Paths for value creation when incorporating open source in the business model - the two sides of the coin

Sanguinetti-Toudoire, Véronique

Université Polytechnique Hauts-de-France, Laboratoire LARSH

veronique.sanguinetti@uphf.fr

Goudarzi, Kiane

Université Jean Moulin Lyon 3, iaelyon School of Management, Laboratoire Magellan,

kiane.goudarzi@univ-lyon3.fr

Résumé :

Open source projects have become mainstream in the software industry and are now spreading to other industrial sectors. In these heterogenous ecosystems based on open property rights, customers mix with retired specialists, teenagers, employees, or competitor copycats. No matter the status, each participant gets the same free access to the value of the product. This is pushing firms in these sectors to seek new configurations of business model. This article aims at understanding how to create ecosystems where value is available for free to anyone while still providing attractive offerings to paying customers.
Through a qualitative exploration of high-level managers' views on their business models, we demonstrate that opening property rights leads to value loss when the ecosystem is not addressed simultaneously. Only open source experts understand how to implement a double-sided open source business model and how to benefit from its network externalities.

Les projets de logiciels libres sont devenus courants dans l'industrie du logiciel et s'étendent maintenant à d'autres secteurs industriels. Dans ces écosystèmes hétérogènes fondés sur des droits de propriété ouverts, les clients côtoient des spécialistes retraités, des adolescents, des employés ou des entreprises concurrentes. Quel que soit son statut, chaque participant bénéficie du même accès gratuit à la valeur du produit. Cela pousse les entreprises de ces secteurs à rechercher de nouvelles configurations de business model. Cet article vise à comprendre comment créer des écosystèmes où la valeur est disponible gratuitement pour tous, tout en proposant des offres attrayantes aux clients payants.
Par une exploration qualitative des points de vue de cadres de haut niveau sur leurs business models, nous démontrons que l'ouverture des droits de propriété entraîne une perte de valeur lorsque l'écosystème n'est pas abordé en parallèle. Seuls les experts de l'open source comprennent comment mettre en œuvre un business model open source à double face et comment bénéficier de ses externalités de réseau.

Mots-clés : Open source business model, RCOV framework, double-sided business model, high level managers

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1. INTRODUCTION

Takeovers in 2018 of two big open source software organizations by the leaders on this market, Microsoft and IBM, are the sign that open source, at first a philosophy of source code transparency, has been fully adopted as a business model by the software industry ((Dahlander et al., 2021). The recent announcements, in line with the covid-19 crisis, from industrials releasing their ventilators with "open source hardware" features (Pearce, 2020) illustrate that open source business model is also emerging in other industrial sectors.

This is all the newer and more important as all industries are undergoing a digital transformation (Correani et al., 2020) and include more software in their processing and their offers. The fact that several firms outside the software industry have started publishing their open source policy[1] is a sign of digitalization introducing open source inside firms.

Business models consist in articulating a set of core components or activities in order to produce a value proposition that can generate value for consumers and thus for the focal firms themselves (Demil & Lecocq, 2010).

All business models are open business models (Bogers et al., 2017; Chesbrough, 2006). Among these open business models, we choose to study those relying on open source software. They are characterized by an open software source code, free access to the code and the possibility of modifying it on condition to leave it open. The development of this code is done by passionate volunteering community ecosystems, but firms also want to monetize open source components and provide an attractive offering to paying customers (Casadesus-Masanell & Llanes, 2011; Linåker et al., 2018; West & Gallagher, 2006). Such open source ecosystems are now famous in software, like the Linux ecosystem (Chesbrough & Appleyard,

1 Examples of open source policies published by firms outside the software industry: https://github.com/decathlon; https://github.com/Decathlon/template/blob/master/contributor-licence-agreement.md ; https://opensource.renaultgroup.com/compliance/; https://www.openchainproject.org/featured/2020/12/15/toyota-iso-5230 (last visited 2022-01-10)

2007) and are emerging in industry, like the Genivi ecosystem or the Eclipse foundation (Eckert et al., 2019). These open source ecosystems are pushing incumbents to seek new configurations of business models.

Open source business models have often been studied (Appleyard & Chesbrough, 2017; Benkeltoum & Mouakhar, 2020; Brunswicker et al., 2016; Casadesus-Masanell & Llanes, 2011; Ciesielska & Westenholz, 2016; Grand et al., 2004; Kortmann & Piller, 2016; Lerner & Tirole, 2002; Lisein et al., 2009; Mouakhar & Tellier, 2017; West, 2003), but up till now the paying customers and the community ecosystems sides have always been studied together in one business model, where the community ecosystem is considered as an external resource.

The challenges faced by firms that decide to open their business model and become part of an ecosystem are still not well understood (Foss & Saebi, 2018). More specifically, the organizational design needed to support their implementation are understudied (Berglund & Sandström, 2013; Foss & Saebi, 2017). Moreover, the interactive and collaborative features of open source business models with ecosystems (Chesbrough & Bogers, 2014) and more generally the interactions between firms and their external stakeholders (Sims & Seidel, 2016) are poorly understood. This raises the important research question of how to address both open source community ecosystems and paying customers at the same time, that is to say **how to shape a sustainable business model when the value is open for free to anyone.**

Our proposition is that firms that want to adopt an open source business model need to address both customers and ecosystems separately and together at the same time, with what is called a double-sided business model. Double-sided business models are a specific kind of multi-sided business models that characterize multi-sided markets (Cozzolino et al., 2018; Gandia & Parmentier, 2017; Parmentier & Gandia, 2017). For instance, Blablacar is using a double-sided business model: one side is how to get customers that need a ride, and the other side is how to get drivers to offer these rides. The two sides of the business model are making exchanges, creating the typical network externalities or inter-side effects that bring value to blablacar and to all double-sided business models. Therefore, our proposition is that firms who want to implement an open source business model with a community ecosystem should in fact implement a double-sided business model: one side of the business model centered on their paying customers, and the other side of the business model centered on open source community ecosystems, while making sure of positive inter-side effects between both sides.

To answer our research question and assess the interest of our proposition, we have adopted a qualitative research design based on high level managers interviews (Aguinis & Solarino,

2019) and on the RCOV framework for business model analysis (Agarwal et al., 2021; Benkeltoum & Mouakhar, 2020; Demil & Lecocq, 2010; Gerasymenko et al., 2015; Ghezzi, 2020).

Our contributions are as follows: First we improve knowledge on double-sided business models that can be extended to any business model with an ecosystem and is not only restricted to platform industry. Second, we demonstrate that high level managers apprehend open source business models differently, depending if they are new-comers or experts on open source. The assertion "firms must recognize value before being willing to openly collaborate, yet opportunities typically cannot be realized without active engagement" (Schepis et al., 2021, p. 270) is validated through our study.

2. LITERATURE

We first review the literature on open and double-sided business models. Second we review existing categorizations of open source business models and their limits. It enables us to proceed a re-reading and analysis of the literature, separating the open source business model into two sides.

2.1. OPEN BUSINESS MODELS

The term *Business model* emerged at the end of the 1990s and has led to a real change in strategic management thinking by emphasizing "value creation and multiple sources of competitive advantages" (Massa et al., 2016).

Business models are open by definition, in the sense that they express relations with suppliers, customers, etc. The *Open Business Model* concept was not popularized until 2006 (Chesbrough, 2006). It describes a firm's use of "key asset, resource, or position, not only in the company's own business but also in other companies's business" in order to develop their business model (Chesbrough, 2006, p.2). This definition was then extended to any external stakeholder, creating multi-stakeholder innovation networks (Reypens et al., 2021). Another way of expressing the open nature of all business models is to say that the business model concept implies the existence of an ecosystem with which it interacts: "the relevant environment, as a performed ecosystem to interact with (more than as a set of constraints to fit with), is important in the business model perspective" (Demil et al., 2018, p. 1225).

The digitalization has a great transformative power on business models, by facilitating the emergence of customer communities and of ecosystems that interact with firms (Joachim & Laszczuk, 2020), thus extending this notion of ecosystems (Adner, 2017). At present, it is a great focus of discussion (Kortmann & Piller, 2016).

To address the collaborative approaches of open business models, the *multi-sided business model concept* was developed, deriving from double-sided markets (Rochet & Tirole, 2003). It is based on the idea that one side is used to make the second side more attractive. For instance, in the newspaper industry, lowering the price for paying customers on one side would increase the number of these customers, and it would enable to attract more advertisers on the other side. Double-sided markets theories are based on economics equations, using prices and quantities. The double-sided, and more generally the multi-sided business model, is the translation in real life of these static models: Instead of price and quantity, the value proposition is a global offer to the customer. This concept assumes that "the key to value optimization lies in managing the interactions and interdependences between the different sides of the business models" (Gandia & Parmentier, 2017, p. 337).

To represent business models, several business model frameworks exist (Wirtz et al., 2016). Among them, the most used are the "*Business Model Canvas*" which is centered on the value proposition (Osterwalder et al., 2011), the "*Content-Structure-Governance*" framework which is centered on the sources of value creation (Amit & Zott, 2001) and the "*RCOV*" framework (Demil & Lecocq, 2010).

The RCOV framework offers a penrosian, parsimonious and dynamic view of organizations (Casadesus-Masanell & Ricart, 2010; Demil & Lecocq, 2010). It offers the possibility of studying the organizational design of a business model, by focusing on the continuous interactions between core components: Resources and Competencies, Organization and Value proposition. Specifically, Resources and Competencies, through a dedicated Organizational structure, will enable Value propositions, leading to value creation for the customers and the focal organization. We use the RCOV business model framework to have a comprehensive and holistic approach of all aspects of the business model elements and to assess the potential importance of the community ecosystem as a resource and/or a specific side of business model.

2.2. OPEN SOURCE BUSINESS MODELS

Several scholars have attempted to characterize and categorize open source business models, whether from the point of view of firms, or considering their links with open source ecosystems. A first range of articles categorized increasing levels of open source adoption in business models (Casadesus-Masanell & Llanes, 2011; Ciesielska & Westenholz, 2016; Grand et al., 2004; West, 2003), distinguished facets of these open business models (Appleyard & Chesbrough, 2017; Kortmann & Piller, 2016; Lerner & Tirole, 2002), or

studied specific open source business model strategies (Brunswicker et al., 2016) and their challenges (Demil & Lecocq, 2014). A second range of articles analyzed the links between open source firms and their ecosystems, either the internal conditions for being able to collaborate with the ecosystem (Alexy et al., 2013; Baldwin & von Hippel, 2011; Foss et al., 2011; Henkel et al., 2014) or the governance mode (Loilier & Tellier, 2011; Pénin, 2011; Von Krogh & Von Hippel, 2006). Altogether, little remains known about the global organization design needed to support the opening of a business model (Berglund & Sandström, 2013; Bogers et al., 2017; Foss & Saebi, 2017).

Our proposition is that firms that want to adopt an open source business model in fact need to settle a double-sided business model: one side centered on their paying customers, and another side centered on the community ecosystem contributors. Customers and contributors are the two sides of the same coin.

To assess this proposition, we first used the already cited literature articles, in order to distinguish in the description and analysis of the business models what is about community ecosystem contributors and what is about paying customers. To do that, from the preceding open source business model categorizations, we chose all top levels of adoption. We translated the information given by the literature into new categorizations, based on the business model RCOV framework. We separated the given information into two frameworks, one for the paying customers side and another one for the community ecosystem side.

2.3. THE PAYING CUSTOMER SIDE OF THE OPEN SOURCE BUSINESS MODEL

According to scholars, the paying customers side of the business model focuses specifically on the choice of what to open and share, and what to sell, leveraging external resources.

Resources and competences

Firms need to make choices concerning human resources and competitive advantages. They have access to external community resources (West, 2003). They need to accept the exposure of their source code and their key employees (Demil & Lecocq, 2014) and develop an in-depth understanding of the property rights implications of open source licenses (Grand et al., 2004).

Organization

Firms need to settle activities and governance mechanisms. The important activities are to avoid irreversible choices about how much to open, to keep an eye on the consequences of their opening strategies, for instance to concentrate their attention not only on their current competitors but also on new ones (Demil & Lecocq, 2014). On top of that, firms need to

develop a balance between exploration and exploitation of knowledge with fast speeding innovative processes (Ciesielska & Westenholz, 2016). The governance mechanisms towards the external customers or competitors are the "market" mode, that is order and pay others to do something (Demil & Lecocq, 2006). This implies to be careful on what information to share, sharing knowledge but not too much, as giving away too much could mean sensitive information is passed on to competitors (Appleyard & Chesbrough, 2017).

Value proposition

Firms need to decide what to propose to paying customers. Hybridization is the main aspect of this value proposition to customers. It means accepting commoditization of the open parts in order to promote their use and to sell complementary goods and associated services (Lerner & Tirole, 2002). In other words, it implies shifting to services and creating value for themselves from always up-to date open source. For instance, Intel is selling an always up-to-date offer and IBM is giving software and selling hardware (Appleyard & Chesbrough, 2017). This value proposition is relying on external resources, a careful choice of what to open and what to share, and the capacity to explore and to exploit, as seen above.

Next to this paying customer side of the business model, we aggregated information on how firms deal specifically with the external open source community ecosystem.

2.4. THE COMMUNITY ECOSYSTEM SIDE OF THE OPEN SOURCE BUSINESS MODEL

The literature is emphasizing the importance of ecosystems for this open source business model to be sustainable. Attracting and maintaining one or several communities is the main challenge (Appleyard & Chesbrough, 2017).

Resources and Competences

Human resources and competitive advantages are the same object of attention as for the customer side of the business model. As far as human resources are concerned, a high level of expertise and technical skills as well as adherence to open source values and norms are required to be accepted by the communities (Grand et al., 2004), and trust relationship with communities are important in order to secure valuable contributions from volunteers (Ciesielska & Westenholz, 2016). There is a need to have internal leaders committed to open source (Appleyard & Chesbrough, 2017).

As far as competitive advantages are concerned, the use of adapted intellectual property rights such as Open Source Licenses will guarantee openness and ensure that innovations are not appropriable (Lerner & Tirole, 2002). It will facilitate adoption and contribution, with the risks of forking, that is the risks of facilitating downloadings and the potential creation of

multiple versions of the focal project (Appleyard & Chesbrough, 2017). Marketing and branding could be protecting strategies, but their efficiency has yet to be proved (West, 2003).

Organization

The activities and governance mechanisms are quite different from what was settled for the paying customer side of the business model. As far as activities are concerned, first the project needs to be parceled into small components (Baldwin & von Hippel, 2011; Henkel et al., 2014) to enable interoperability, standardization, and improvements from different teams simultaneously. The next challenge is to attract communities related to their own projects, but the process remains unclear, as well as the necessary activities to maintain them. What is known is the increasing costs of participation to numerous open source projects and communities as well as costs of coordination (Grand et al., 2004). This means reengineering the internal processes at an organizational level and at individual developer-level (Alexy et al., 2013), for instance "rewarding employees for sharing and acquiring knowledge, and high level of delegation of decision rights" (Foss et al., 2011, p. 219).

As far as governance is concerned, the governance with these open source external stakeholders has been described as an "organized bazar" (Demil & Lecocq, 2006), meaning that there are some mechanisms for coordination even if there is a loss of control on the software communities' directions (Ciesielska & Westenholz, 2016). The process of cooperation with entities, who may pursue different aims and have different habits, is facilitated through the establishment of governance rules, processes and rituals (Von Krogh & Von Hippel, 2006). At last, knowledge sharing is a crucial part of the process, as giving away information, for instance about strategy process and outcomes, will increase the company's legitimacy among the ecosystem and facilitate collaboration (Pénin, 2011).

Value proposition

The value proposition is a common value proposition to the whole ecosystem (Adner, 2017) which is different from the one addressed to the paying customer side of the business model. To attract an active community and active contributors, the prerequisite is that the innovation will remain open and not appropriable and that the shared data and information are relevant to the community (Brunswicker et al., 2016). Then it is important that participants will benefit from the process of innovation, will learn something or improve their reputation (Balka et al., 2014). The concept of hybridization model is activated too: either, as Apple does, firms decide to open the accessory parts of their software code, or, as Linux does, they open the very core (Boudreau, 2010; Casadesus-Masanell & Llanes, 2011). The components are

available for free, but under the status "use it at your own risk", which is a common feature of all open source licenses. Economic returns need to be shared with contributors, based on a gift/counter gift principle (Grand et al., 2004; Loilier & Tellier, 2011).

As a conclusion of the literature (see table 1), we can say that separating all components constituting open source business models into a two-sided business model, one side aimed at paying customers and the other side aimed at community ecosystem contributors, enabled us to start grasping the governance and organizational challenges caused by open source business model adoption.

Table 1. Proposition of characterization for open source double-sided business models

PAYING CUSTOMER SIDE	RCOV	COMMUNITY ECOSYSTEM SIDE
External resources and competences: Access to community ecosystem	**RC** Resources Competences	*Internal Resources and Competences*: high skills, adherence to open source philosophy, trust Need for internal leaders
Accept openness and develop understanding of open source licenses	Comparative advantage	*Develop openness* to favor adoption and contribution, and ensure non appropriability Risks of forks
Find and use information Balance exploration / exploitation	**O** Organization Activities Governance	*Attract contributors, develop communities* Parcel into small components Reengineer the internal process
Market mode with customers Choose what to open and share and what to keep secret		*Organized bazar mode with ecosystem* Establish governance rules, processes Share everything on the project
Value proposition for paying customers Commoditization of the open parts Shift to services or selling other goods	**V** Value Proposition	*Value proposition for the whole ecosystem* Project relevant to the community Hybridization: open for core or complementary Available for free, economic returns shared

Through our empirical study, we wanted to understand if such a construction is only a view of the mind or if it really makes sense. We also wanted to get insights into the organizational aspects of inter-side effects.

3. METHODOLOGY

To answer our research questions, we performed a qualitative study based on high level managers interviews.

3.1. HIGH LEVEL MANAGERS

We chose high level managers (Aguinis & Solarino, 2019) because they are in charge of adjusting business components in order to achieve an overall consistency with the targeted strategy (Penrose, 1959). Moreover, they are in charge of the organizational design, that is translating strategy into action (Baldwin, 2012).

We approached them in the following way: We participated in professional meetings or read the professional press, in order to detect appropriate high-level managers and contact them. The snowball method also allowed us to obtain interviews with interesting managers. We chose them in the following way: We tried to go around the issue, by choosing people strongly involved in open source, and people new to open source, in large and small firms, in software and industry. We focused on the software sector and the industry sector, more specifically robotics and mobility, because that's where open source is growing right now.

Altogether, we performed 20 interviews with high level managers in software, robotics and mobility industries (see appendix). We asked them questions about their potential use of open source in offers to customers, the specific features of open source business models, the way they were processing, and finally the risks and advantages of open source business models.

We supplemented this analysis with attending meetings in 24 workshops about open source business models in the mobility sector. These workshops were organized in France between 2016 and 2021 either by Renault automotive organization, by the "Fabrique de la Mobilité - FabMob", a French national association promoting open source mobility, or by other professional clusters. Lastly, we used secondary information on open source business models coming from weekly press reviews and radio shows made by the French free and open source APRIL association.

3.2. CONTENT ANALYSIS BASED ON THE RCOV FRAMEWORK

We performed a content analysis of the semi-directive interviews. To ensure data accuracy, we offered the transcript back to the interviewers for review (Smith et al., 2018). Altogether, interviews amount to 295 pages and 167,131 words.

We used the RCOV framework for business model analysis. This framework has already been used by several scholars to analyze business models (Agarwal et al., 2021; Benkeltoum & Mouakhar, 2020; Demil & Lecocq, 2010; Gerasymenko et al., 2015; Ghezzi, 2020). It enabled us to get a comprehensive approach of all aspects of the business model elements. This is important in order to understand the organizational reconfiguration of the business model towards an open source business model.

A few codes were derived from the literature and the RCOV framework, and we found other codes by comparing interviews using a "comparison table" (Miles & Huberman, 1994). We

used the Open Source qualitative thematic analysis tool RQDA[2], based on R, for this purpose (Chandra & Shang, 2017). We double-coded our interviews, which allowed a more precise coding. A second round of double-coding obtained an 81% matching of same coding between the two coders. This enabled us to check internal validity.

Once the content analysis done, we prepared a video summarizing our main findings and sent it to the interviewees, in order to get their feedback (Okoli & Pawlowski, 2004). Their feedback was useful to get more precise examples and understand better the specificity of the community ecosystem side of the open source business model. The multiple sources of evidence used for triangulation and the feedback about our findings with our interviewees allowed us to check our construct validity.

By confronting cases of high-level experts that are positioned at different locations in the open source expertise, we were able to give a comprehensive view of the specific double-sided business model that is required when implementing an open source business model.

4. FINDINGS

Our main findings are as follows: First high level managers apprehend open source business models differently, depending if they are new comers or experts on open source. Second, network positive externalities only arrive when understanding that for open source business models to be successful, there is a need to address both paying customers and the community ecosystems, at the same time but separately.

Thanks to our interviews, we are able to distinguish how high-level managers have a different comprehension of open source business models depending on their expertise of open source, and on how to address both community ecosystems and paying customers.

4.1. NEW COMERS TO OPEN SOURCE CONSIDER ONE BUSINESS MODEL

New comers to open source have none or limited experience of open source (see appendix). They consider the community ecosystems as external resources, living on their own, who provide freely available external components made by volunteers, and will take care of the research and development of these components. This is a real saving (see figure 1).

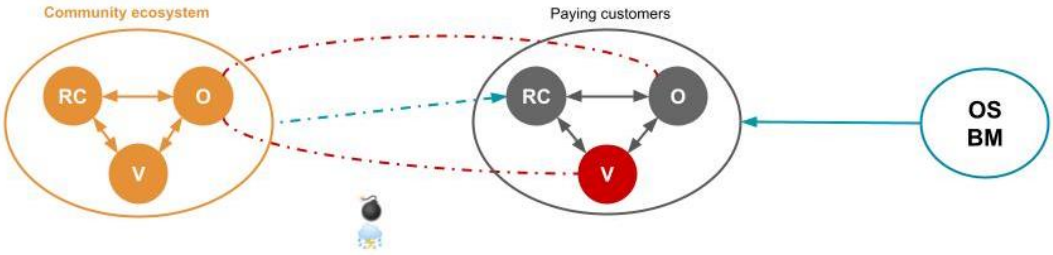
2 HUANG Ronggui (2016). RQDA R-based Qualitative Data Analysis. R package version 0.2-8. http://rqda.r-forge.r-project.org/

*"It may allow somehow to **diminish his basic research expenditures** on his own IP **and to be able to reallocate it elsewhere,** because the others will do it for him" (Industry, Manager 1)*[3].

But as was already pointed out by previous research, they do not understand how to create value for their firms out of this organizational design, if everyone has a free access to these components.

*"If everybody can use it for free and have it for free like a free beer, **how can I manage to make a living out of that?**" (Industry, manager participating to a meeting on Open source business models, 2021-05)*

Figure 1. Open source BM for managers of some experience of open source



When having a little experience about open source, meaning they have already tried it perhaps because they were asked to by a customer, high level managers understand that community ecosystems have their own shared value, philosophy and organization.

This is the cause of more challenges. First, they wonder why non-merchant ecosystems would help firms making money thanks to their components.

"Why would communities help me, a commercial organization?" (Industry, manager 4)

Second, because of the specific bazaar governance of the communities, the fact that contributors contribute if they want, when they want, how they want, how could firms ensure their customers with the business continuity that is so important to them?

*"There are a lot of liability issues: you don't want your tire tearing apart while you are driving. (...) **With Open Source it is more difficult to master the risks**. Business continuity is very important, in a business you need to have control over the risks." (Industry, Manager 9)*

"If there is a bug, who is responsible? When it's a manufacturer who has his own software, we know who it is." (Industry, manager 4)

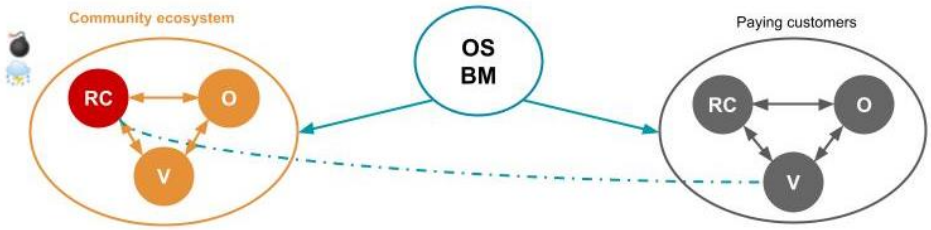
4.2. EXPERTS OF OPEN SOURCE CONSIDER A DOUBLE-SIDED BUSINESS MODEL

3 The numbering of the managers is random and does not follow the alphabetical order. The experts' answers represent only their own opinions.

High-level managers experts about open source clearly indicate that community ecosystems represent the main issue, even if they do not pronounce the word double sided business model. According to them, firms need to do a lot of things in order to attract and keep users and contributors.

The first challenge is to create a community, that is to create an interest for the open source project. This is where the double-sided business model appears (see figure 2).

Figure 2. Open source BM for experts of open source - *Step 1 Create*



On the community ecosystem side on this double-sided business model**,** the community Resource is the issue, as it is very difficult to attract contributors.

> *"We developed a great solution around Android. I have a few indicators that make me say that people use it, because through different channels, I get news about my solution, which can only be from people who have taken it and installed it, and from time to time, I receive emails, like: ah, thank you for your solution. What I'm missing is software code contribution. That is, the people who told me about it, didn't produce code. They didn't contribute. I'm on an open source solution with zero contributor. There may be users, but not such a volume that it can give back intelligence." (Software, manager 13b)*
>
> *"To release, that is to say to put under an Open Source license, if you do nothing with it, it is useless. That is to say, yes, technically, you have an Open Source software, but if you have not created communities, if you do not have multiple contributions, if you do not know how to manage these multiple contributions, in fact, you have only done a very small part of the work." (Software, manager 12)*

In terms of Organization, high-level managers insisted on the need to prepare for cooperation, that is to split the project into small components, choose the appropriate open license, and communicate strongly and professionally to attract members. By communication, they explained that they need web sites, marketing supports such as demos videos, a platform where to publish the source code, serious documentation on the code, and several posts on specific professional blogs in order to get known and get beta testers, users, etc. Finally, in terms of Value, they insisted on the need to design a shared value proposition and philosophy.

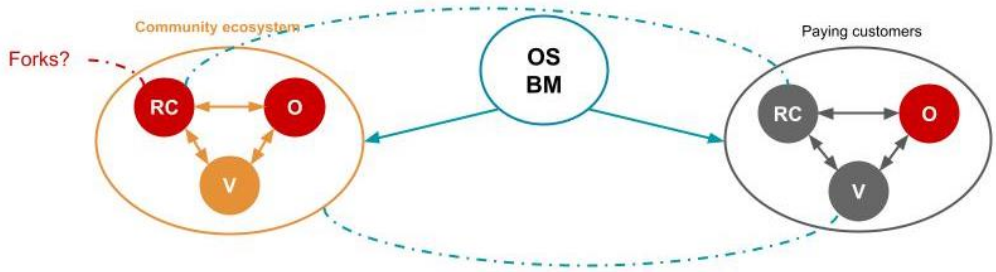
This means projects or components that are relevant to the community, freely available, with the mention "use it at your own risk" and the appropriate open license.

> *"An Open Source project that grapples with a currently unsolved issue will gather a very strong community. Let's take the example of the Go language released on 10/11/2009. In 2012, a group of people started to write an extension to the standard library. Today, the project has a community of about 5000 people." (Software, manager 2, interview feedback)*

On the paying customers side of this open source business model, high-level managers insisted on Organization and Value proposition. In terms of Organization, firms need to choose what to open and what to keep secret or private. In terms of Value, they will "sell" a well-known project, that many people have already downloaded and tested.

The second challenge is to develop both the community ecosystem and the paying customers, that is to say developing both sides (see figure 3).

Figure 3. Open source BM for experts of open source - *Step 2 Develop*



On the community ecosystem side, Organization is the issue and high-level managers explained that they have a lot to do to organize the possibility of contributing, outside, but also inside for their own employees. This means reengineering the internal process, based on knowledge sharing and "sweat equity". They also need to facilitate the cooperation inside the community ecosystem. New methods have emerged recently, such as the code of conduct, the care team, the inclusive documentation, as well as implementing standardization and automated testing methods.

> *"We must have a "code of conduct". The most useful one today is called the "Covenant", it's a document that allows us to regulate, not the organization of the community, but in any case, what we can and cannot do. We have a "Care Team", these are people you can call, if you ever feel attacked at a committee, to make a report, and then we take care of the problem. In the care team, today we have five people. And then, the core team, these are all the people who have access rights, who are at the heart of the community, who are either employees of ours or not at all, that's about twenty people. And we have a few thousand active*

contributors, that is to say, people who contribute either regularly or from time to time a few times a year." (Software, manager 15)

Last, high-level managers expressed the need to secure the open source project, with strong branding and marketing methods, in order to prevent forks, that is contributors downloading the project and starting a new one from this one. Branding seems the best protection of the open source components.

"The trademark, they can't use it, they have to use another one. The trademark is not open source, it is not part of the open source package." (Software, manager 8)

With Ubuntu, you have the right to use the Ubuntu brand but only if you have permission. The company that makes Ubuntu, they are called Canonical, they are not called Ubuntu, but at the same time, they control the brand, it's not a community product, it's a product developed by Canonical that has invested millions in community building. All this to say that the question of the name is crucial and there is not necessarily only one truth in this field (Software, Manager 14).

On the paying customers side, in terms of Resources and Competences, high-level manager experts of open source explained that they need high skilled employees being able to twist the use of the open projects.

"Even if it's all Open Source, (...) you have to understand how the tool really works to make the most of it." (Software, manager 2)

In terms of Organization, they need these high skilled employees to constantly monitor communities and project developments, and see how to internally use those components.

"We need to monitor actors, licenses and non-resolved tracks constantly." (Software, manager 3)

At last, in terms of Value proposition, high level manager experts of open source all insist on hybrid value propositions. It could be setting freemium model, customizing a generic open source offer, or selling an always up-to-date offer. Firms create value for themselves by selling services and commitment about continuity.

"If you pay by the bug, my interest as an editor is going to be to put bugs in the software, even time bombs, so that customers call me and pay. I don't want to have that kind of behavior at all, so the only way to clean up the relationship is to have an insurance relationship, which is to say, I'm making software, and you're going to pay a reasonable amount, less than you would if it was proprietary software, but you're going to pay every year or even to commit to three years if it's a three-year project. That's the model we tried to impose, and it worked out in my previous company." (Software, Manager 14)

> *"The customer never asks for source code. He has a problem, a need, he wants to implement a messaging system or he needs to collaborate, etc. And a solution is going to be yes, a software maybe open source, but we can integrate hardware, maintenance, support, guarantees, content updates, or services if it is in the cloud." (Software, High-level manager, peer-to-peer training in open source business models)*

High-level manager experts on open source think about network externalities, even if they do not name them.

4.3. NETWORK EXTERNALITIES OF THE DOUBLE-SIDED BUSINESS MODEL

High-level manager experts on open source expressed several positive or negative network externalities. Concerning the positive interside effects, first, the knowledge exchanges are important between community members and people working inside the firm, sometimes they are in fact the same people. Second, the ecosystem can develop itself because of resources lent by firms, whether in terms of money, time or material. Lastly, paying customers are offered hybrid formula, based on a healthy ecosystem and advanced collaborative methods.

> *"For us, as for other people, it took us a long time to realize that Open Source is not that [opening the source code]. This is the most representative aspect of it, but Open Source is more about collaborative working, a very specific and advanced way of collaborative working. (...) Open Source really brings a change of paradigm, that is to say a way of conceiving an IT tool that is different from a traditional publisher. We can see this even with Oracle; Oracle did not see the trends in Search, they did not see the trends in NoSql, they remained somewhat frozen in their market, without taking the evolutions into account. Whereas an open market is open to demands, it necessarily integrates them because it is its model, and as a result, it is always up-to-date." (Software, manager 12)*

But the open source double-sided business model has also its own challenges. High level manager experts of open source expressed their concern about difficulties raised by the co-existence of these two sides, linked to the knowledge sharing and to the global IT market. As for the knowledge sharing concern, the objectives are totally different in the two sides of the business model. Knowledge is very much shared in communities, but much less in the traditional relationships between suppliers and their customers, so called the "market governance".

> *"The comments that I get so far, like that one I had yesterday from one of the last companies to join us in Europe, is that they are very positively surprised by the fact that we're so open in our discussions. They're used to other ways, like when you have a discussion with a provider and you are a user, there is typically a culture of calculating the necessary amount of*

information to get to the point where I want to get you, and sometimes there're hiding elements which are important, but, we personally don't have secrets" (Software for industry, manager 10).

This difference is also reflected in the choice of the appropriate open source license. Firms will not choose the same license depending on whether they focus on the ecosystem or on generating value from their paying customers.

"We took an MIT license which is extremely permissive versus Stallman's GPL. The fundamental difference between the two is that the GPL is contaminating, the MIT / BSD is non-contaminating. On an MIT / BSD license, people can get the code, create a fork, even sell the code without any problem, if they make changes to the code, they don't have to give it back to the community: it's extremely permissive. The next stage is the public domain (Software, manager 15).

"There is a range between the Affero-GPL, which is probably the most restrictive in terms of obligations, versus the MIT or BSD licenses, which are considered the most permissive. (...) Our current license is the L-GPL, which is kind of the middle of the road" (Software, manager 14).

Here we have two cases: One firm is considering the open source software as a side project, they want to have the maximum of adoption and benefits from it, therefore they make a clear distinction between the company and the community. The other firm is placing the open source software at the core of their business model. Therefore, the appropriability question is important even if they hope to grow an ecosystem around their solution. Altogether firms need to find ways to balance adoption and appropriation risks.

The second concern is about the global IT market. The ideal ecosystem is a worldwide ecosystem, but it remains difficult to have an equivalent size for paying customers.

"Their business model is to take advantage of the Open Source movement to get contributions but above all to have an express distribution of the software. If you look at the download stats for the software YYY, you have had an extraordinary number of downloads and deployments. With a proprietary model, that's not possible. They get paid on the small instance, maybe the 1% of people out of hundreds of thousands of installations, who want an Enterprise version or service." (Software, manager 12).

"Is it normal that a software that represents 85% of the websites in the world has not managed to find a business model?" (Software, manager 15)

Even if the ecosystem is a worldwide knowledge sharing ecosystem, on the paying customers side of the business model, it is difficult to be present in all countries where there are contributors.

"All the business models based on service don't work, because we're talking about a global community, and it's very difficult to deploy the service internationally. It means having people on site, it's very capital intensive. (...) Today our brand XXX is a brand known all over the world, the reality is that our company is established in four countries and that's all. We have about 70 partners in the world, but there are many countries where we don't have a partner" (Software, Manager 15).

This is all the more problematic to generate value for firms themselves, as the ecosystem may grow "too much" and take the lead for the maintenance services. This probably explains why there are so many small companies in the open source software sector, and just a few as large as their ecosystem.

"The company XXX, they have exceeded one billion downloads, that's something colossal, it's a very nice company that makes a few million euros, but that remains small compared to the exceptional footprint of their software." (Software, manager 15)

Therefore, Value propositions for the two sides of the open source business model have different dynamics, which complicates the task of business leaders.

We summarize the double-sided characteristics in table 2.

Table 2 – Double-sided open source business model

RCOV		**Paying customers side BM**	**Community ecosystem side BM**
RC Resources and competences	*Reaping the most benefits requires high level of commitment*	Access to ecosystem of communities, Pool of available components	High level of expertise Adherence to open source philosophy to be accepted by communities and secure contributions Leaders committed to open source
	Find ways to balance adoption and appropriation risks	Open source licenses to limit piracy and appropriation Exposure of open source code and key employees	Open source licenses to facilitate adoption and contribution; Risks of forks Branding, marketing Tools (inclusive documentation, version tracking, automated testing, implementation standardization)
O Organization	*Choose what to open, find the best way to attract contributions and exploit them*	Choose what to open, based on differentiating or not Monitor communities and project developments (explore) Incorporate components in internal development (exploit)	Parcel into small components Attract community Contribute Reengineer the internal process, delegate, reward employees, learn to contribute
	Everything is to be shared with the communities but not with customers	Market mode Share knowledge but not too much	Organized bazar mode Share knowledge, Gift / counter gift, sweat equity Loss of control on communities' directions Code of conduct, care team, core team
V	*Who*	Paying Customers	Worldwide potential contributors

Value proposition	*Both Value propositions are hybrid but dynamics are different*	Hybridization: Customization of a freely available generic, continuously up-to-date offer Sell other goods or services Insurance and liability engagement	Project/ component open and not appropriable, relevant to the community Shared philosophy Hybridization: Open for potential contribution to core or to periphery
	How	Price for product or services Subscription formula for follow-up	For free, Use it at your own risk

5. DISCUSSION

First, our findings clearly indicate the importance of having a double-sided vision of the business model and to address at the same time the community ecosystem and the paying customers. Therefore, our proposition is valid, and we reconcile the different streams of research on open source firms. We clarify the process to attract contributors, and the necessary activities to maintain them. Our results insist on the importance of branding, and confirm West's proposition (West, 2003). The main challenge of open source business model is the coexisting necessity to open to create value and the impossibility to create value for firms with open components (Demil & Lecocq, 2014; West & Gallagher, 2006). Studying open source business models with a double-sided vision enabled us to stress the necessary professionalism to attract and keep the ecosystem, and new value propositions to paying customers. Liability issues are very important in industry, and value proposition should address this question. But we also bring new challenges to light, such as the internationalization challenge: The ecosystem is to be thought worldwide, but proposing services to customers is more local, and services are very labor intensive.

Second, we contribute to the theory of double-sided business models. Up till now, existing theory on multi-sided business models and markets focuses mainly on platforms (Adner, 2017; Cozzolino et al., 2018; Gandia & Parmentier, 2017; Jacobides et al., 2018; Mancha & Gordon, 2021; Parmentier & Gandia, 2017; Rochet & Tirole, 2003; Vanhaverbeke & Cloodt, 2014). In these platforms, as we explained with the example of Blablacar, firms try to create value for themselves on each side of the business model, and they expect positive inter-side effects. We enlarge this theory to other sectors than platforms. In open source business models, there are no platforms, but there are two different sides nevertheless, the paying customers side and the community ecosystem side. Firms that want to develop an offer based on open source components need both sides in order to generate value for customers and for themselves. The double-sided business model that we documented is different from a dual business model architecture, like Nespresso and their "razor and blades" business model,

where the user must purchase additional products like coffee capsules. It is also different from the business model portfolio which brings several more or less independent business models together (Snihur & Tarzijan, 2018). Without a double-sided business model and a specific attention both to the ecosystem and the paying customers, open source is more likely to drive a loss of value.

6. CONCLUSION

To conclude, our research questions were how to address both paying customers and the community ecosystem at the same time, that is to say **how to shape a sustainable business model when the value is open for free to anyone.**

Theoretically, we highlight the importance of addressing the community ecosystem as a specific side of the business model, and we characterize the network externalities of double-sided open source business models outside platform industry.

We also provide managerial contributions. First, we highlight the strategies that can trigger network externalities, as well as the associated business models. Then, by confronting the various points of view of high-level managers, we help open source experts understand why newcomers are so "resistant" to the idea of open source. We also help newcomers to move from value loss to value creation through the implementation of a two-sided business model. This can help managers to take the right decisions when setting up an open source project.

We are aware of limitations in our research. We could improve our study by having even more informants. This would help studying the difficult coherence of the two sides and the possibility to fund the community ecosystem more precisely. Another promising avenue of research would be to study how incumbents move step by step towards discovering value creation for themselves through open source community ecosystems. For example, it would be interesting to study the automotive sector, to see how firms move from value loss to double-sided business models by considering open source in their offers.

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APPENDIX - LIST OF HIGH LEVEL MANAGERS

NAME	NEW COMERS TO OPEN SOURCE
Balland N.	R&D Manager at Transalley, Mobility cluster, France. Developing a first open source vehicle project for research and education, for ARIA -Automotive Professional Association
Baschet T.	Business Unit Director Zehnder Group (radiators). Using an open functionality of android to control the heaters installation remotely. No open source logic on their products.
Bourdon B.	Community manager at Movin'on, an open innovation cluster about sustainable mobility, curious of value creation with open source business models.
Bourguignon P.	Mobility Consultant, open source vehicle project, curious of open source business models
Caverot G.	Founder of BA Systèmes (Robotics, some with Open Source), Innovation and robotics Manager, specialist of open innovation, a few experiences of open source.
Martinaud B.	Serial entrepreneur, coach for early age start-ups and international development. Leads the Mooc "openclassrooms.com/courses/lancez-votre-projet-innovant"
Portigliatti M.	Scientific Director of Michelin, in charge of research investments, leading Michelin's open innovation strategy on a global scale, concerning products, mobility and use topics.
Roger V.	Corporate Business Development CEA, Optics and Photonics Division, Open Innovation specialist
Taront JC.	Founder of Eurobaut, Européenne de robotique et d'automatisme, France. Applications developer for industrial robotics. 5 salaries. No open source.
Unger L.	Open Lab Paris Director at Renault (Mobility solutions) Back-up for one Open Source experimentation POM. For the past ten years, leading internal open innovation methods.

NAME	EXPERTS OF OPEN SOURCE
Bauwens M.	Theorist of the collaborative economy and founder of the Peer-to-Peer Alternatives foundation (http://wiki.p2pfoundation.net/)
Becue G.	General Manager of SMILE, France. Open Source software integration and management since 2001, 1200 salaries in 2017, mainly in Europe. Strong experience in open source: 35 white books on open source subjects with several million downloads, co-created The Open Source School.
Bordignon M.	ROS-Industrial Europe Consortium General Manager, Germany. ROS-Industrial is an Open Source robotics software project that extends the advanced capabilities of ROS to new manufacturing applications. 12-year experience in robotics and open source
Emde C.	Consortium General Manager of OSADL (Network providing services to use open source software for automation in industry, Germany); 20-year experience in open source.
Fermigier S.	Founder – CEO of Abilian, an Open Source application platform vendor, France. Created in 2012. Director of CNLL
Launay M.	Founder – CEO of Ecreall since 2005 (Free Software services, France), President of the open source Nord Pole cluster. Specialized in open source collaborative solutions
Meriot S.	Security Software Engineer at OVH (Hosting with Open Source, France), using open source to publish security tools. Personal experience of contribution to open source projects.
Montarges P.	Co-Founder of Alter Way, Open Source Web Platforms specialist, France. Created in 2005, 150 salaries in 2017. Vice-president of the CNLL (Comité National Logiciel Libre), President of Systematic Paris Region Open source Hub.
Potencier F.	Founder of the open source symfony web framework project. In 2017, 10% of web sites in the world are based on symfony. Founder of SensioLabs in 1998, open source software services
Rivalan J.	R&D Manager at Alter Way (Open Source Web Platforms specialist, France. Elected member of the OW2 administration Council (open source think tank) in 2021.

NB: The experts' answers represent only their own opinions.