evolves towards an emerging ecosystem. However, this study concerns only a closed organisation.

Plakidas et al. [37] addressed the evolution of the R ecosystem and Teixeira & Hyrynsalmi [45] studied how several competitive ecosystems co-evolve. Yet, these studies are restricted to the evolution of already existing ecosystems and they do not address how an entity transforms into an emerging ecosystem.

Digital games are software products, and are therefore an important part of the software industry. The main difference between these from our perspective is the end use, general software is intended to be a tool or service used to fulfil a specific task. Contrary to this games are sold as entertainment, a voluntary action done for pleasure. [specifics at 22] Traditionally, distribution of games has been using the creator-publisher model, especially when games are distributed in physical format. Nowadays, with the advent of digital distribution, a growing number of games are published through digital stores independently by the creators, bypassing the publishers.

Steam was one of the first digital storefronts as it was announced in 2002 and published as public beta on January 2003. In example Apple's App Store and Android Market (now Google Play) were both opened during 2008 and Apple's iTunes added

store-features on April 2003 [12]. Other stores specialised in games are for example GOG.com by CD Projekt[4] opened during 2008 and Origin by Electronic Arts[5] since 2011.

After this development story, we highlight the role of previously largely ignored ecosystem actors, consumers and especially the prosumers. In this paper, we follow a definition used previously on games and gamer related research by [57]. In this definition

> *"gamers who produce fan art, mods, or game-related materials to further contribute to the development of specific game titles can be thought of as "prosumers"."*

In this study gamers are the consumer base of Steam, and they have the possibility to have an active and influential role as prosumers. Their actions do have repercussions that shape or even revert the decisions made by the other actors in the network and the owner of the whole ecosystem.

3 Method

As noted, research papers related to Steam and its history turned out to be surprisingly few in numbers. In practice, this means that we found one Master's thesis by Shen [41] about the development of Steam, and an article by [21] with a short chapter about the history of Steam. Because of this we widened the net to include publications and interviews from gaming industry related news sources and other sources where these topics were discussed. Then again, as noted by [7] game industry related matters are in many cases reported in so-called "grey literature" instead of peer-reviewed academic publications.

During the data gathering period the non-academic sources were searched by using Google's search engine. Search strings were formed case by case. In the beginning they were broad and general (e.g. "valve + steam + history OR development") and refined for specific events or features (e.g. "valve + steam + workshop feature"). The academic references were sought by using search engines by ACM, IEEE and Google Scholar. As both, Valve and Steam are common words in the English language, all the searches used 'Valve' and 'Steam' together, but results still contained lots of papers from non-related fields. For this reason, the word 'game' was added to the base search string. Therefore, the basic searches were started with strings like "valve + steam + game + history" and "valve + steam + game + development". In both cases additional or clarifying sources were gathered by following citations and references.

The search criterion was to find sources where Steam's development was either the main topic or important milestones were reported and possibly clarified by people from Valve itself. Every possible branch of the story is not presented here, as our inclusion criterion dictated that we exclude material that has not attributed to the expanse of Steam. From this multivocal literature, we constructed the story presented shortly in Section 4.

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[4] `https://www.cdprojekt.com/en/core-business/\#gog`
[5] `https://www.origin.com/fin/en-us/store/about`

4   Birth and Evolution of Steam

In the following, we will present the story of Steam so far through its five distinct phases. The first part presents Valve's development before Steam, the second tells Steams first-steps, the third describes Steam as a digital store and the fourth and fifth sections discuss Steam as an ecosystem. At the end of this section, a summary of the birth and evolution of Steam is presented in table 1.

4.1   Development of Valve before Steam (1996–2002)

The story of Steam starts with the foundation of its creator, Valve Corporation (originally Valve Software) in 1996 by Gabe Newell and Mike Harrington. In its early years, Valve concentrated on creating a multiplayer first-person shooter Half-Life, which they released in 1998. The distributor for this release was Sierra Entertainment and the core engine was licensed from id Software.

Importantly for their future, Half-Life included on its release also the level-design tool Worldcraft and software developer kit (SDK) for the players to create their own content and modifications. These tools led to popular modifications by fans, and in turn Valve hired them to turn the modifications to standalone games or purchased rights to work on them (e.g. Team Fortress Classic, 1999 and Counter-Strike, 2000).

During these early years updates for games were distributed as executable files that you could download from either the game creator itself or from a gaming related site that distributed them. This decentralised method of updating games led to situations where the player base was divided in groups that had different, incompatible versions of the game. This caused problems especially if an update was new or a game was updated several times during short time interval. Players with the wrong version of the game were not able to connect to the game servers, and this caused outcries and diminished the playing experience. [25]

To solve this problem Valve, whose games were popular multiplayer games, envisioned a tool that could be used to distribute updates for their own games, and also included additional features important for their games like anti-piracy and anti-cheat capabilities. During the process the digital store was added to the plan. They approached companies that had experience with creating similar kinds of network services (e.g. Microsoft, Yahoo! and RealNetworks), but they were turned down. Instead of abandoning the plan, they decided to create Steam by themselves. [25]

4.2   Steam as a Valve's Tool (2002–2004)

Steam was officially announced at the Game Developers Conference on March 22nd, 2002 by Gabe Newell[6]. In this initial announcement Steam was labelled as a broadband software delivery technology [54], and Valve's own titles were mentioned as the content, but that other service providers were already sought [44]. Beta testing for the new platform was conducted during early 2003[7] as a mandatory part of the beta program

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[6] https://valvearchive.com/events/2002/GDC/
[7] http://counterstrike.wikia.com/wiki/Steam

for the then upcoming Counter-Strike 1.6. After this period Steam was released on September 12, 2003 [38].

An initial release on Steam was not mandatory for all games offered by Valve, but this changed in 2004 with the release of the much anticipated Half-life 2, sequel to their original hit [21]. During this launch Valve's infrastructure was unable to deal with the number of authentication requests and collapsed under the strain. As this authentication was required for all copies, even those bought on discs, gamers were not able to play the game even on a single player mode with the physical game discs on their computers' disc drive. [38] This rocky start of Steam and its performance problems did not give a good impression of itself to the gamers.

Within this period, all the games available on Steam were either created by Valve or Valve created them in cooperation with other studios. Additionally, during this period Valve also released their game engine Source for third-party developers. Valve's own games using this engine were popular and thus helped to spread Steam among the players, but Source was one of the first tools for game developers that also gained fame for Valve and their new service.

4.3   Steam as a Digital Game Store (2005–2009)

During this period Steam went through important milestones which would shape its future. First, in late 2005, other game developers started to sell and distribute their games through Steam. The very first non-Valve -related game on Steam was the Rag Doll Kung Fu by developer Mark Healey [11]. Other smaller teams and studios followed this and Steam started to gather momentum as the digital store for PC gamers.

The next major milestone for Steam's growth and emerging status came during 2007 when major developer-publisher studios like id Software and Eidos Interactive added their games to the catalogue [24]. Year 2007 also brought the "first-ever Steam storewide sale". This event was held between December 24th 2007 and January 1st 2008. [15, 46] Later on these sales would grow to become an anticipated event for the PC gaming crowd.

For third-party developers Valve launched the Steamworks on May 2008. Steamworks is a software development kit, a collection of tools and application programming interfaces, that allowed other developers to publish their own games in Steam without Valve being part of the integration phase. Before the Steamworks Valve had to be part of the process and act as a publisher for third-party games as they were the only one with access to the Steam's databases and other features [30].

Steamworks initial release eased the access to Steam and its features for third-party developers. Additionally Steamworks made it easier for them to implement digital rights management and crucial features for multiplayer games. This, in tandem with Steams rising in popularity in general, furhter increased other companies' interest in supporting the platform. Since its launch there have been several updates on Steamworks, for example during March of 2009 the support for downloadable content (DLC) and matchmaking were added to it. [47] Overall, during this period Steam solidified its status as the marketplace to be for the developers of PC games.

4.4   Steam as Software Ecosystem (2010–2014)

Steam had already been a community for gamers as the service connected them to each other and gave them a voice in the form of forums, chat features and by game reviewing. During this period gamers got more tools and opportunities from Valve to exercise their creativity and the voting power of their wallets.

Steam Workshops was added to Steam in October 2011[8]. With this addition users could create and share content they had created for games that could be expanded or modded by the users. In 2012 players got Steam Greenlight, a service with which they could decide by voting which games Valve would add to the Steam store. In the course of this year, non-gaming software was also added to steam, in a sense ending Steam's run as service only to the gamers. Family sharing features were added to enable content/game sharing among family members.

In March of 2013 the Steam Early Access[9] was launched. Under this service players could buy games that were still in various states of development and give feedback to the developers[10]. During 2014 the Steam Curators were introduced as part of the Discovery 1.0 update. The Discovery update's aim was to help buyers find games from Steam as the influx of games was making the process difficult by sheer volume. Curators are people or groups of people that make recommendations and reviews of games to other users of the Steam. [48, 50]

Signs of rising ambitions of Valve were shown as in 2012 they announced SteamOS, a Linux-based operating system and Steam Machines, console-type gaming devices for running it. The first prototypes of Valve's virtual reality headset were showcased during Steam Dev Days 2014. Steam Dev Days was supposed to be a yearly event, but so far it has been held only twice, during the years 2014 and 2016.

4.5   Steps beyond Software Ecosystem (2015–2018)

Up to this point Steam had been a platform for buying and playing games, a service that connected gamers to game developers and to each other. On the purely digital content delivery front, Steam expanded its offerings to include movies and television shows for streaming [e.g. 32]. Another feature catering for the gamers in Steam was the Steam Refund[11] service, which could be used to request refunds from purchases made through the Steam storefront.

But in the fourth quarter of 2015 the previously announced hardware projects started to materialise. SteamOS and Steam Machines, along with the Steam Controllers (gaming controllers) and Steam Link (digital media player for streaming Steam content to television sets) were released for consumers at this point. [51]

Valve's departure from digital content continued when they, in cooperation with HTC, developed the HTC Vive virtual reality headset [42]. For virtual reality Steam got a SteamVR extension and the Steamworks VR API was introduced. Valve also

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[8] `https://store.steampowered.com/news/16509/`

[9] `https://www.theverge.com/2013/3/20/4128644/steam-early-access-buy-and-play-games-still-in-development`

[10] `https://store.steampowered.com/earlyaccessfaq/`

[11] `https://store.steampowered.com/steam_refunds/`

released the OpenVR software development kit to help VR content creators tackle the interoperability issues of various VR headsets. [55] During this period, one of the features added to Steam was the Steam Workshop which, Koch and Bierbamer [23] claim is Valve's *"attempt to create an ecosystem"*.

Table 1. Summary of the major milestones of and changes in Steam per phase.

Development of Valve before Steam (1996-2002)
Founding of Valve
Half-Life released
Decentralized method of updating games, resulting in divided player base
Plan for digital store
Steam as Valve's Tool (2002-2004)
Steam announced
Beta testing for the new platform
Steam released
Release of Half-Life 2
Performance issues lead to a rocky start
Release of Source game engine to third party developers
Steam as a Digital Store (2005-2009)
Other game developers start selling through Steam
Major developer-publisher studios add their games to Steam
"First-ever Steam storewide sale"
Launch of Steamworks, making Steam more accessible for third-party developers
Steamworks starts to support DLC
Steam as Software Ecosystem (2010-2014)
More tools and opportunities available for creativity and voting power
Steam Workshops was added for creation and sharing of content
Steam Greenlight introduced, a service for voting games into the store
Non-gaming software was added
Family sharing features were added
Steam Early Access was launched
Steam Curators were introduced
SteamOS was announced
Steps beyond Software Ecosystem (2015-2018)
Steam now includes movies and shows for streaming
Steam Refund service was added
Release of SteamOS for consumers
Release of Steam Machines for consumers
Release of Steam Controllers for consumers
Release of Steam Link for consumers
VR on Steam through the introduction of SteamVR and Steamworks VR API
Release of OpenVR SDK

5   Discussion

In the following, we will first discuss the key findings regarding the research questions of this study. It is followed by a discussion on the recent emergence of the 'ecosystem of ecosystems' and how these are manifested in Steam. The final subsections discuss the key observations and the limitations of this study.

5.1   RQ1: How does a digital marketplace transform into an ecosystem?

It almost seems that Steam's evolution has followed quite 'natural paths', emerged from the needs of the customers. That is, there was no visible plan to create Steam as an ecosystem from the fist day; however, through distinct phases it has evolved into its current shape. Steam started as an update tool, but as we have illustrated it has since grown far beyond its original scope. Many have already called it an ecosystem, like McElroy [31] even though he refers to a speech by Newell [35] where he is not using the term.

The same trend continues when Valve announced new additions to the service that they call the Ultimate Online Game Platform and the Ultimate Entertainment Platform [52]. Examples of this trend are the release of SteamOS, which by Dexter [5] was titled *"SteamOS Joins the Steam Ecosystem"* and in the case of HTC Vive, Gilbert [8] wrote how Valve is *"setting up an ecosystem with free tools for any company to use"*. However, occasionally, the term 'ecosystem' has been credited to Newell himself, such as by Statt [43] where it is stated that *"Newell has stressed that the point of the open-source philosophy behind Steam is not only to be as consumer- and community-friendly as possible, but also to build out the ecosystem as quickly and aggressively as possible."*

From a pure statistics viewpoint, as a distribution ecosystem, there has been aggressive growth. In the beginning of 2002 Steam started with one game from one company, at the end of 2017 it had 7,599 new released games and in the first six months of 2018 there are already over 4,600 new additions to the catalogue. This catalogue is serving a user/customer base of over 125 million users with a record of 18 million concurrent users.

Steam was born as an idea for updating software produced and sold by one company. Now we can look at it and see it as a multifaceted and multilayered ecosystem. On the one hand, Steam can be characterised as a monarchistic organisation where value is created by hybrid contributions distributed over a common platform [27]. On the other hand, a different kind of picture can be created by using vocabulary from [19]. Using their vocabulary, Steam is a privately owned software and service platform containing an extension market. From the accessibility viewpoint this market is either a screened market, but depending on role of participants it is either free or paid. Also, following Manikas et al. [28], we can see how Steam has started as a technological infrastructure which attracted other actors to join it. After this, it can be debated if it is a business-rooted or an actor-rooted ecosystem or hybrid of these two. Steam clearly has been an evolving and morphing system [33] during its existence, and seems to be continuing down this road.

Finally, it is worth to note that not all software ecosystems were just born as an ecosystem. While, for example, Google's Android operating system and its marketplaces

were built as an ecosystem from the beginning, this study reported a different kind of story: the transformation of a software tool into an ecosystem. When compared to the transformation of a closed software product line company towards an open platform ecosystem company by Hanssen [10], similar distinct phases on the road to a software ecosystem can be identified. However, as Hanssen [10] focused on in-depth analysis of the company, his results also reflect the internal development of the case company. Whereas our focus is on Steam as an entity, thus our results reflect more on the development of the tool.

5.2   RQ2: The role of users

In the field of software ecosystems, consumers are excluded as they are the 'plankton' that keep the ecosystem alive as formulated by Jansen and Cusumano [18]. In other branches of ecosystem studies, consumers are noted [26], but their role and impact are not often at the centre of the studies.

In Steam, consumers are not voiceless or powerless. In Steam the plankton can become a 'modder' and provide extension(s) to a game using the Steam Workshop features. Also, they can participate in a game's success or failure by participating in their development while they are in the Early Access program. Other means of participation are the more traditional ways of writing reviews or becoming a curator who recommends games to others. So they are an active part of the ecosystem in several ways, not just by being the source for revenue to be shared by the business side of the ecosystem. Every consumer taking part in the Steam ecosystem has a voluntary chance to become a *prosumer* [39].

As mentioned, one way of showing their power is the usage of the reviewing feature [14]. This feature is intended for making (honest) reviews about games they are playing, so that other players can get guidance on whether they should buy some game or not. This is also how it is mostly used. However, gamers have also started to use it as a weapon, in the form of 'review-bombing'. In most cases this is a negative action where a large group of gamers rate a game negatively during a short period of time for some reason. For potential buyers this means that they will see that the game has lots of negative feedback and so the review-bombing makes the game less attractive for purchase. Valve has implemented fixes for this but the phenomenon has not been totally curbed[12].

The Early Access model introduced in 2013 has granted active consumers a way to participate in the game development process. This opportunity has since been seized by both the prosumers and the game development companies, as currently there are over 200 games offered for the player/prosumer communities through the Early Access service. Another new feature, the paid mods created by other gamers, that seems to be intended to embrace the prosumers received a different welcome. Instead of adoption, the community of gamers and modders rallied against paid content in the Workshop. For example on change.org, 132,458 voters petitioned for the removal of this feature, and in this case gamers won. Valve (and in this case Bethesda, another gaming company)

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[12] E.g.   `https://www.theverge.com/2017/9/20/16336290/valve-steam-review-bomb-charts-abuse-update`

jointly removed the feature.[13, 14] These events are covered more in-depth in the article by Joseph [21].

As a final note, the role and involvement of consumers in software ecosystems should be studied more. Previously, consumers have been mainly seen adding value to the ecosystem by verbal or numerical reviews [e.g. 14] or as the aforementioned 'plankton' that keeps the ecosystem alive by providing the financial food to it. The case of Steam shows that the role of consumers—or prosumers—can be more important than previously presented in the software ecosystem literature. This might be due to the fact that games are entertainment software, which gamers use voluntarily to have fun. Bluntly this means that for the gamers it is not enough to just get the software(game) as it is in their role during working hours as workers using productivity software. If, as gamers, they are not getting value for their money and time, they will complain in reviews and on other forums, or use the Steam Refund service to get their money back instead of blowing through the game like they might be doing during working hours with productivity software. This also opens interesting research and development avenues for other kinds of ecosystems, especially in case of marketplace-driven ecosystems.

5.3   Ecosystem made of ecosystems

The digital distribution service role of Steam is the backbone and the root of the ecosystem created by Valve, with estimated profits in *"high number hundreds of million dollars"*[15]. This part of the ecosystem is partly for business-to-business and partly for business-to-consumers transactions. All earnings always involve Valve as everybody pays a fee to Valve for their sales inside the ecosystem. Revenue to the third party companies, and to the other content producers, comes from the sales to other companies or to the customers. There also exist sub-ecosystems inside the overall Steam ecosystem. These can be divided into several classes. There are the per game 'bubble-ecosystems' created around individual games where creative gamers have created new content or mods to some popular game using the available tools and Steam Workshop features. Then, some games have their own internal economies and virtual currencies, creating another layer of ecosystems. For example, Team Fortress 2 and Counter-Strike: Global Offensive have microtransactions for cosmetics items. In some of these games players can also trade items they have gathered, which has created in-game markets and in some cases third party market sites. There are also hardware-specific and bound ecosystems inside Steam, like Steam VR, which is bound to virtual reality hardware and APIs, thus being separated from the general PC entertainment software available in Steam.

Other bubbles are formed around the productivity software sold in and distributed through Steam. These could be seen as business to business ecosystems coexisting with gaming software, which are part of the business to consumers ecosystem.

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[13] `https://www.change.org/p/valve-remove-the-paid-content-of-the-steam-workshop`

[14] `http://steamcommunity.com/games/SteamWorkshop/announcements/detail/208632365253244218`

[15] `https://www.forbes.com/forbes/2011/0228/technology-gabe-newell-videogames-valve-online-mayhem.html`

There is interaction between these separate layers and bubbles. The big question for Valve has been how to control these bubbles and the virtual economy in the overall Steam ecosystem. To tackle some of these issues, Valve hired economist Yanis Varoufakis as the economist-in-residence [53]. As a final note, the field of "ecosystem of ecosystem" is, to the authors' best knowledge, still mainly uncovered area in the software ecosystem research and future work is needed.

5.4   Key observations, limitations and future work

We recapitulate our key observations in the following:

1. Users have had a clear role in the evolution of the Steam ecosystem. This contradicts the extant literature, which often understates the role of consumers in the ecosystems. While Steam as a 'video game ecosystem' might differ with its key characteristics from other kinds of ecosystems [c.f. 13], this, nevertheless, hints that consumers as active participants – i.e., prosumers – of an ecosystem should be addressed more.
2. The evolution story of Steam has followed quite 'natural paths', which enriches our understanding of the transformation and birth of software ecosystems. While the previous studies have reported the transformation starting from technical changes [10, 37, 45] as well as from the customers' requirements [10], no major external changes were seen driving the transformation. Yet, more qualitative studies are needed to understand the internal rationalities behind the change.
3. Finally, this study also notes the emergence of 'ecosystem bubbles' inside the Steam ecosystem. While there is a growing interest towards ecosystem of ecosystems [16], these still remain an underresearched area. However, future work is needed to better understand the dynamics of these kinds of multilayered ecosystems.

As with all studies, there are certain limitations restricting the validity of this study and generalisation of the results. First and foremost, we are looking at Steam and its history as outsiders, relying on clues and scraps of information coming from third-party sources. As so, it might be that we are missing some parts of the story and, thus, future work should verify these results as well as add more details by interviewing the personnel related to the development of Steam.

Secondly, generalisation of this study is remarkably limited to this kind of an entity. Steam is an interesting research subject due to its popularity, being the first and the largest gaming ecosystem; however, it is hard to generalise from such a case.

In addition to the already proposed issues for further studies, Steam also offers an interesting study subject to understand the value creation and caption in an ecosystem. Thus, by studying Steam, a more comprehensive picture of ecosystem value creation mechanisms could be created. Furthermore, Steam and its rival gaming ecosystems could also serve as case study subjects for further studies aiming to understand the competition between ecosystems. For example, Valve's games currently cannot be found from, e.g. GOG.com by CD Projekt, while some of CD Projekt's games can be found on Steam.

Also, in general, marketplace-driven ecosystems offer an interesting cases for the study of how the power of different actors are manifested on them. For example, in the

case of Steam it is privately owned and solely under control of the mother company Valve and its decisions, but so far they seem to have been distributing their power to other actors, e.g. the power to accept new products into the ecosystem has been moved from Valve to consumers and then from this player curated model to simpler paid-entry.

Another future direction would be to observe and study how ecosystems respond to an emerging competition. In case of Steam, there are, for example, two emerging competitors in the form of Discord and Tencent. Discord is a popular communication app with 130 million users [4] and Tencent is well-known Chinese gaming company with a reported total revenue of $22 billion and owner of WeGame, a digital video game store and social platform [3]. Both of these examples are currently reported in the industry media as potential rivals for Steam's current dominance in PC gaming as they are pivoting their operations [4, 6].

6   Conclusion

In this work, we documented the birth and evolution of a gaming software ecosystem: Steam by Valve Corporation. Steam started its life as a digital tool to distribute digital updates for games. Currently Steam does that and has also crossed from totally digital phenomena to the physical side with related hardware products. Steam can be easily described as a software ecosystem and this study discussed the distinct evolution phases of it and especially how the end-users have their own active and power-wielding position inside it. The study contributes to the field of software ecosystem research by responding to the call of more work on different kinds of software ecosystems. Furthermore, the case of Steam emphasises the need to discuss the role of consumers in the software ecosystems more, as well as to study the emergence of 'ecosystem of ecosystems' in large ecosystems.

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