Journal of Business Research xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Journal of Business Research

journal homepage: www.elsevier.com/locate/jbusres

Digital platform openness: Drivers, dimensions and outcomes

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ARTICLE INFO

Keywords:
Digital platforms
Platform openness
Value creation
Value appropriation
Drivers of openness

ABSTRACT

This multi-method study aims to shed light on digital platforms' decisions regarding their openness. Platform openness results from a series of decisions on how open a platform is regarding: (a) suppliers, (b) customers, (c) complementary service providers, as well as to (d) product categories and (e) channels. By conducting a scoping literature review, we analyze the current body of knowledge about the drivers, dimensions and outcomes of platform openness. Using an expert panel discussion and analysis of real-world digital platforms, we confront this existing knowledge with current business challenges to identify research challenges. We address how future research can advance platform research by tackling these challenges.

1. Introduction

Two-sided or multi-sided platforms open up their business to external users, like suppliers and customers, to enable mutually beneficial transactions between them. Platforms provide an infrastructure that facilitates these interactions with the aim to create value to their distinct users, while appropriating value for themselves (Maffè & Ruffoni, 2009). The advent of digital communication technologies has allowed platforms to facilitate nearly frictionless user participation and transactions, and capitalize on growing user bases via reinforcing network effects (Eisenmann, Parker, & Van Alstyne, 2006).

Extant research identified the challenges and tradeoffs that platforms face during implementation (Cennamo & Santalo, 2013, 2015), and in particular, with regard to dealing with various degrees of platform openness (Hagiu & Wright, 2018; Parker & Van Alstyne, 2017; Thomas, Autio, & Gann, 2014). Van Alstyne, Parker, and Choudary (2016a: p. 1) argue that platforms often fail because they do not optimize "openness": "*If platforms are too closed, keeping potentially desirable participants out, network effects stall; if they're too open, there can be other value-destroying effects, such as poor quality contributions or misbehavior of some participants that causes others to defect.*" Although openness increases platforms' market potential (Ondrus, Gannamaneni, & Lyytinen, 2015) as a greater number of users extend platforms' functionality via increased network effects and innovation potential (Binken & Stremersch, 2009; Claussen, Essling, & Kretschmer, 2015; Gawer, 2014), one of the key challenges of this increased openness is the need to maintain control over all parties involved (Boudreau, 2010; Cennamo, 2018).

While previous research takes an actor-based approach providing useful insights on the openness toward suppliers, customers, and complementary service providers (Hagiu & Wright, 2018; Thomas et al., 2014; Van Alstyne et al., 2016a, 2016b), it ignores other openness decisions, such as the inclusion of product categories and channels that constitute an essential part of the firm's value creation, and that determine the platform's attractiveness in the eyes of its dominant users: suppliers and customers. Including these two openness dimensions enriches our understanding of how changes to these five openness dimensions (and their interplay) create value to multiple parties.[1] Hence, we define platform openness[2] broadly as the platform's openness toward granting access and authority to suppliers, customers, and

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[1] Although there might be other openness dimensions, we consider these five to be of the greatest strategic importance for a platform.

[2] Throughout the paper, we define openness in terms of the platform's portfolio decisions but do not explicate whether the ownership of the platform is open or proprietary. Platforms, like Android or Linux, can be 'open' in terms of shared ownership and control. We relate this aspect to the interoperability of platforms, such that a greater interoperability translates into a greater openness toward complementary service providers.

https://doi.org/10.1016/j.jbusres.2019.07.001
Received 18 July 2018; Received in revised form 29 May 2019; Accepted 1 July 2019

complementary service providers, and toward the inclusion of categories and channels.

Openness is important to platform success as it determines how well platforms can leverage their external users' resources to match their internal capabilities (Thomas et al., 2014). Assessing how to optimize openness is, however, a challenging task due to user tradeoffs, interdependencies, and dynamic effects that make it more difficult to predict and manage the evolution of a platform (Gawer & Cusumano, 2008; Thomas et al., 2014).

We still know little about what drives openness, and the mechanisms through which openness impacts value creation and appropriation. The first aim of this paper is to identify the dimensions of platform openness, and place the concept in a larger nomological network. The second aim is to identify managerially relevant research challenges that help to guide future research to address the issues managers face regarding openness. To attain these goals, we link the theoretical findings (based on a scoping literature review) to the practical business challenges (based on a panel discussion with industry experts, and an analysis of existing real-world platforms). Our study offers three distinct contributions. First, we treat platform openness in a more comprehensive and integrative way by including product categories and channels as important nonactor-based openness dimensions, and depict platforms as shaping their own openness signature configured out of five openness dimensions. This approach helps to consider openness in the light of important business model decisions regarding the inclusion of channels and products.

Second, we embed the concept of platform signature in a larger research framework by identifying its drivers and outcomes based on a scoping literature review. This framework enables scholars and practitioners to assess what may drive platform openness, as well as predict the mechanisms of how a change in a platform's openness may create or destroy value for its users.

Third, by identifying the business challenges related to managing platform openness, we contribute to a better understanding of its complexity in practice. By eliciting the origins of its complexity (interdependencies, dynamic nature), we determine what scholarly knowledge is needed to help managers to make more informed decisions. Based on these managerially relevant issues, we identify research challenges that help to advance platform research.

The paper is structured as follows: we conceptualize digital platform openness in Section 2, followed by a discussion of our methodology in Section 3. In Section 4, we show the results from our scoping literature review to identify what we know about the drivers and outcomes of platform openness. In Section 5, we confront the extant academic knowledge with practice to see what "real-world" challenges remain unresolved. In Section 6, we provide recommendations about how platform research can tackle prevalent research challenges. Section 7 concludes.

2. Conceptualizing digital platform openness

2.1. Digital platforms

Platforms can be investigated at the organizational, product family, market intermediary, and platform ecosystem level (Thomas et al., 2014). This study focuses on the market intermediary level in which platforms act as an intermediary between two or more market participants, and facilitate exchange activities through an intermediating technology like they do in online auctions, price comparison sites, search engines, credit cards, and online retail platforms.[3] We focus on transaction-based platforms in which products are exchanged among a network of equivalently positioned economic actors[4] (cf. Perren & Kozinets, 2018). Digital platforms provide a common set of design rules and a digital infrastructure to facilitate exchanges between multiple users, who might otherwise never have the opportunity to interact with each other (Ondrus et al., 2015). The platform's fine design and structure of variable and fixed charges determine the willingness of its users to join a platform, as well as the net surpluses users gain from potential interactions (Hagiu & Wright, 2018).

2.2. Digital openness dimensions & signature

Platform openness is defined as "the extent that [the platform] places fewer restrictions on participation, development, or use across its distinct roles, whether for developer or end user" (Eisenmann, Parker, & Van Alstyne, 2009). Previous research (Boudreau, 2010; Eisenmann et al., 2009) defines actor openness according to two dimensions: *access* (i.e., who is allowed access to the platform?) and *authority* (i.e., how much is the actor allowed to do on the platform?).[5] A platform is "open" to the extent that: (1) no restrictions are placed on participation in its development, commercialization or use (access); and (2) any restrictions (authority) are reasonable and non-discriminatory regarding entry requirements, requirements to conform with technical standards, or payment of licensing fees (Eisenmann et al., 2009). This definition helps to understand platform's openness to its external partnering users, but focuses purely on firm-external platform aspects of tapping into the requisite variety offered by external parties (Thomas et al., 2014). As such, it foregoes the firm-internal platform types and aspects such as how the platform selects, ranks and represents offerings, and provides access to products and information. As a consequence, it neglects the openness to two other, internal non-actor platform dimensions, namely product categories and channels offered. We argue that, apart from making decisions on *who* is allowed on the platform and *how* much authority is granted to these users, platforms also need to decide on *categories* (*"what"*) of assortments and brands and the *channels* (*"where"*) of communication and distribution (Kumar, George, & Pancras, 2008; Neslin et al., 2014). Categories and channels constitute an important part of the platform's business model (Osterwalder & Pigneur, 2010), and changes to the platform's openness toward product categories (what products are offered?) and channels (through which channels is the product communicated and delivered?) have important implications for how value is created for customers (Saghiri, Wilding, Mena, & Bourlakis, 2017). These internal non-actor platform dimensions consequently are essential separate dimensions that are complementary to the user-related platform dimensions in creating value for customers. The openness on all these dimensions (or attributes) is expected to define the digital *platform signature*; that is, the platform's image or fingerprint for openness as perceived by its users.

Hence, platforms need to define their openness for each of the following five openness dimensions: three actor-based (suppliers, customers, complementary services providers), and two nonactor-based (categories and channels) dimensions. For the former, openness is a two-dimensional construct comprising both access and authority, while for the latter it relates to access only (see Table 1).

[3] Thomas et al. (2014) distinguish the market intermediary form from organizational platforms (as organizational capabilities enabling superior performance), product family platforms (a product family leading to derivative products) and platform ecosystem (as industry architectures, like the Internet). Though our focus is on market intermediary platforms, we do not exclude relevant papers discussing related platform forms.

[4] Platforms' core product can include goods, services or information.

[5] Although the two dimensions constitute openness, note that these dimensions are distinct and not necessarily highly correlated. Platforms can be very open on access while being very restrictive in giving up control; at the same time, platforms can grant much authority to a select group of users. For platforms delivering products to customers, suppliers' authority goes beyond the mere activities *on* the platform itself but also includes the freedom to customize the delivery and pricing of these products.

Table 1
Platform openness dimensions.

Openness dimension	Action	Definition	Subdimensions	Literature stream	Representative publications guiding our conceptualization
Supplier openness	Suppliers sell products that are core to the platform.	Degree of access that suppliers have to a platform, and what they are allowed to do on the platform.	Access	Platform sourcing	Boudreau (2010); Eisenmann et al. (2009); Van Alstyne et al. (2016a, 2016b)
			Authority	Platform sourcing	Hagiu and Wright (2018)
Customer openness	Customers transact on the platform to acquire or consume the service or product delivered.	Degree of access that customers have to a platform, and what they are allowed to do on the platform.	Access	Market segmentation: niche versus mass market	Masters and Thiel (2014); Cennamo and Santalo (2015)
			Authority	Customer co-creation	Balka et al. (2014); Cui and Wu (2016)
Complementary service provider openness	Complementary service providers sell non-core services to complement the platform's core product.	Degree of access that complementary service providers have to a platform, and what they are allowed to do on the platform.	Access	Platform sourcing	Eisenmann (2008); Jacobides, Cennamo, and Gawer (2018); Ondrus et al. (2015)
			Authority	Platform sourcing	Hagiu and Wright (2018)
Category openness	Platforms determine composition of product categories and items.	Openness to a variety of product categories and items.	Access	Category management, merchandise quality	Kumar et al. (2008); Oppewal and Koelemeijer (2005); Sirohi et al. (1998)
Channel openness	Platforms determine range of distribution and communication channels.	Openness to interact with and access platform through a variety of communication and distribution channels, and to seamlessly switch between them and perform functions.	Access	Omni-channel management	Emrich et al. (2015); Kleinlercher, Emrich, Herhausen, Verhoef, and Rudolph (2018); Wang et al. (2015)

Supplier openness refers to the degree of access that suppliers, who are not part of the platform, have to the platform, and what they are allowed to do on the platform (Van Alstyne et al., 2016a, 2016b). In terms of access, platforms can become less open by not allowing each supplier to access the platform. In terms of authority, platforms can either use a restrictive controlling strategy, or alternatively give up some control and use an enabling strategy in which some decisions (also known as 'transfer rights') are transferred to the supplier (e.g., the degree to which suppliers are allowed to directly interact with the customer when it comes to product delivery) (Hagiu & Wright, 2018); enabling platforms allow for less restrictive selection, monitoring and abandoning of suppliers, while controlling platforms use a less open strategy by placing more requirements on suppliers, e.g., by inducing exclusive entry or even exit costs.

Customer openness refers to the degree of access that customers[6] have to a platform, and what they are allowed to do. Apart from restricting access based on explicit criteria (e.g., nationality, language, age, and/or gender) (Mačiulienė & Skaržauskienė, 2016), platforms may also implicitly preselect them by favoring and serving a specific target market. This target market is then served using a preselected retail mix including pricing, promotion, product assortment, delivery and after-sales services, among others. In terms of authority, certain digital platforms allow customers to co-create value by providing access to the production, assembly, delivery, marketing and service phase (cf. Balka, Raasch, & Herstatt, 2014; Cui & Wu, 2016). Customers can co-produce, design, modify or assemble product offerings (Wikipedia, Threadless t-shirts, Makerbot 3D printing), participate in delivery (pick-up points), engage in promotional activities (Kickstarter project endorsements to friends), or write reviews (Amazon).

Complementary service provider openness refers to the degree of access and authority given to external service providers that complement the platform's core product (Kannan, 2017; Suarez & Cusumano, 2010). Such providers constitute a broad group often defined as "complementary service providers," "sponsors" or "interoperable platforms" (cf. Gebregiorgis & Altmann, 2015; Ondrus et al., 2015). We define complementary service providers broadly, and include all complementary services provided by external parties like payment, financing, insurance, security, and delivery services, but also the linking with other interoperable platforms to allow for cross-platform access (e.g., Facebook users using their account to log in on befriended platforms).

Category openness refers to the openness to the number of product categories and items offered on the platform. Category decisions refer to the overall composition of the assortments in terms of breadth (number of categories) and depth (number of items within a category) as well as their relations to each other (e.g., substitutive, complementary, and independent). Important in this aspect is the fact that, in the decision process on category openness, platforms have to distinguish between (a) the choice on which categories to carry and (b) the selection and display of specific product items (e.g., representing as many items as possible versus a selection of premium or price-promoted items; or displaying single vs. multiple offerings of the same item). For platforms, customers' assortment quality perceptions, which are essential to value creation (Sirohi, McLaughlin, & Wittink, 1998), are driven by the specific set of products shown – selected from the full assortment – and the way these products are presented. Discount platforms may increase assortment value by prominently displaying product items that are on sale, whereas platforms focusing on fast and convenient transactions may limit product category choice and selectively display a relevant set of product categories or items (possibly based on individual customers' prior search and purchase behavior).

Channel openness refers to the openness of the digital platform to access it via a variety of communication and distribution streams (cf. Saghiri et al., 2017). Digital platforms may vary in allowing its users to

[6] Customers include businesses (B2B clients) and end-customers (B2C clients)

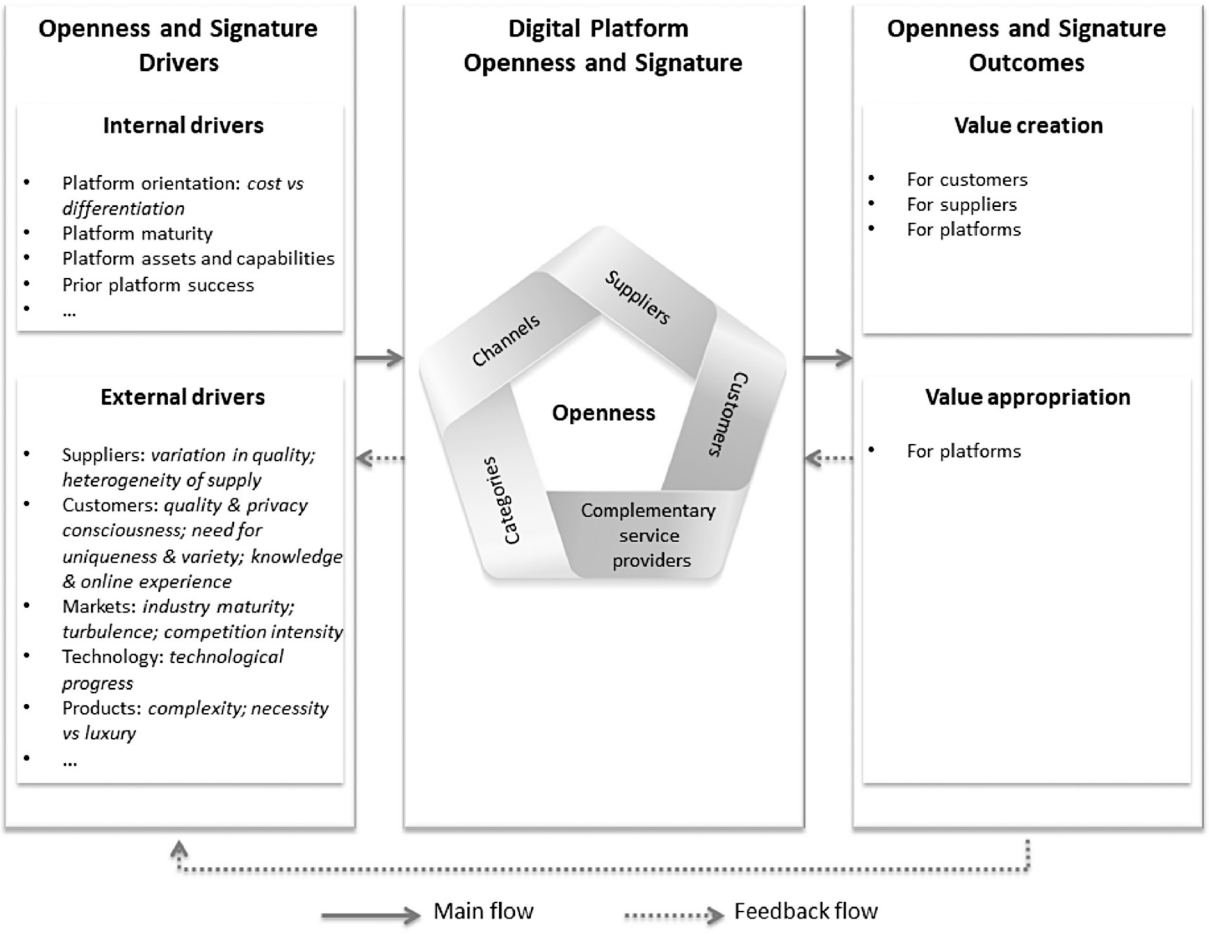

Fig. 1. Research model.

access the platform (e.g., WhatsApp's messaging is predominantly designed for mobile phone use, while competitors like Signal and Telegram promote access also via other online devices such as tablets and desktops). Platforms may increase channel openness by using more digital and physical channels and/or by allowing customers to switch seamlessly between channels (De Haan, Kannan, Verhoef, & Wiesel, 2018). Platforms may also restrict certain channel functionalities in terms of search, evaluation, transaction, pick-up and return of products (Herhausen, Binder, Schoegel, & Herrmann, 2015). Importantly, platforms may choose to create channel synergies by enabling the access to resources of other channels (e.g., ordering products from Amazon marketplace, while shopping in Amazon's physical store; Verhoef, Neslin, & Vroomen, 2007).

Note that a single decision regarding openness may affect multiple openness dimensions simultaneously. For instance, the decision to restrict the number of channels suppliers are allowed to use in their customer interactions not only affects channel openness, but also affects supplier authority openness. Hence, platforms should take a holistic approach to platform openness, as platform openness involves a set of interdependent dimensions. Making decisions on each openness dimension in isolation may lead to unexpected, and undesirable effects.

2.3. Embedding platform openness in a larger nomological net

To embed the concept of platform openness, we provide a simple organizing research framework, depicted in Fig. 1, that identifies a set of drivers that influence platform's decisions on openness and platform signature. The drivers do not deterministically define an ideal configuration of platform openness, but they guide the decision making of platforms in the degree to which they can open their platform and seek particular outcomes. Changes to platform openness are inherently linked to the underlying business model, as "*any change in openness… may influence the value proposition of products and services offered by a platform owner, resulting in potential changes to price and structure*" (Wan, Cenamor, Parker, & Van Alstyne, 2017: 9), which in turn will affect the popularity and attractiveness of the platform to customers and suppliers. Our framework thus assumes that such decisions on openness (objective attributes) relate to the platform's signature (perceived openness), which in turn leads to outcomes in terms of the creation of value for its users and the appropriation of that value. Hence, changes to platform openness likely have financial consequences, as openness determines the value the platform creates to its users as well as how much it can appropriate.[7] Although value creation is important to the initial and prolonged success of platforms, ultimately, a platform should be able to capture value from its activities to survive (Teece, 2010). Our framework further acknowledges the dynamics and interdependencies that characterize platforms.

3. Methods

This paper employs three steps to (i) analyze the empirical relationships of platform openness with other concepts (based on a

[7] Note that we do not claim that (objective) platform openness or (subjective) platform signature determine platform success. We only assert that changes to platform openness or signature likely influence platform's financial performance through altering value creation and appropriation. We thank an anonymous reviewer for highlighting this issue.

Table 2
Outcomes of platform openness.

Stakeholder benefits/costs	Suppliers		Customers		Complementary service providers		Categories	Channels
	Access	Authority	Access	Authority	Access	Authority		
Platform								
Benefits								
Ability to create value/grow	+ [1,15,16,17,19, 20]		+		+		+ [NP3]	+ [NP4]
Ability to capture rents	− [1,15,17, 18]	−	+	−	−	−		
Access to user resources	+ [6,9,15]	+ [12]	+	+ [12]	+	+ [12]		
Cross-selling opportunities	+ [15]						+ [NP2]	
Sharing of platform development costs	+ [8,9,17]			+				
Innovation	+ [2,3,12,17]/− [8,20]	+ [2,6,7,12,20]		+ [12]	+	+ [12]		
Ability to differentiate	− [5,9,18]	+ [6]			−	+		
Costs								
User coordination costs and issues	+ [2,10,12,20]	+ [12]	0	0	+	+	n.a.	n.a.
Non-user operational costs	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	+	+
Customers								
Benefits								
Co-creation opportunities		+ [12]		+ [1,12]		+ [12]		+
Choice: size, variety and quality of merchandise or service options	+ [1,2,3,7,20]			+	+	+	+	
Costs								
Search costs	0/+	+		+/−	+	+	−	−
Poor quality delivery	0/+ [20]			+ [NP1]/− [13]				
Suppliers								
Benefits								
Ability to differentiate	−	+			−	+		
Co-creation opportunities		+ [12]				+ [12]		
Costs								
Competitive intensity	+ [2,20]	+/− [12]			+	+/− [12]		

Note: benefit or cost is enhanced (+) or reduced (−) when openness increases. A 0 means that the costs can be marginal if managed well by the platform.

Notes:

Study platform studies		Non-platform studies
1. Alexy, West, Klapper, and Reitzig (2018) (C)	NP1	Franke et al. (2010) (E)
2. Boudreau (2010) (E)	NP2	Kumar et al. (2008) (E)
3. Boudreau (2012) (E)	NP3	Oppewal and Koelemeijer (2005) (E)
4. Boudreau and Jeppesen (2015) (E)	NP4	Wang et al. (2015) (E)
5. Ceccagnoli, Forman, Huang, and Wu (2012) (E)		
6. Cennamo and Santalo (2013) (E)		
7. Cennamo (2018) (E)		
8. Eisenmann et al. (2006) (C)		
9. Eisenmann et al. (2009) (E)		
10. Gawer and Cusumano (2002) (C)		
11. Grøtnes (2009) (E)		
12. Hagiu and Wright (2018) (C)		
13. Heidenreich et al. (2015) (E)		
14. Jacobides et al. (2018) (C)		
15. Ondrus et al. (2015) (E)		
16. Parker and Van Alstyne (2017) (C)		
17. Parker, Van Alstyne, and Jiang (2016) (E)		
18. Wang et al. (2015) (E)		
19. West (2003) (E)		
20. Wessel et al. (2017) (E)		

Note: (C) = conceptual paper, (E) = empirical paper.

scoping review), (ii) identify existing business challenges (based on academic-industry expert interactions) and (iii) synthesize the findings of this mixed method approach to derive research challenges. These three steps are described as follows:

Step 1: We start with a scoping literature review (Arksey & O'Malley, 2005; Paré, Trudel, Jaana & Kitsiou, 2015) to take stock of the existing literature on the dimensions, drivers and outcomes of platform openness. We examine the extent, range and nature of research that has been performed on these topics from a theoretical, conceptual and/or empirical view to identify "what we already know". Appendix I describes the details of our review, while Table 2 summarizes the results of our review.

Step 2: In a second step, we identify the business challenges related to managing platform openness in practice. To develop an in-depth understanding of the business challenges that managers face, we convened with executives from four companies to discuss their challenges, opportunities, and realities regarding the management of digital business. In multiple interactive panel sessions, during a two-day Thought Leadership conference on Digital Business Models, 40 scholars and 5 industry experts shared their academic and business insights. In this stage, we also assembled a cohort of digital platforms and categorized them according to their platform openness characteristics. In order to achieve a proper breadth in understanding the variety, we reviewed existing studies providing systematic classifications or taxonomies and selected a range of platforms from multiple sectors. By analyzing the selected cases, we highlight the complexity of managing platform openness in practice.

Step 3: In the final step, we contrast the existing academic knowledge with the business challenges to infer managerially relevant research challenges that may help future research to overcome them in future studies.

4. Literature scoping review: drivers and outcomes of platform openness

4.1. Supplier openness

4.1.1. Outcomes of supplier openness

The evidence found in the literature of providing greater supplier openness mostly focused on the access dimension, and much less on the authority dimension (for a notable exception, see Hagiu & Wright, 2018). In terms of access, platforms are encouraged to attract large numbers of suppliers to produce an attractive assortment to increase customer utility and enhance the ability to grow (Ondrus et al., 2015); the increasing assortment size allows the platform to cross-sell items and improves profitability (Kumar et al., 2008). Furthermore, the development and promotional costs to build the platform can be shared (Eisenmann et al., 2006, 2009). A downside of this greater openness is the greater difficulty of appropriating rents, as it leads to a greater dependency on and a corresponding need to share the profits with suppliers. Next, platforms with greater supplier openness face difficulties to differentiate the platform, as competitive platforms can easily "buy" the same product offerings from the same suppliers (Wirtz & Ehret, 2018). Securing supplier exclusivity is, however, not always an option, and can be very costly (Eisenmann et al., 2006). Managing a greater number of suppliers generally also increases coordination costs, as costs of failure, monitoring and communication increase with more suppliers (Hagiu & Wright, 2018). Without proper quality checks, greater openness diminishes the level of control over suppliers, which ultimately increases the likelihood that customers will be confronted with suppliers of poor quality (Gawer & Cusumano, 2002).

Many platform studies investigated the impact of supplier openness on platform innovation, as indicated by the platform's supply of novel products that are new to the market and not offered by competitors. Results were mixed. In terms of access, greater openness enhances platform innovativeness, but suppliers innovate less with increased supplier competition (Boudreau, 2010). To increase innovation, platforms need to attract a pool of heterogeneous suppliers to create a collective diversity (Boudreau, 2012). Boudreau (2010) demonstrated that granting access is more effective in improving innovativeness compared to giving greater authority to suppliers. Increasing the number of suppliers, however, decreases suppliers' innovation incentives, as the greater competition intensity –especially when similar products are offered– reduces their profitability.

In terms of authority, the preferential or discriminatory treatment of suppliers is considered to reduce supplier openness in terms of authority (Eisenmann et al., 2009). Related to this preferential or discriminatory treatment, Cennamo (2018) found that stimulating the number of suppliers by introducing platform-owned suppliers paradoxically lowers platform's ultimate penetration, as it reduces innovation incentives of external suppliers that lower overall platform penetration and performance. Sweet-hearting deals may persuade and secure suppliers to make huge ex ante investments and introduce extremely high-quality products solely for the platform (Binken & Stremersch, 2009; Eisenmann et al., 2006), but at the same time such a strategy clearly reduces incentives for nonpreferred suppliers to innovate and deliver high-quality products (Cennamo, 2018; Cennamo & Santalo, 2013).

Providing suppliers more authority and freedom is valued by suppliers. Hilkert, Benlian, Sarstedt, and Hess (2011) found that suppliers (i.e., app developers) of a software platform are more satisfied when they receive greater authority. They appreciate the greater freedom to co-create value with end-users and to differentiate themselves from other providers on the platform (Benlian, Hilkert, & Hess, 2015).

4.1.2. Drivers of supplier openness

While some empirical evidence exists on how external drivers influence openness, such evidence is missing for internal platform characteristics (e.g., platform orientation, CEO's preference). Regarding supplier characteristics, a greater variability in quality among suppliers increases the chances that platforms opt for restrictive sourcing. When supply varies greatly in terms of quality, and when customers value quality, markets tend to be characterized by increasing returns to quality in which high quality offerings dominate the market (cf. Binken & Stremersch, 2009). In such circumstances, platforms benefit from attracting a restricted set of high-quality suppliers and secure their platform exclusivity – even if such high-quality providers do not provide an extra boost to platform adoption, it takes away the opportunity for rival platforms to increase their platform sales (Binken & Stremersch, 2009).

Market characteristics, like industry maturity, also drive supplier openness (Eisenmann, 2007, 2008; Gawer, 2009). In nascent or highly turbulent markets, where innovation is important but risky, platforms often choose to open up and stimulate supplier-led innovation, thereby shifting the risk to invest in the wrong technology to suppliers (cf. Teece, 1986). When shifting from the market growth to maturity phase, knowledge becomes more readily available about the performance of suppliers, and platform differentiation becomes more difficult to achieve. In search for differentiation, platforms try to secure the exclusivity of the high-quality suppliers by giving them greater authority and more benefits, or by acquiring them (Cennamo & Santalo, 2013; Mantena, Sankaranarayanan, & Viswanathan, 2010; Muzellec, Ronteau, & Lambkin, 2015). Hence, as markets mature, platforms tend to become more restrictive regarding the sourcing of suppliers.

Product characteristics, such as product complexity, also drive supplier openness (Hagiu & Wright, 2018). For complex products like medication and technical tools, customers may need explanation and support from experts to make the right decision. When platforms are held responsible, they become wary to transfer decision rights to suppliers, and hence restrict access and lower levels of authority. Only when such instructions can be standardized and executed well by suppliers, then platforms may grant some authority and freedom on

non-key aspects.

4.2. Customer openness

4.2.1. Outcomes of customer openness

In terms of access, platforms choose to increase their openness toward customers – using a mass market rather than a niche approach – to stimulate the occurrence of network effects. A downside of this approach is that it can result in a "one-size-fits-all" solution that lacks a focus and ignores the specific needs of customers (West, 2003; Wirtz & Ehret, 2018).

In terms of authority, platforms choose to give customers more control to make use of their resources, such as knowledge, creativity, and other valuable assets (Thomas et al., 2014). The use of customers' knowledge and creative resources help to stimulate platform innovation, as evidenced on crowdsourcing platforms (Dell Storms, LEGO ideas) and on apparel platforms (Threadless, NIKEiD). Customers, who are given greater authority, for instance, by taking on the role of suppliers when selling (eBay) or sharing of properties or possessions (Airbnb, Sharely), or by taking on the role of complementary service providers when writing product reviews for other customers (IMDb and Booking.com), may receive additional value from the co-creation process. Customers value co-creation opportunities, as it helps them to find or customize products to more closely fit their needs, and/or because of the value derived from the process itself (Cui & Wu, 2016), also known as the "I designed it myself" effect (Franke, Schreier, & Kaiser, 2010). However, as they make ex ante investments and share their valuable resources, such enabling may restrict platforms' ability to capture value. Next, a downside of giving customers greater freedom and influence is that they lower control and increase the risk to dissatisfy and frustrate customers (Gebauer, Füller, & Pezzei, 2013; Heidenreich, Wittkowski, Handrich, & Falk, 2015).

4.2.2. Drivers of customer openness

When customers have rather homogeneous needs and do not need special features, open mass market strategies help to attain network effects and win the battle for network dominance (cf. Eisenmann et al., 2006). Restrictions – that is, restricting customer access or targeting specific niches – only make sense when customers are quality conscious and/or when negative same-side effects occur on the customer side. The selectiveness of platforms toward customers can provide members who value exclusivity with desired membership benefits for which they are willing to pay extra. To create prestigious and exclusive atmospheres, platforms selling luxury brands often decide to restrict accessibility (Hennigs, Wiedmann, & Klarmann, 2012), as expanding to new customer segments may alienate existing users (cf. Cennamo & Santalo, 2015).

Industry maturity also plays an important role in driving customer openness. In emerging or nascent markets, when turbulence is high and customer needs are relatively unknown, platforms do well to target a relatively small and homogenous niche (Nemati & Khajeheian, 2018; Sawhney, 1998). In line with Blake Masters and Peter Thiel's adage to attain a monopoly by first dominating a new niche market rather than the pursuit of market share in a larger, preexisting market (Masters & Thiel, 2014), platforms operating in new markets should cast a narrow net and concentrate on serving a niche that can serve as a base for expansion into related segments and application markets (Sawhney, 1998).

In terms of authority, platforms grant customers decision rights when customers know their roles and are capable of performing the task at hand (Hagiu & Wright, 2018; Meuter, Bitner, Ostrom, & Brown, 2005). Platforms face difficulties to grant decision rights and allow for co-creation when customers have greater privacy concerns that limit their willingness to share personal information with the platform (Cavusoglu, Phan, Cavusoglu, & Airoldi, 2016; Tajvidi, Richard, Wang, & Hajli, 2018).

4.3. Complementary service provider openness

4.3.1. Outcomes of complementary service provider openness

Although the type of product differs (i.e., core product versus complementary service), the outcomes of openness to complementary service providers tend to be similar to those related to suppliers. Yet, in comparison to the outcomes of supplier openness, research has paid much less attention to investigate complementary service provider openness. Research shows that platforms may increase the openness toward complementary providers to further improve the platform's core offering. Increasing openness to external complementary service providers helps to reduce customer risks via the offering of specific payment systems, like escrow services (PayPal) that can provide structural assurance and reduce monetary risks (Fang et al., 2014).

4.3.2. Drivers of complementary service provider openness

Certain digital or software platform types, because of their high modularity and ease of integration, are more amenable to include complementary service providers than others (Ondrus et al., 2015). Platforms are likely to be more open to complementary service providers when customers' tastes and risk attitudes differ, as it can add value by matching the numerous high-variety customers to specific complementary service providers (Gawer, 2009). A greater inclusion of providers may cater to the heterogeneous customer needs through offering customizable options around the (standardized) core product. Next, customers' risk can be mitigated effectively by providing additional payment or security services (Fang et al., 2014).

4.4. Category openness

4.4.1. Outcomes of category openness

Platforms' choice for the breadth (number of categories) and depth (number of items) of the products offered constitute an important part of their value proposition. Popular platforms such as Amazon, Netflix, iTunes and Booking.com can be driven by the need to offer ever-increasing assortment sizes, according to the premise that customers value products chosen from plentiful assortments (Mathmann, Chylinski, De Ruyter, & Higgens, 2017). The outcome of greater openness toward categories is, however, not straightforward due to the dynamics of customer preferences and evolving competition (Mantrala et al., 2009): an ongoing debate exists on whether "more-is-better" (Oppewal & Koelemeijer, 2005) or that "less-is-more" (Iyengar & Lepper, 2000). Larger assortments increase the likelihood that customers can find a product that closely meets their needs and facilitate product comparisons, but may also induce additional cognitive costs and cause choice overload in digital environments with unlimited shelf space (Lee & Lee, 2004). Empirical findings demonstrate that customer preference for larger assortments is subject to diminishing returns. Although greater category openness may initially increase anticipated consumption utility, purchasing probability, and ease of comparison, at high levels of category openness, the marginal benefit of additional categories is offset against the costs of choice overload that complicate decision making and decrease both purchasing probability and satisfaction (Chernev, Böckenholt, & Goodman, 2015; Mathmann et al., 2017).

4.4.2. Drivers of category openness

Platforms' tendency to increase the number of categories is strongly driven by customers' heterogeneity and desire for variety (Sloot, Fok, & Verhoef, 2006). Customers' search for variety can cause market expansion effects that, in turn, encourage platforms to expand the number of categories offered (Cachon, Terwiesch, & Xu, 2008; Datta, Knox, & Bronnenberg, 2018). Apart from customers' desire for variety, a higher levels of customers' assessment orientation (i.e., the desire to thoroughly assess a broad spectrum of choices before deciding) (Mathmann et al., 2017), as well as their desire for one-stop shopping (Messinger &

Narasimhan, 1997) call for higher category openness.

Technological drivers, especially in the field of search technology, can lower customer search costs, facilitate product comparisons, reduce choice sets and decision task complexity, and thus mitigate the risks of choice overload (Lynch & Ariely, 2000). Such technologies enable platforms to enlarge product categories for niche products, which can result in fatter and longer long tails (Brynjolfsson, Hu, & Simester, 2011; Hinz, Hill, & Kim, 2016).

Product complexity drives category openness via increasing the costs of broadening product categories because platforms then endure higher costs to train staff and monitor suppliers to maintain a minimum level of control and ensure product quality. Higher levels of desired product quality call for more specialization of the platform (Chernev & Hamilton, 2009; Kwak, Duvvuri, & Russell, 2015).

4.5. Channel openness

4.5.1. Outcomes of channel openness

Previous studies find positive platform outcomes from channel openness, also coined as the "availability effect," because adding channels decrease customer search costs and lead to increased sales (Neslin et al., 2006; Wang, Malthouse, & Krishnamurthi, 2015). Increasing the distributive reach through adding physical connections to the online platform has been found to increase overall transactions because of the acquisition of new customers (Avery, Steenburgh, Deighton, & Caravella, 2012) and greater customer retention (Pauwels & Neslin, 2015). However, high channel openness also increases (non-user) operational costs. Apart from higher operational costs, opening up the platform via the introduction of a physical channel also increased product returns (Pauwels & Neslin, 2015). Yet, the cannibalization effects of introducing a physical channel next to an online channel are limited, and in some cases positive cross-channel synergies exist that stimulate online sales (Avery et al., 2012).

Restricting channels' functionalities have mixed outcomes. On the one hand, restricting channels in their ability to perform specific functions may lead to fewer channel conflicts and higher sales success, as channels can more easily differentiate themselves (Fürst, Leimbach, & Prigge, 2017). On the other hand, restricting channels to perform specific functions may lead to disadvantages in the "competition for customer's mindsets" as dissimilar appearances of the platform across channels decrease customers' patronage intentions (Emrich & Verhoef, 2015).

4.5.2. Drivers of channel openness

As an internal driver, Jindal, Reinartz, Krafft, and Hoyer (2007) found that a firm's cost or differentiation focus determined channel openness: low-cost platforms prefer high levels of channel openness to increase market coverage and attain economies of scale, while companies scoring high on customer orientation tend to show low channel openness to avoid conflicts with resellers and build strong(er) relationships with customers.

Market characteristics, like turbulence and level of competition, also drive channel openness decisions via market valuation. For instance, firms operating in highly competitive, and highly turbulent markets benefit more strongly from offering additional channels in terms of market valuation growth than those operating in less dynamic markets (Homburg, Vollmayr, & Hahn, 2014). First-mover platforms benefit less from higher channel openness (e.g., addition of online channel) than early followers (Geyskens, Gielens, & Dekimpe, 2002).

Product characteristics affect openness decisions in several ways. Neslin et al. (2014) conceptualize about the possible interactions between what to buy (products or brands) and where to buy (channels). Hedonic or luxury products such as jewelry, cosmetics and fashion incentivize high channel openness of platforms because customers want to experience the products across different channels, whereas purchase of utilitarian products happens in specific channels, promoting low openness (Kushwaha & Shankar, 2013). Emrich, Paul, and Rudolph (2015) showed that channel openness is particularly desired when product categories offered have high substitutive relations (such as with specialist retailers carrying deep categories), whereas for products with high independent relations (such as with general merchandisers carrying broad, unrelated categories) a more selective approach may be favored in which the digital platform provides a larger assortment than the other channels.

Finally, regarding customer characteristics, more knowledgeable and experienced online customers require lower levels of channel openness (Cao & Li, 2015; Jindal et al., 2007). In contrast, more innovative customers (Konuş, Verhoef, & Neslin, 2008) and more experiential shoppers (Pauwels & Neslin, 2015) prefer to use multiple channels, which call for higher levels of channel openness.

5. Business challenges: what do we need to know?

In this section, we shift from the academic perspective of what has been studied to the business perspective of making effective platform signature decisions. Based on the business challenges identified, we reflect on and categorize a number of business examples to explain the complexity of managing platform openness in practice due to the interplay of dimensions, the interdependencies between actors, and platform dynamics.

5.1. Platform openness is a complex interplay of openness on underlying dimensions

In practice, deciding on platform openness is not a simple dichotomous choice between open vs. closed, but it rather involves a complex set of decisions on how to configure openness on each dimension. In Table 3, we categorize several intermediary platforms, and find that platforms substantially differ in their openness scores on the dimensions, but also that different constellations of openness, or platform signatures exist. Our taxonomy differs from existing empirical typologies that limit their focus to the interplay between users and platform intermediation (e.g., Perren & Kozinets, 2018), as we also include the openness to channels and product categories. Our classification of *unified* vs. *diversified*, *price* vs. *service quality*, and *frictionless* vs. *experiential* (for an explanation, see Table 3) is neither theoretically grounded nor exhaustive, but is merely used to display the diversity of platform signatures.

From a managerial perspective, platforms face the challenging task to configure openness in such a way that the 'right' set of suppliers and complementary service providers are matched to the 'right' set of customers using the 'right' selection of product categories and channels. To complicate matters, the effects of the underlying dimensions are not uniform and interdependencies can exist between dimensions, such that the effect of opening up one dimension may strengthen or weaken the effect of another. For instance, if the platform follows a growth strategy using a high openness toward suppliers, it may accelerate growth when combining this dimension with high levels of openness to customers (greater market potential), product categories (cross-selling opportunities) and channels (availability effect). But, at the same time, this opening up creates additional platform challenges to detect opportunistic behavior or low-quality sellers, to facilitate customer search within the wider range of product categories, and to coordinate product flows and product returns due to the increased complexity. Although channels interfaces can be tailored to the demands of specific customer segments to still create economies of scope (see example of OTTO in Table 3), coordination efforts tend to increase to avoid channel conflicts (Lemon & Verhoef, 2016).

Hence, multiple configurations exist, and there seems to be no single best approach. Assuming that the dimensions do not influence each other can be risky and lead to wrong decisions. Openness decisions should holistically be determined to see which configuration is most

Table 3
Taxonomy of real-world intermediary platform signatures.

Platform signature	Unified vs. diversified		Price vs. service quality		Frictionless vs. experiential	
Openness decisions regarding…	Unified shopping platforms	Diversified shopping platforms	Shopping club platforms	Curated shopping platforms	Smart shopping platforms	Customized shopping and social platforms
Examples	Amazon	OTTO	Brands4friends	Outfittery	Mint	Threadless, Pinterest
Supplier access	High	Low	Low	High	Low	High
Supplier authority	Low	High	Low	Low	Low	Low
Customer access	High	Low	Low	Low	High	High
Customer authority	Low	Low-high	Low	High	Low	High
Complementary service providers access	High	Low-high	Low	Low	Low-high	Low-high
Complementary service providers authority	Low	Low-high	Low	Low	Low-high	Low-high
Categories	High	High	Low	Low-high	High	Low-high
Channels	Low-high	High	Low	Low	Low	Low-high

Platform signature	Example	Description	Focus
Unified shopping platforms	Amazon	Platforms that serve a wide range of customer segments using many suppliers, a great variety of product categories and channels, while restricting authority of customers and suppliers to basic functions, and using a single communication interface: i.e., a single website.	Economies of scale
Diversified shopping platforms	OTTO	Platforms that target multiple niches and adjusts their communication interfaces accordingly. A selective strategy is used toward a limited number of suppliers, who are granted greater authority. Unique channel-product-customer combinations are created with specific platform-based services, like shared family accounts and wallets.	Economies of scope
Shopping club platforms	Brands4-friends	Platforms that have daily price promotions of single brand suppliers for a restricted set of product categories, which are temporarily available for members. The low openness on all portfolio aspects; that is, only a few suppliers at a time, targeted at club members only, with limited complementary services using very narrowly-defined categories and channels, enables lowest price offerings.	Price/transaction value
Curated shopping platforms	Outfittery	Platforms that enable customers to interact with (human) advisors, who customize offerings based on personal conversations. Assortments are procured across virtually all available suppliers using loose collaborations within a narrowly defined product category. The platform only uses digital channels, offers many platform-based complementary services, and addresses narrow customer segments that have a higher willingness to pay.	Service quality
Smart shopping platforms	Mint	Platforms that assist customers to reduce effort using mobile applications for their purchase decisions across a wide range of products and services, like financial and energy products. Platforms preselect a limited set of suppliers, using many external complementary services or develop platform-based services, such as mental budgeting tools and planning support. Technological tools are used to cater to the heterogeneous needs of the many customer segments.	Reduce customer effort
Customized shopping and social platforms	Threadless, Pinterest	Community-based platforms that offer customers (as well as suppliers), the opportunity to co-create value and customize their end product using interactive toolkits that enhance the customer experience.	Enhance customer experience

successful, and fits given the characteristics of the demand side (customer heterogeneity, need for variety, quality and price consciousness), the supply side (heterogeneity in supply and quality), the product at hand (complexity), as well as the platform characteristics (orientation, prior success). Interdependencies between the openness dimensions can enable synergies but may also hamper the performance of other dimensions. What business need to know is how this openness framework can be used to identify opportunities and threats that emerge from the configuration of openness decisions across the dimensions, and their resulting synergetic and competitive effects, such that a desired platform signature can be formed.

5.2. Openness decisions are subject to actor interdependencies and tradeoffs

In the previous section, we identified the interdependencies (competitive or synergetic effects) that exist between dimensions, but interdependencies also exist between platform users (De Reuver, Verschuur, Nikayin, Cerpa, & Bouwman, 2015; Wan et al., 2017) such that improving the outcomes of one actor will influence the outcome (benefit or cost) of another user. Increased supplier openness may lead to a broader choice set for customers, but for suppliers it simultaneously increases competition that tightens profit margins. As platforms need to create value to both sides, actor interdependencies can cause tradeoffs to the platform: favoring one side will, in many cases, hurt the other side, as the different users have mixed and potentially conflicting strategic objectives and interests (De Reuver et al., 2015). Although Cambridge Analytica benefitted from greater authority to collect more data from Facebook users, it harmed the privacy of Facebook users who lost confidence in the platform's integrity. Designing an effective platform signature thus becomes more complex as these tradeoffs will have to be considered simultaneously.

What business needs to know is how openness decisions engender tradeoffs by analyzing how favoring one type of user reduces value for other users. As not all openness decisions imply a tradeoff (a zero-sum or win-lose game), businesses also need to know under what circumstances openness decisions may create simultaneous benefits (a positive-sum or win-win game) for multiple users. Furthermore, business needs to acquire knowledge on how to resolve conflicts between users and maintain their commitment to the platform.

5.3. Openness decisions are subject to platform dynamics

Based on real-life business cases and case descriptions in articles, sufficient empirical evidence exists that platforms can deliberately change their openness, but that such decisions are also subject to, and influenced by past decisions and platform evolution (Eisenmann, 2008; Gawer & Cusumano, 2008). Platforms may change their organizational goals during platform evolution. New platforms usually focus on building user bases by offering a relatively small and well-defined set of product categories and channels, and then in growth phases deliberately open their channels and product categories to increase value for its users. But once critical masses appear on both user sides, platforms' strategic focus tends to shift from open (value creation) to closed (value appropriation) models. In time, with increasing competition between platforms, platforms' need for differentiation also becomes stronger, making it more likely that they will secure exclusivity in supply and/or develop unique platform-based products.

A platform's evolution does not always follow a predictable path, as specific events (e.g., scandals, market updates) may pressure platforms to react and adjust their openness strategy. Etsy, an online marketplace for arts and crafts supplies, was pushed to alter its openness strategy in response to shareholder pressure (Gelles, 2017). In an attempt to win back lost customers, Etsy expanded on its platform-based services by more strongly assuring refunding in case of problems, and by restricting access to a smaller set of suppliers and limiting their authority to set price conditions (i.e., mandatory use of all-inclusive pricing).

Although platforms may be more powerful than their users, they need to be cautious when restricting platform openness to capture more rents. Such decisions may help to capture more value in the short run, but may backfire in the long run by increasing conflicts and distrust that lower users' willingness to support and transact via the platform. Such restrictions can have long-lasting effects on platform performance, as existing customers tend to leave when they can no longer find their preferred suppliers, complementary services, channels and categories (cf. Neslin & Shankar, 2009; Payne & Frow, 2004).

What business needs to know is how to project the implications of openness decisions to account for endogenous dynamics and changing platform objectives. Such information is needed upfront, as platform decisions become more rigid and difficult to change over time.[8] Furthermore, platforms need to know to what degree restricting openness (using a variety of measures that vary in severity) harms their power and affects their short-term and long-term performance.

6. Research challenges in platform openness research: how to move forward?

Based on what we already know (Section 4) and need to know (Section 5), we identify four research challenges that may guide future research on platform openness regarding (a) its conceptualization and measurement, (b) the identification of drivers and outcomes, (c) the incorporation of interdependencies, and (d) the incorporation of platform dynamics.

6.1. Conceptualizing and measuring platform openness

Little agreement exists in the literature on how to dimensionalize and measure the concept of platform openness. One of the reasons for this lack is that it is a multidimensional construct that can be measured – at different levels (cf. Ondrus et al., 2015; Thomas et al., 2014) – both objectively and subjectively. To resolve ambiguity and stimulate cumulativeness of research, scholars should clearly define (a) the level of measurement (at what level: organization, intermediary, ecosystem?), (b) how openness is measured (objective vs. subjective, inclusion of dimensions), and (c) which users are reflecting upon openness.

Openness can be measured objectively and subjectively. Studies that objectively measure openness typically analyze the impact of factual platform changes to openness on market outcomes (cf. Boudreau, 2010; Wessel, Thies, & Benlian, 2017), while subjective studies use survey techniques to measure platform openness through the eyes of its users in order to assess the impact of openness perceptions on user attitudes, intentions and behaviors (Benlian et al., 2015). A first limitation is that studies – from both streams – largely ignore the inclusion of customers (for a notable exception, see Song, Baker, Wang, Choi, & Bhattacherjee, 2018). To account for the multiple users, it is important that future research is not limited to the supply side, but also incorporates the customer side. Second, most scholars agree on the multidimensionality of platform openness (Benlian et al., 2015), yet, very few studies specify subdimensions (access and authority) and identify the non-actor aspects. Future research should structurally identify and measure the (sub)dimensions of platform openness for both actor- and nonfactor-specific aspects. Third, extant research ignores the interrelationship between objective platform changes and platform signature. Future research should explore how users interpret objective platform dimensions to construct platform signatures, identifying whether they make inferences per dimension, or make holistic evaluations. Studies in the field of open innovation initiatives (e.g., open source software,

[8] The business model literature also argues that business models become more difficult to change over time, as companies invest and optimize business processes, and because customers get attuned to the use of certain channels and availability of product categories (Christensen, Bartman, & Van Bever, 2016).

crowdsourcing) may provide useful insights into how objective changes to the platform (related to access and authority) relate to the perceptions of suppliers (cf. Wessel et al., 2017), while studies in the field of co-creation may help to understand how customers perceive and interpret the authority dimension (Balka et al., 2014; Cui & Wu, 2016).

6.2. Identification of drivers and outcomes

Although many studies acknowledge that platforms make changes to openness (Eisenmann, 2007; Gawer, 2009; Thomas et al., 2014; West, 2003), few studies systematically identify the *drivers* of such changes to platform openness. A starting point is to collect data from various platforms from various industries to assess how industry (customer, supplier, competitor, market and technology) and internal characteristics (platform maturity, orientation, prior success) may drive platform openness.

Similarly, although openness has been postulated to influence several platform *outcomes*, including control (Boudreau, 2010), cost sharing (Eisenmann et al., 2006), coordination issues (De Reuver et al., 2015; Gawer & Cusumano, 2002), market growth (Boudreau, 2010), innovation (Boudreau, 2012), ability to create and capture value (Parker & Van Alstyne, 2017; West, 2003), few studies empirically test the effect of openness on such outcomes.

An important reason for the limited number of studies studying the drivers and outcomes lies in the dynamic nature of changes to platform openness (temporal effects, path dependencies) that complicates the establishment of cause-and-effect relationships. Most studies are therefore restricted to quasi-experimental designs by linking platform changes to its openness with longitudinal data on (performance) outcomes. Empirical studies are limited to measuring intermediate performance outcomes in terms of value creation like market growth or innovation (Boudreau, 2010, 2012), but ignore the financial outcomes like value appropriation and profitability. Furthermore, in relation to the multidimensional nature, many scholars consider the impact of openness at an aggregate level, but do not investigate how the distinctive subdimensions of access and authority may differentially impact growth, value creation and value appropriation. In this respect, Wan et al. (2017) have already suggested that subdimensions of the same openness dimension may have opposite effects; for example, supplier access may stimulate competition between the platform and its suppliers, while supplier authority may stimulate collaboration. More research is needed to empirically test the causal relationships between the drivers and openness, and between openness and outcomes. Quasi-experimental designs can provide initial insights and help to further specify the nomological net surrounding platform openness.

6.3. Incorporation of interdependencies

Many studies point to the role of interdependencies and how they may affect openness decisions and outcomes. Yet, few of these studies make these interdependencies between dimensions and between actors explicit, and even fewer test them empirically.

Regarding dimension interdependencies, future research should measure the multiple dimensions simultaneously, and not limit the analyses to individual dimensions, as this ignores the likely interplay between dimensions and can potentially bias results.

Regarding actor interdependencies, it is important to understand how decisions impact the distribution of benefits across actors to find out how platforms can maintain high levels of cooperation among multiple, self-interested contributors, who may have conflictive interests. When users perceive platforms to appropriate an unfair share of benefits, suppliers and customers may circumvent the platform and transact outside the platform, or suppliers may collectively create a new competing platform (Wan et al., 2017). Organizational research on umbrella organizations, in which a powerful network firm guides and coordinates a network of independent firms operating under a uniform entity (cf. Wincent, Thorgren, & Anokhin, 2014), may provide useful insights into how to secure users' cooperation. Furthermore, to determine how parties respond to platform decisions, psychological experiments can assess users' fairness perceptions and (changed) usage intentions in response to platform changes that favor focal users or the other side.

6.4. Incorporation of platform dynamics

Existing studies often acknowledge but do not explicitly address the dynamics of openness decisions. Yet, as such decisions are clearly influenced by previous decisions and have a temporal dimension, it is important to address and incorporate feedback loops into future conceptual models (Rahmandad & Sibdari, 2012).

For certain IT or mobile platforms, scholars can relatively easily track openness decisions (e.g., changes in platform features, supplier scope, product offerings, channel availability), and/or shifts in platform goals (e.g., hiring of new CEOs), and link them to platform outcomes (user participation, user satisfaction, market share). To measure and analyze these dynamics, multivariate time-series econometric models like, for example, Vector-Autoregressive (VAR) models (see e.g. Leeflang, Wieringa, Bijmolt, & Pauwels, 2017) are useful, as they explicitly incorporate over-time dynamics and feedback effects. Such models, however, are often demanding regarding data, the latter not always (sufficiently) being available. In such circumstances, agent-based models or simulation (games) can be a viable alternative to generate the required data to mimic the platform dynamics and assess the (dynamic) impact of openness' decisions on outcomes (Rahmandad & Sibdari, 2012).

7. Conclusion

The concept of platform openness has recently received much scholarly interest. This study is a first attempt to synthesize the existing knowledge on drivers, dimensions and outcomes of digital platform openness. Using a simple research framework, we take stock of the existing findings that relate to the dimensions underlying a platform's signature on openness. This overarching research framework may help researchers and practitioners to understand under which circumstances platforms are more likely to use an open or closed strategy, and predict the consequences of making changes to the platform openness for the platform and its users.

We identify three research challenges – interplay between dimensions, interdependencies between actors, and platform dynamics – that complicate the management of platform openness. Based on this, we provide several avenues for future research to advance research and address apparent research challenges. Although extant research has made significant progress in defining openness, much work remains to be done to understand the specific drivers and outcomes of openness, its interdependencies and dynamics. We hope that our work, and our research framework in particular, spurs researchers to advance openness research to inform both theory and practice.

Acknowledgement

We would like to thank Rissa Bouwsema for her support and technical assistance regarding the literature review.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jbusres.2019.07.001.

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