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Analysis

Modelling the Interplay Between Institutions and Circular Economy Business Models: A Case Study of Battery Recycling in Finland and Chile

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ABSTRACT

This article develops an analytical framework for modelling the complex interactions between circular economy business model activities and the features of diverse institutional operating environments. Developed framework combines business model conceptualization with institutional theorization to understand how institutions influence on business conduct. Business model concept is used to describe organizational activities and managerial cognition in a structured manner and institutional theory is used to identify features that may facilitate or hamper particular activities in a particular operational environment. Countries' institutional environments related to the advancement of circular economy differ from each other and therefore comparison between the situations provides an interesting context to study the dynamics between companies' business models and the institutional features. We apply our analytical framework to a case study of two recycling companies operating in Finland and Chile to explore links between the firm-level activities and developments outside the firm. The results highlight the interdependent nature of the relationship between the business models and context-specific institutions, the logics between positive and negative value materials, and the differences between countries in the promotion of circular economy.

1. Introduction

The implications of institutions on the advancement of circular economy has been studied at the level of entire business environments (e.g. Pajunen et al., 2013; Ranta et al., 2018) but only few studies have paid attention to the close interdependence between institutional frameworks and single companies' business models (e.g. Fischer and Pascucci, 2017; Moreau et al., 2017). In this article, we develop a framework for modelling how institutional conditions influence circular economy business models of battery recycling companies. We argue that combining business model concept with institutional theorization can help to understand how institutions influence on the activities and opportunities of a particular company. This notion adds to the literature because institutional theory has paid only little attention to companies' resources and capabilities, concentrating instead on the rules and regulations in place in different operational environments. It can be said that thus far institutional theory has black-boxed the role of business models and consequently there is little evidence on how specific institutional factors influence on firm-level business activities.

The transition from a traditional, linear economic model to circular economy is motivated and driven by the goal of improved resource efficiency (Ghisellini et al., 2016; Korhonen et al., 2018). Since the earliest stages of ecological economics, the basic idea of circular economy – i.e. continuous reuse of resources – has been central to the field. In 1991 Herman E. Daly noted in his essay a problem that "circular flow of exchange is coupled with a physical flow of matter-energy which is *not* circular" (Daly, 1991, 195). Even much earlier Kenneth Boulding had used spaceship-metaphor to describe "a closed system" in which "all outputs from consumption would constantly become inputs for production" (Boulding, 1966, 7) and Nicholas Georgescu-Roegen had brought into discussion the ultimate limits of the use of natural resources (Georgescu-Roegen, 1971). The term 'circular economy' was first used by David W. Pearce and R. Kerry Turner in their now-classic book *Economics of Natural Resources and the Environment* (Pearce and Turner, 1990, 35–40). These early ideas have not only been instrumental to the development of ecological economics as a field of research, and later circular economy as a concept; they have also inspired the development of many other concepts and fields, including for example industrial ecology (Frosch and Gallopoulos, 1989) and cradle-to-cradle design (Braungart and McDonough, 2002).

Today, national governments are promoting circular economy by introducing new laws and regulations, but differences in priorities

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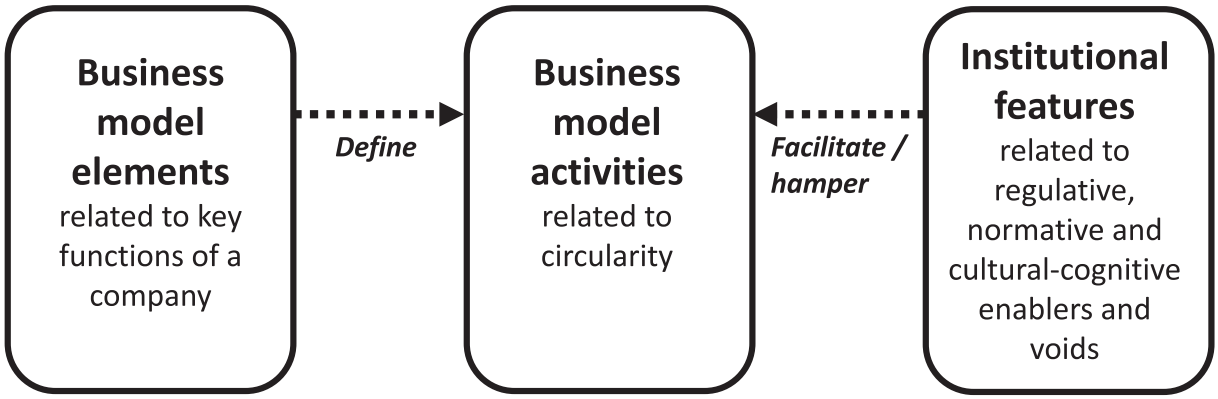

Fig. 1. Analytical framework for modelling the interplay between institutions and circular economy business models.

mean that these changes are happening at a different pace in different countries. The transition to circular economy unfolds through a succession of modifications to the national institutional frameworks and to companies' business models (Boons and Lüdeke-Freund, 2013; Lewandowski, 2016). In this article, we focus on situations in which the advancement of circular economy requires both institutional changes and an ability on the part of companies to adapt and adjust to those changes. Our analysis demonstrates that in different locations institutions influence in different ways on business models of the companies. Our study suggests that business models must always be weighed against the local institutional structure, which constitutes context-specific institutional enablers and voids for business activities. Our findings are informative beyond the studied industry of battery recycling because they shed new light on the mental models operating behind firm-level activities and institutional-level features as well as complex interactions between institutional contexts and businesses' attempts to move toward circularity.

Motivated by the observation that the specific dynamics between business models and the institutional environments are not well understood in the context of circular economy, we pose the following research question: how do institutional features facilitate and/or hamper the circular economy business model activities? In the forthcoming, we will develop an analytical framework for modelling the institutional influences on companies' business models and we will demonstrate the success of the model with the analysis of two recycling companies operating in very different institutional environments of Finland and Chile.

2. Literature on Institutions and Business Models

The environment in which companies operate is characterized by the prevailing socio-cultural institutional structure. By institutional structure, we refer to the "rules of the game in a society" (North, 1990, 3), or a system of rules comprising formally and informally defined institutions (e.g. Ostrom, 2005) that determines what actors are allowed to do and what not (Bocken et al., 2014, 55). Based on their different working mechanisms, institutions can be divided in three broad categories of regulative, normative and cultural-cognitive institutions (Scott, 2013, 59–70). Regulative institutions, such as laws and regulations, are formally defined coercive rules. Normative institutions, such as routines and ways of doing things, are rules that are based on social obligation. Cultural-cognitive institutions, such as shared beliefs and logics of action, are constitutive schemas that operate mainly through mimetic processes. Different types of institutions operate in a reciprocal relationship and their mutual significance varies depending on the context and the situation at hand (e.g. Levänen, 2015a).

We argue that the concept of business model can be used as an analytical tool for structured analysis of how companies' activities are influenced by regulative, normative and cultural-cognitive institutions. In this study business model is not seen as a theory on its own (Ritter and Lettl, 2017), but as a conceptual representation of firm-level organizational activities (Massa et al., 2017; Zott and Amit, 2010). Theoretical foundation of the business model concept is built on transaction-cost economics, resource-based view and dynamic capabilities (Barney et al., 2001; DaSilva and Trkman, 2014; Williamson, 1981; Zott et al., 2011). The concept provides a structured approach to model organizational activities and managerial cognition (Baden-Fuller and Morgan, 2010; Martins et al., 2015). This kind of modelling helps to understand causal links between the firm-level activities and developments outside the firm (Baden-Fuller and Mangematin, 2013). Importantly, business model conceptualization can be used in the analysis of single firm's responses to exogenous shocks, such as institutional changes in the operating environment (Osterwalder et al., 2005; Teece, 2010, 191). We use business model concept to describe how institutional influences take place at firm-level.

When institutions are understood in terms of a set of rules, the operating environment as a whole can be seen as a "game", and a business model accordingly as a company's "game plan" or a story of how it aims to play the game, i.e. how it conducts its business in that particular environment (Magretta, 2002). By adjusting its activities in relation to the elements of a business model, a firm can adapt to the institutional structure. When the "rules of the game" (the institutional framework) for a recycling business change, companies need a new "game plan" (business model) in order to benefit from or at least adjust to the new situation, which may require a revision of the entire business logic. Companies' capacity to adjust to institutional changes becomes critically important in the context of circular economy because countries typically pursue advancement at that area by modifying their institutional frameworks. It is important to notice, however, that no institutional environment is an optimal "game" for all "players." Rather, the institutional structure is always imperfect, and therefore companies must constantly adjust their business model activities to fit the current expectations of the institutional environment.

Based on the theoretical premises outlined above, we have developed an analytical framework (Fig. 1) for modelling the relevance and applicability of a particular business model to a particular institutional environment in the context of advancement of circular economy. The idea of our analytical framework is that it can be used in the modelling of the interplay between institutions and circular economy business models in different contexts. This is possible because an analyst can include in the modelling context-specific business model elements and circular economy features that are critical from the perspective of applied industry. Detailed instructions for applying the framework in different contexts as well as a description about how we utilized it in our research are presented in Appendix A.

Here developed analytical framework helps to identify: 1) business model elements that are critical from the perspective of advancement of circular economy, 2) activities taking place in relation to each business

model element, and 3) institutional features influencing these activities in different ways. Business model elements describe the basic functions of a studied company, which are typically related to value proposition, value creation and value capture. This element structure defines what kind of circularity-related activities can be incorporated into the business model. Circularity-related business model activities can be structured, for example, to offer, supply chain and partnerships, customer segment and interface and financial model. Institutional features are external factors that may facilitate or hamper circular circularity-related business model activities. By providing a structured view on the dynamics between business model elements, related activities and institutional features, our analytical framework helps to understand complex relationships between company and the surrounding institutional environment.

The extent to which it is possible to incorporate circularity economy features into a business model depends on the context-specific combinations of regulative, normative and cultural-cognitive institutional features that influence on the business model activities in different ways. We have divided institutional features in two theoretically grounded categories that we call institutional enablers and voids. *Institutional enablers* make certain business activities easier to conduct than others (e.g. Chatterjee et al., 2002; Ostrom, 2011) while *institutional voids* hamper or prevent certain business activities or cause market exclusion (e.g. Khanna and Palepu, 1997; Mair and Martí, 2009). In a same way as institutions themselves, institutional enablers and voids can be regulative, normative or cultural-cognitive by nature. In this research, institutional enablers are considered to facilitate circularity in business model activities while institutional voids hamper it. Inclusion of different types of institutional enablers and voids identified in our analytical framework provides a way of modelling the institutional implications on particular business model activities.

3. Research Context

Inefficient e-waste recycling causes various direct and indirect environmental and social hazards, such as soil and water pollution and other serious health implications. In many areas, non-existent recycling systems also create conditions for criminal activities to flourish. (UNEP, 2015) It is clear that e-waste is a complex and multidimensional problem, and that the development of business models for responsible battery recycling presents an urgent challenge for the sustainable management of consumer electronics (MacArthur, 2013, 41–43). This creates an interesting context for studying the interplay between institutions and business models. It is important to recognize that institutional capacities to support the development of circular economy business models differ between regions and countries, and accordingly that moving toward a circular economy requires different strategies in different locations.

The lack of suitable business models is evidently hampering efforts to fully realize business-driven solutions for increased recycling and at once to advance circular economy. Battery recycling demonstrates a wider need for circular economy and sustainable business models that can effectively couple a wide range of social and environmental concerns with the realities of business conduct (Bocken et al., 2014; Porter and Kramer, 2011). This article focuses on institutional influences, but we would like to emphasize that those present only one set of variables affecting business environments and business conduct in circular economy. Firm-level strategy ultimately enables the success of a single company, but the institutional environment defines the types of strategies that are likely to survive in the long run.

3.1. Recycling of Portable Batteries in Finland and Chile

We compare the development of circular economy in Finland and Chile by exploring the ways in which the national institutional framework affects firms' business models in the battery recycling field. Both Finland and Chile have worked actively to promote recycling in general, but because the countries are at different stages of economic development, their institutional capacities to promote circular economy are also different. Finland is a representative example of a country that offers strong institutional support for recycling of e-waste. Chile, in turn, is a representative example of a country in which similar institutional framework is only evolving.

Finland has relatively advanced environmental legislation and regulations for e-waste management. The institutional framework for promoting and supporting recycling and the reuse of e-waste has been in place since 2008. The Waste Act (646/2011) includes guidelines for extended producer responsibility (EPR) in keeping with the EU Waste Framework Directive (2008/98/EC). Today around 50% of portable batteries are recovered and recycled in Finland. Chile, on the other hand has only recently begun to develop its environmental regulation. In the context of this analysis, the most important legislation is the Recycling and Extended Producer Responsibility Law (No. 20.920) that was enacted in 2016. Figures vary depending on the sources, but around 16% of electronic waste is recycled in Chile (CyV, 2009, 4), with just 0.05% of alkaline batteries are securely disposed (CyV, 2011, 5). Portable batteries remain outside the recycling system.

Our focus here is on the recycling of portable batteries and accumulators as defined in the EU directive (2006/66/EC). This category includes alkaline, lithium-ion (Li-ion), nickel metal hybrid (Li-Mh), nickel-cadmium (Ni-Cd) and primary lithium batteries. Although they do not lend themselves to end-of-life reuse, repair or refurbishing, these battery types provide different opportunities and challenges for companies aiming to recycle them and recover the raw materials, which makes this category particularly interesting in the context of business models and institutions and their relation to circular economy.

4. Data and Methods

The case study research method makes it both possible and necessary to explore not only the entity in focus, but also its immediate surroundings and environment. In the words of Robert Yin (2009, 18), "(a) case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident." This is particularly relevant to our investigation because we study companies operating in very different contexts. To allow in-depth analysis, only two case companies were included in the comparison. The units of analysis in our investigation are business model elements and their interactions with institutions. Both case companies are well-established businesses and are national forerunners in e-waste recycling. This is important because we wanted to understand how institutions influence on companies that are proactively looking for new opportunities in the field.

Akkuser, the first case company, operates in Finland and was launched in 2006 in anticipation of the business opportunities expected to emerge with the introduction of EPR regulations. The company has developed proprietary technology for the mechanical recycling of alkaline and lithium-ion batteries. Today, Akkuser is the only company that recycles portable batteries in Finland. It receives batteries both from Finland and other European countries. Midas, the second case company, operates in Chile. It was launched in 2003, and it became actively involved in the recycling industry since 2008. Today Midas offers integrated electronic waste recycling solutions for companies in Chile, providing facilities for the recycling and reuse of raw materials such as iron, copper and aluminum. However, it does not have the capacity to recycle portable batteries, which are securely disposed instead.

In the research process we used an abductive approach (Dubois and Gadde, 2002) to create a theory-driven iterative process for data analysis. The primary data for our analysis consist of interviews with representatives of the case companies and relevant stakeholder

organizations, such as environmental authorities, producer organizations and research organizations. All interviews were recorded and transcribed. The detailed information on interview analysis is presented in Appendix A and on primary data in Appendix B. In addition to interviews, we conducted participatory observations in both case companies and we used documentary materials (legislative documents, case company reports and websites and reports by non-governmental organizations) as secondary data sources.

5. Findings

We identified a number of regulative, normative and cultural-cognitive institutional enablers and voids for case companies' circular business model activities in both the Finnish and Chilean contexts. Table 1 introduces case companies' business model elements and related circular economy business model activities and summarizes institutional influences on business model activities. These influences are described in in details in the subsequent text.

5.1. Enablers and Voids on Circular Offer in Finland

In Finland the Act on batteries and accumulators (520/2014, §5 and §10) lays down national targets for the recollection of battery waste and for battery recycling efficiency. The recollection rate for recycling purposes is currently set at 45%.[1] The recycling efficiency rate specifies the percentage of materials to be extracted from recollected batteries for reuse purposes: that target is currently 50%. Both of these targets are in line with the EU battery directive (2006/66/EY). The battery recollection target and recycling efficiency rate are critically important regulative enablers from the point of view of Akkuser's business model. The case company complies with current recycling efficiency targets, allowing it to provide a competitive product and service offer. *"In lithium-ion and alkaline batteries we have a recycling efficiency rate of over 90%, as all fractions go to reuse purposes. Compared to our competitors, the difference is that we produce no emissions in the process."*[2] (Operations Manager, Akkuser) Meeting the official recycling efficiency target is a major competitive advantage for a recycling business, as pointed out by a senior officer from the Finnish recycling monitoring authority (ELY Centre): *"If you don't comply with the recycling efficiency targets, then you can't become an authorized recycler."*

The major institutional void hampering Akkuser's offering pertains to the large and increasing number of different battery types in the market. A senior officer from the recycling monitoring authority explained: *"So in principle it's the importers who decide what is being imported and what battery technologies are used in devices. […] But, of course, they don't necessarily think that far ahead. […] When a product is designed to use a certain type of battery, the importers won't consider another battery type just because its recycling is less expensive."* From Akkuser's perspective, this regulative void translates into a technological challenge because the technical possibilities for recycling numerous battery types are limited. "*Whenever we make a new investment, we have to comply with the recycling efficiency targets. However, the investments themselves are driven by other underlying reasons, such as changing battery technologies and clients' demands for raw materials.*" (Operations Manager, Akkuser) While it would be easier and less expensive to recycle fewer battery types, the institutions currently in place are unable to steer the operating environment in that direction. In the absence of global regulation, it is difficult to get manufacturers to develop batteries that are easier to recycle.

5.2. Enablers and Voids on Circular Offer in Chile

In Chile, standards for battery recycling are laid down in sanitary regulations for hazardous waste management (Supreme Decree No. 148/2003). Although this legislation is geared to minimizing, recycling and reusing hazardous waste, it provides little technical guidance or financial incentives on how batteries should be recycled and therefore does not serve as a functional regulative enabler for recyclers' circular offers.[3] The lack of institutional incentives makes the recycling of battery waste an unprofitable business, and consequently no initiatives have emerged for the recycling of batteries. The manager of the Chilean case company Midas explained that "*if battery recycling were just a private venture, if the government were not involved at all, then lithium batteries would not be recycled at all […] and the same goes for carbon-zinc and alkaline.*"

Regulatory and technological development go hand in hand with the promotion of increased business in recycling. In Chile, the lack of regulatory incentives for the improvement of recycling efficiency has resulted in a lack of socio-cultural perception of urgency to seek of suitable technologies for battery recycling. The manager of Midas explained this as follows: "*Here in Chile, no one is doing recycling technology. […] Why? Because these are expensive and complex processes and require a lot of patience and perseverance.*" The lack of regulatory incentives for increased recycling also constitutes a cultural-cognitive void in the search of suitable technologies from abroad. Even though certain battery types contain materials with positive value, Chilean recycling companies are not actively looking for new opportunities from their recycling. Midas, for example, which is working proactively to improve its recycling solutions for the use of other types of e-waste, has been unable to find a suitable solution for battery recycling.

5.3. Enablers and Voids on Circular Supply Chain in Finland

The major regulative enabler of Akkuser's supply chain is that under EPR regulations, all producers and importers of batteries are required to operate a take-back system and to recycle batteries at specified rates. In practice, the collection of portable batteries is outsourced to a producer organization that collects fees from importers. The producer organization uses these funds to organize Akkuser's supply chain and take-back system and to financially support the recycling of negative value waste streams. Although the current target rate for battery recollection may be considered relatively low in terms of promoting circular economy, it still serves as an institutional enabler for Akkuser's supply chain. As an operations manager explained: *"The EPR regulations are the most important enabling factor as all producers are obligated to collect batteries."* Without the EPR regulations, battery waste would not be taken back into the recycling system.

The Act on batteries and accumulators (520/2014 §15) obligates producers to *"provide comprehensive information to households about environmental and health risks and instructions on recycling through public campaigns and advisory services"*, but still low social awareness about the importance of battery recycling is a major cultural-cognitive institutional void hampering Akkuser's supply chain. In the words of a manager from a producer organization: "*In the end it's down to the consumer to decide what to do with a device that should be removed from use. […] Perhaps the biggest challenge is to encourage the consumer to make sure the battery waste ends up in appropriate recycling.*"

Finland has in place a dense network of collection points for alkaline batteries and used devices, yet large amounts of batteries still end up in household waste or just disappear. Finnish supermarkets have an obligation to provide collection points for alkaline batteries, but lithium-

[1] Calculated according to European Commission Regulation No. 493/2012.

[2] All excerpts are the authors' translations of the original Finnish and Spanish interviews.

[3] Source: *Minuta: Baterías y Pilas: Impacto sobre el Medio Ambiente* by Biblioteca del Congreso Nacional de Chile (http://www.bcn.cl, accessed September 28, 2016).

Table 1
Business model elements and circularity-related business model activities of case companies and their institutional implications.

Business model elements		Circular economy (CE) business model (BM) activities	Institutional features			
			Enablers in Finland	Enablers in Chile	Voids in Finland	Voids in Chile
Value proposition	Offer	CE BM offer relates to reduce, reuse and recycle -value propositions (e.g. Park et al., 2010). We focus on recycling and materials recovery offering.	Recycling efficiency standards (regulative).	*No functional institutional enablers*	Disparities in global norms on recyclability (regulative).	No regulations for improved recycling efficiency (regulative). Lack of active search of recycling technologies (cultural-cognitive).
Value creation	Supply chain	CE BM supply chain relates to management of product returns, reverse logistics and communication in the supply chain to promote circularity and the creation of value for different actors in the value chain (e.g. Shaharudin et al., 2015). We focus on management of product returns.	EPR-based requirements for the take-back system (regulative).	Corporate social responsibility-based organization of e-waste recollection (normative).	Low social awareness about the importance of battery recycling (cultural-cognitive). Lack of efficient take back system (normative). International disparities in waste definitions (regulative).	Challenges related to social organization of recycling (cultural-cognitive). The role of informal recycling (normative).
	Customer interface	CE BM customer interface relates to reuse of recovered materials (e.g. Geng et al., 2012). We focus on companies' capacities to create value for their customers.	*No functional institutional enablers* End-of-Waste Regulation (a potential regulative enabler).	Responsible Recycling Standard R2 (normative). ERP regulation (a potential regulative enabler).	Lack of incentives for remanufacturers to reuse recovered materials (regulative). Remanufacturers' reluctance to pay extra for recycled cobalt (cultural-cognitive).	Lack of formally defined targets for recovery efficiency (regulative). Tradition of disposing encapsulated batteries underground (cultural-cognitive).
Value capture	Financial model	CE BM financial model relates to generation of revenues and capturing value from the recycling and recovery of materials (e.g. Geng et al., 2009).	EPR revenues for negative value waste (regulative).	*No functional institutional enablers*	Volatile metal prices together with costs incurred from negative value waste (regulative)	Lacks in understanding the logic of recycling of negative value waste (cultural-cognitive).

ion batteries and their hazardous waste properties are a more complex matter. Currently there is no efficient take-back system for lithium-ion batteries in Finland, which constitutes a normative institutional void for recollection.

The market for used batteries is relatively small in Finland, and therefore Akkuser has to import batteries in order to run a profitable business. This, however, involves a regulative institutional voids various challenges because European countries have different definitions for different types of battery waste. In some countries batteries are considered "green waste," in others, including Finland, batteries are classified as "hazardous waste" because of the fire safety risks associated with the processing of batteries. This means additional costs for a recycler operating in Finland, as explained by the case company's operations manager: *"No one wants to send us small volumes from Europe. If you have shipment worth 8000 euros, you'll be paying a fee of 2000 euros even before you can send it off to Finland."* Business actors operating in countries with less strict definitions of "green waste" are therefore at an advantage compared to actors in countries with tighter regulations, which obviously hampers the diffusion of best practices for the promotion of circular economy.

5.4. Enablers and Voids on Circular Supply Chain in Chile

The take-back system for electronic waste in Chile is mainly organized through corporate social responsibility activities and other programs, which can be regarded as normative institutional enablers for circular supply chain. The manager Midas gave an example: "*In Chile we have an ongoing campaign called Rock and Recycle. We're visiting schools mainly in Santiago but also in other regions, about 30 schools, and setting up recycling campaigns for cans, bottles and electronics, and we're providing education on recycling, without any obligation from the government, together with the producer*." In the absence of formally organized take-back system, Midas had to invest in its own transportation fleet to collect end-of-use devices directly from clients. Its main clients include major ICT multinationals, and recycling is based on their voluntary involvement in this kind of corporate social responsibility activity. As there are is no official infrastructure in place to coordinate the e-waste take-back system, Midas has had to organize and finance the operation itself, and therefore it only collects and recycles the most valuable types of e-waste.

Chile is currently undergoing a major transition in the social

organization of recycling. The country faces the same kind of cultural-cognitive institutional voids related to low social awareness about battery recycling as Finland, which may also hamper efforts to adapt to new regulations aimed at promoting circular economy. As explained by a professor from the Pontifical Catholic University of Chile (PUC): "*Because we [Chileans] are not used to recycling, we're also not used to extended responsibility; we don't understand what happens with things [waste streams], why it is important to recycle, and therefore there is no capacity [to recycle]*." As a result, a large proportion of used batteries end up in domestic waste or is simply lost.

Informal recycling, which is an important source of income for large numbers of people comprises significant normative institutional void on the supply chain management in battery recycling business. "*What happens is that we have a (recycling) market that is now developing. Formerly that market was super-informal in Chile*." (Director, Chilenter) Informal e-waste pickers are mainly interested in the positive value materials embedded in electronic devices, but not in their batteries, and large numbers of batteries therefore remain outside the collection cycle. If recycling companies assume a bigger role in e-waste recycling in the future, the government will face a major challenge in creating compensatory jobs for waste pickers.

5.5. Enablers and Voids on Circular Customer Interface in Finland

There are currently no significant functional institutional enablers for Akkuser's circular customer interface. However, the EU's End-of-Waste Regulation (2008/98/EC) may open up new opportunities in battery recycling by enabling the transition of recycled material from waste to product status: "*It's obviously easier to send products than waste (to remanufacturers) but obtaining that product status takes some considerable effort. In the near future we will be applying for product status for fractions produced from li-ion batteries. As yet they don't have that status*." (Operations Manager, Akkuser) If successfully implemented in the future, end-of-waste regulation can be expected to increase the demand for recycled materials and thus bolster the markets for these materials, but at this point this is mere speculation. The future will tell if achieving product status will contribute to this case company's circular customer interface. At this point End-of-Waste criteria should be considered only as a potential regulative enabler for circular customer interface.

The lack of incentives for remanufacturers to use recycled materials, such as fractions produced from battery waste (see Section 5.1 above), is a powerful regulative institutional void that impacts adversely on Akkuser's efforts to strengthen its circular customer interface. Additionally, remanufacturers are not willing to pay extra for recycled cobalt, which possibly could for example improve their brand image, and this can be considered as a socio-cognitive void for the development of circular customer interface.

5.6. Enablers and Voids on Circular Customer Interface in Chile

The main focus for Chilean recycling companies is to ensure at least the secure disposal of battery waste, as required by the voluntary Responsible Recycling Standard (R2). Midas, for example, separates battery waste from other e-waste, and then forwards the batteries to another company that first physically encapsulates and then disposes them in secure sites in Northern Chile. The manager of the company explained: *"Then the used batteries will be taken up there (in the north of Chile) […] far from any nearby town. R2 norms require that we make sure that disposal providers follow the rules and you can see that there is no future risk (of leakage). […] So in this situation, our trucks take our waste up north."* R2 can be considered as a normative institutional enabler for circular customer interface.

New EPR legislation in Chile is aimed at imposing greater responsibility on manufacturers and importers by establishing formal battery recycling targets, but for the time being it remains unclear how these targets will evolve and how they will influence the business models of Chilean battery recycling companies. A PUC professor explained the current situation as follows: "*The problem is that environmental institutions are very young in Chile, and the new EPR legislation is very complex and hard to understand. Implementation will therefore probably be delayed because the importance of the law is not made sufficiently clear, and the whole system will come to nothing*." At the moment, ERP legislation may be regarded as a potential regulative enabler for circular customer interface.

Currently, a lack of formally defined targets for recovery efficiency functions as a strong regulative institutional void that hampers Midas's efforts to create a circular customer interface. In addition, widely accepted way of disposing encapsulated batteries underground can be considered as a cultural-cognitive void that hampers the development of recycling in many ways.

5.7. Enablers and Voids on Circular Financial Model in Finland

EPR regulations constitute a major regulative enabler for Akkuser's circular financial model. Half of its revenue stream comes from regulatory-driven fees, and the other half from the resale of recovered materials. The company receives compensation from the producer organization for sorting, recycling and disposing of battery waste. There is no fixed fee, but prices are negotiated on a case-by-case basis: *"If the supplier (i.e. producer organization) sends us unsorted batteries, then we'll charge them for doing the sorting. There's a fee for each sorted fraction, which is positive or negative, depending on the battery type."* (Operations Manager, Akkuser) In the case of alkaline batteries, the producer organization is charged for sorting and recycling, while for lithium-ion batteries there is only a sorting fee. In fact, Akkuser pays some redistributors for lithium-ion batteries because of their positive value.

Volatile metal prices together with costs incurred from negative waste value fractions constitute a regulative institutional void, which hampers Akkuser's financial model. Falling metal prices present a threat to the viability of the reuse of recovered raw materials. As pointed out by the operations manager, *"The price of nickel has dropped by one-half and the price of cobalt by 30%, so these are huge challenges for us."* Subdued metal prices mean that this case company is unable to recycle Ni-Mh batteries, and for that reason these batteries are redistributed to a German recycling company. Similarly, Akkuser can only recover 20% of the raw materials embedded in alkaline batteries, which creates costs for the company. *"The rest (black mass of alkaline batteries) is delivered to Germany and every month we get a hefty bill from them."* (Operations Manager, Akkuser).

5.8. Enablers and Voids on Circular Financial Model in Chile

Currently, there are no functional institutional enablers for a circular financial model in the battery recycling business in Chile. It is evident from our finding that companies in this field have to generate their revenue from other activities than the processing of batteries. In the case of Midas, battery disposal is only a cost item. The costs are incurred from organizing and managing a take-back system for electronic waste, sorting batteries from other electronic waste and redistributing the waste for disposal. Midas's manager gave an example: *"Every two months we pay 10,000 dollars for the disposal of 25 tons. Lithium batteries alone account for costs of between 1,000 and 1,500 dollars (for between 6 and 10 tons of lithium batteries a year.)"*

In the absence of institutional enablers, it is difficult for companies to establish financial models that would allow them to benefit from battery recycling. Costs incurred from battery recycling demonstrate more deeply rooted lacks in understanding the logic of recycling of negative value waste, which can be considered as a cultural-cognitive institutional void. Even though recycling companies can still generate revenue from recycling other electronic waste that has positive value, similar business with negative value waste, such as batteries, would require institutional support.

6. Discussion

Previous research has recognized the need for more exact understanding of the interaction between institutions and firm-level activities (e.g. Lopez et al., 2018; Levänen and Hukkinen, 2013). However, in complex operational environments, such as batteries recycling, it is often very difficult to observe in an analytical manner how institutions influence on single firms' ways of doing business. To tackle this problem, we have developed an analytical framework that combines business model concept and institutional theory to model the institutional influences on firm-level activities. Business model concept can work as a powerful analytical tool to structure complex real-life phenomenon, especially when coupled with appropriate theorization (Ritter and Lettl, 2017). This article makes a point that when business model concept is combined with institutional theory, it is possible to analyze the details of the interplay between institutions and business activities in the context of advancement of circular economy. Our analysis has both theoretical and managerial implications which are discussed next.

6.1. Theoretical Implications

When aiming to better understand the interplay between institutions and business models an analyst or a practitioner should be able define context-specific business model elements based on analytical or practical interests or needs. Company's business model elements can be seen as boundary objects (Star and Griesemer, 1989): they operate in the boundary between company and its surrounding world and their modification may enable a company to adjust to a particular institutional environment. We have shown how business model elements define what kind of circularity-related activities companies can incorporate into their business models. Our analytical framework provides a structured view on the complex relationships between business model elements, related activities and institutional features. Thus gained understanding helps to clarify how regulative, normative and cultural cognitive institutional features may facilitate or hamper certain business model activities.

Modelling the interplay between business models and institutions helps also to understand managerial cognition; in this case mental models operating behind firm-level and institutional-level changes (c.f. Levänen and Hukkinen, 2013; Martins et al., 2015). Successfully coordinated feedback mechanisms, i.e. ways of knowledge exchange, between diverse actors' realities is critically important in the promotion of circular economy (Levänen, 2015b). We acknowledge that here conducted modelling exercise offers only one way to approach the situations under analysis, but at the same time we argue that the demonstrated idea of combining business model conceptualization with institutional theorization is important addition to the literature that currently has little to say about how context-specific institutional features influence on particular business model activities.

6.2. Managerial Implications

Our research showed that the profitable processing of different types of end-of-use batteries requires different types of business logic in different locations. One of our key findings was that some types of battery waste have positive value, others have negative value. The recycling of positive value battery waste follows the traditional market-driven business logic, while the recycling of negative value battery waste does not. Our analysis makes explicit that in assessing the performance of circular economy business models, it is critically important to understand how and why the institutional environment may support certain business logics and at once hamper other logics. A manager who aims to incorporate circularity into the elements of a business model of a particular company should have access to detailed information about how institutional features affect certain business activities. Modelling is one way to gather such information in a systematic and structured way.

Our study also shows how companies can overcome institutional voids by adjusting their business models. We found that promoting recycling of positive value waste requires more cultural-cognitive and normative institutional development, while promoting negative value waste requires regulatory institutional development. The main challenges for recycling positive value battery waste come from cultural-cognitive dissonance concerning recycling-friendly practices, normative information asymmetries concerning best available technologies and the absence of regulatory institutions that can prevent batteries from ending up outside the recycling system. Business-driven recycling of negative value battery waste relies almost entirely on formally-defined supportive institutional functions, such as the collection of recycling fees that allow producer organizations to run battery take-back schemes and the delivery of batteries to a recycler company. Therefore, recycling of negative value battery waste calls for a closer connection between business models and regulatory institutions geared to supporting circular economy.

Based on our analysis it can be said that in countries that provide strong institutional support for recycling businesses, a large proportion of both positive and negative value e-waste typically becomes recycled. On the other hand, in countries that offer only thin institutional support for recycling business, negative value e-waste is typically not recycled at all, and sometimes even positive value e-waste ends up dumped. Therefore, in order to understand what is needed to strengthen circular economy in a particular country, it is critical to understand what stage that country has reached in its institutional development.

6.3. Limitations and Areas for Future Research

There is no optimal “rules of the game” nor perfect “game plans” in advancement of circular economy, but there is need for further studies on how to move toward optimal in different parts of the world. In our analysis, both business model activities and institutional features relate to recycling, which represents only one way to promote circularity. We encourage similar research to focus on businesses operating in other value chain positions, such as reuse, repair and refurbishing. Second, our focus was restricted to institutional implications for business models, although we acknowledge that more research is needed on the formation of new institutional mechanisms similar to EPR. Finally, we also found that there are no incentives to design batteries that are more recyclable. Future research should work to identify functional incentives for planning toward truly closed loops (see also Prosman et al., 2017).

7. Conclusions

To really understand how circular economy can be taken further through institutional changes we need better conception of the dynamics between specific institutions and companies' business models. In line with institutional theory, this article suggests that the institutional environment of companies can be understood as a game. The game metaphor helps us to understand that while the advancement of circular economy is a slow process, it is important that different actors have the capacity to gradually modify both the rules and the ways the game is played. In practice, this kind of modifying capacity requires real and ongoing dialogue between the authorities, industries, researchers and civil society.

The theoretical contribution of this paper is the new insight it provides into what institutional embeddedness of business models means in the context of advancement of circular economy. An important methodological implication is the recognition that in order to present a rigorous analysis of circular economy business models, we need an approach that simultaneously addresses the details of business model activities, institutional features and their interplay. Therefore, it is important to evaluate the performance of institutions and business

models in tandem rather than separately.

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Appendix A. Instructions for applying our analytical framework in different contexts

Applying our analytical framework happens in three steps that are explained below. With respect to each step, we also describe how we proceeded in the research for this article. The three steps are also summarized in Table A.1.

1. Identify basic business model elements of the studied company or companies. Basic business model elements are typically related to value proposition, value creation and value capture (Zott et al., 2011) and they describe how the business is supposed to work.
   How we did this? We studied the recycling markets of batteries in Finland and Chile to understand the operational environments and the business logics of the studied companies.
2. Elaborate basic business model elements in relation to circular economy archetypes, i.e. reuse, remanufacturing and recycling (Lieder and Rashid, 2016). Aim to identify the most important circularity-related business model activities in relation to each basic business model element. At this point, you can make analysis more specific by adding a more specific business model structure that defines business model elements, which are especially relevant form the perspective of specific circularity-related business model activities. Business model structure must always be defined context-specifically and examples of different structures can be found from the literature.
   How we did this? We identified numerous circularity-related business model activities in each basic business model element and we wanted to conduct more detailed analysis. For that purpose, we took into use the business model element structure proposed by Boons and Lüdeke-Freund (2013, 13), which includes elements for offer, supply chain, customer interface and financial model. To operationalize our search for significant circular economy business model activities and related institutional features, we outlined questions that are presented in Table A.2.
3. Finally, identify regulative, normative and cultural-cognitive institutional features and evaluate their implications on business model activities. Aim to pinpoint especially features that facilitate (enablers) or hamper (voids) circularity-related business model activities. Based on your findings, you can estimate how well studied business model element may advance circular economy in its institutional context.
   How we did this? We aimed to identify institutional enablers and voids from our primary data, i.e. interview transcripts, which we coded and analyzed using ATLAS.ti software. First, we used model elements as primary codes for both case companies, and after that, we formulated memos comprising all data related to each primary code. Finally, we could identify institutional enablers and voids were from the memos. The Finnish data were analyzed by two researchers from Finland, and the Chilean data by two researchers from Chile and one researcher from Finland.

Table A.1
Steps for applying the analytical framework.

Step 1: Identify basic business model elements.	Step 2: Elaborate basic business model elements in relation to circular economy archetypes and aim to identify the most important circularity-related business model activities in relation to each basic business model element.	Step 3: Identify regulative, normative and cultural-cognitive institutional features and evaluate their implications on business model activities.
A structure that describes the basic functions of a studied company, which are typically related to value proposition, value creation and value capture.	Circularity-related activities are relevant form the perspective of a particular circular economy architype and are defined in relation to business model elements.	Factors that facilitate or hamper circularity-related business model activities.

Table A.2
Questions guiding the search for circular economy business model activities and related institutional features.

Business model elements		Circular economy business model activities	Institutional features	
			Institutional enablers	Institutional voids
Value proposition	Offer	How is the circular value of materials' recovery embedded in a product or service offer?	How do regulative, normative and cultural cognitive institutional features support materials recovery?	How do regulative, normative and cultural cognitive institutional features hamper materials recovery?
Value creation	Supply chain	How are product returns managed to achieve a functional supply chain, and how is communication organized to improve recyclability?	How do regulative, normative and cultural cognitive institutional features support supply chain organization and communication?	How do regulative, normative and cultural cognitive institutional features hamper supply chain organization and communication?
	Customer interface	How is the materials' circulation organized and managed for the reuse of materials?	How do regulative, normative and cultural cognitive institutional features support materials reuse?	How do regulative, normative and cultural cognitive institutional features hamper materials reuse?

(*continued on next page*)

Table A.2 (*continued*)

Business model elements		Circular economy business model activities	Institutional features	
			Institutional enablers	Institutional voids
Value capture	Financial model	How do circularity-based value proposition and value creation generate revenues and costs?	How do regulative, normative and cultural cognitive institutional features support the profitability of recycling companies?	How do regulative, normative and cultural cognitive institutional features hamper profitability of recycling companies?

Appendix B. Information on the primary data

Table B.1
Interviews conducted in Finland and Chile.

Name of organization	Position of interviewee	Duration of interview	Country	Description of organization
Akkuser	Operations manager	1 h 38 min	Finland	Recycling company in Finland
Recser	Manager	1 h 10 min	Finland	Producer organization for portable batteries and accumulators
Finnish Environment Institute (SYKE)	Senior officer	29 min	Finland	Research institute under environmental administration
Centre for Economic Development, Transport and the Environment (ELY Centre)	Senior Officer	1 h 14 min	Finland	Monitoring authority for battery recycling
Midas	Manager	1 h 16 min	Chile	Recycling company in Chile
Recycla	CEO	39 min	Chile	Recycling company in Chile
Chilenter	Director	49 min	Chile	Chilean government foundation promoting e-waste recycling
Respel	Senior consultant	59 min	Chile	Monitoring authority for hazardous waste
Pontifical Catholic University of Chile - Political Science Department	Professor	51 min	Chile	University research unit evaluating environmental policies

References

Baden-Fuller, C., Mangematin, V., 2013. Business models: a challenging agenda. Strateg. Organ. 11 (4), 418–427.

Baden-Fuller, C., Morgan, M.S., 2010. Business models as models. Long Range Plan. 43 (2–3), 156–171.

Barney, J.B., Wright, M., Ketchen, D.J., 2001. The resource based view of the firm: ten years after 1991. J. Manag. 27, 625–643.

Bocken, N.M.P., Short, S.W., Rana, P., Evans, S., 2014. A literature and practice review to develop sustainable business model archetypes. J. Clean. Prod. 65, 42–56.

Boons, F., Lüdeke-Freund, F., 2013. Business models for sustainable innovation: state-of-the-art and steps toward a research agenda. J. Clean. Prod. 45, 9–19.

Boulding, K.E., 1966. The economics of the coming spaceship earth. In: Jarrett, H. (Ed.), Environmental Quality Issues in a Growing Economy. Johns Hopkins University Press, Washington.

Braungart, M., McDonough, W., 2002. Cradle to Cradle: Remaking the Way We Make Things. North Point Press, New York.

Chatterjee, D., Grewal, R., Sambamurthy, V., 2002. Shaping up for E-commerce: institutional enablers of the organizational assimilation of web technologies. MIS Q. 26 (2), 65–89.

CyV Medioambiente, 2009. Diagnostico produccion, importacion y distribucion de productos electronicos y manejo de los equipos fuera de uso. http://www.mma.gob.cl/1304/articles-55497_Diagnostico_de_equipos_de_informatica_celulares_2009.pdf, Accessed date: 28 September 2016.

CyV Medioambiente, 2011. Diagnostico produccion, importacion y distribucion y el manejo de los residuos de pilas. http://www.mma.gob.cl/1304/articles-55497_Diagnostico_Pilas_2011.pdf, Accessed date: 28 September 2016.

Daly, H., 1991. Steady-state Economics: Second Edition With New Essays. Island Press, Washington.

Dasilva, C.M., Trkman, P., 2014. Business model: what it is and what it is not. Long Range Plan. 47 (6), 379–389.

Dubois, A., Gadde, L.-E., 2002. Systematic combining: an abductive approach to case research. J. Bus. Res. 55 (7), 553–560.

Fischer, A., Pascucci, S., 2017. Institutional incentives in circular economy transition: the case of material use in the Dutch textile industry. J. Clean. Prod. 155, 17–32.

Frosch, R.A., Gallopoulos, N.E., 1989. Strategies for manufacturing. Sci. Am. 261 (3), 144–152.

Geng, Y., Zhu, Q., Doberstein, B., Fujita, T., 2009. Implementing China's circular economy concept at the regional level: a review of progress in Dalian, China. Waste Manag. 29 (2), 996–1002.

Geng, Y., Fu, J., Sarkis, J., Xue, B., 2012. Toward a national circular economy indicator system in China: an evaluation and critical analysis. J. Clean. Prod. 23, 216–224.

Georgescu-Roegen, N., 1971. The Entropy Law and the Economic Process. Harvard University Press, Cambridge.

Ghisellini, P., Cialani, C., Ulgiati, S., 2016. A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. J. Clean. Prod. 114, 11–32.

Khanna, T., Palepu, K.G., 1997. Why focused strategies may be wrong for emerging markets. Harv. Bus. Rev. 75 (4), 41–51.

Korhonen, J., Honkasalo, A., Seppälä, J., 2018. Circular economy: the concept and its limitations. Ecol. Econ. 143, 37–46.

Levänen, J., 2015a. Ending waste by law: institutions and collective learning in the development of industrial recycling in Finland. J. Clean. Prod. 87, 542–549.

Levänen, J., 2015b. Overcoming the institutional obstacles of industrial recycling. In: Doctoral Dissertation. 2015:16 University of Helsinki. Publications of the Department of Social Research. http://urn.fi/URN:ISBN:978-951-51-1025-1, Accessed date: 1 April 2018.

Levänen, J.O., Hukkinen, J.I., 2013. A methodology for facilitating the feedback between mental models and institutional change in industrial ecosystem governance: a waste management case-study from northern Finland. Ecol. Econ. 87, 15–23.

Lewandowski, M., 2016. Designing the business models for circular economy—toward the conceptual framework. Sustain. For. 8 (1), 1–28.

Lieder, M., Rashid, A., 2016. Towards circular economy implementation: a comprehensive review in context of manufacturing industry. J. Clean. Prod. 115, 36–51.

Lopez, F.J.D., Bastein, T., Tukker, A., 2018. Business model innovation for resource-efficiency, circularity and cleaner production: what 143 cases tell us. Ecol. Econ(in press), https://www.sciencedirect.com/science/article/pii/S0921800917303294.

MacArthur, Ellen, 2013. Foundation. In: Toward the Circular Economy: Economic and Business Rationale for an Accelerated Transition.

Magretta, J., 2002. Why business models matter. Harv. Bus. Rev. 80 (5), 3–8.

Mair, J., Martí, I., 2009. Entrepreneurship in and around institutional voids: a case study from Bangladesh. J. Bus. Ventur. 24 (5), 419–435.

Martins, L.L., Rindova, V.P., Greenbaum, B.E., 2015. Unlocking the hidden value of

concepts: a cognitive approach to business model innovation. Strateg. Entrep. J. 9 (1), 99–117.
Massa, L., Tucci, C.L., Afuah, A., 2017. A critical assessment of business model research. Acad. Man. Annals 11 (1), 73–104.
Moreau, V., Sahakian, M., van Griethuysen, P., Vuille, F., 2017. Why social and institutional dimensions matter for the circular economy. J. Ind. Ecol. 21 (3), 497–506.
North, D.C., 1990. Institutions, Institutional Change and Economic Performance. Cambridge University Press, Cambridge.
Osterwalder, A., Pigneur, Y., Tucci, C.L., 2005. Clarifying business models: origins, present, and future of the concept. Commun. Assoc. Inf. Syst. 16, 1–25.
Ostrom, E., 2005. Understanding Institutional Diversity. Princeton University Press, Princeton.
Ostrom, E., 2011. Background on the institutional analysis and development framework. Policy Stud. J. 39 (1), 7–27.
Pajunen, N., Watkins, G., Husgafvel, R., Heiskanen, K., Dahl, O., 2013. The challenge to overcome institutional barriers in the development of industrial residue based novel symbiosis products - experiences from Finnish process industry. Miner. Eng. 46-47, 144–156.
Park, J., Sarkis, J., Wu, Z., 2010. Creating integrated business and environmental value within the context of China's circular economy and ecological modernization. J. Clean. Prod. 18 (15), 1494–1501.
Pearce, D.W., Turner, R.K., 1990. Economics of Natural Resources and the Environment. Harvester Wheatsheaf, London.
Porter, M.R., Kramer, M.R., 2011. Creating shared value. Harv. Bus. Rev. 89 (1–2), 1–17.
Prosman, E.J., Waehrens, B.V., Liotta, G., 2017. Closing global material loops: initial insights into firm-level challenges. J. Ind. Ecol. 21 (3), 641–650.
Ranta, V., Aarikka-Stenroos, L., Ritala, P., Mäkinen, S.J., 2018. Exploring institutional drivers and barriers of the circular economy: a cross-regional comparison of China, the US, and Europe. Resour. Conserv. Recycl(in press), https://www.sciencedirect.com/science/article/pii/S0921344917302653?via%3Dihub.
Ritter, T., Lettl, C., 2017. The wider implications of business-model research. Long Range Plan. 51 (1), 1–8.
Scott, W.R., 2013. Institutions and Organizations: Ideas, Interests, and Identities, fourth ed. Sage Publications, Thousand Oaks.
Shaharudin, M.R., Govindan, K., Zailani, S., Tan, K.C., 2015. Managing product returns to achieve supply chain sustainability: an exploratory study and research propositions. J. Clean. Prod. 101, 1–15.
Star, S., Griesemer, J., 1989. Institutional ecology, 'Translations' and boundary objects: amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. Soc. Stud. Sci. 19 (3), 387–420.
Teece, D.J., 2010. Business models, business strategy and innovation. Long Range Plan. 43 (2–3), 172–194.
UNEP (United Nations Environment Programme), 2015. Waste Crime – Waste Risks: Gaps in Meeting the Global Waste Challenge. UNEP.
Williamson, O.E., 1981. The economics of organization: the transaction cost approach. Am. J. Sociol. 87, 548–577.
Yin, R.K., 2009. Case Study Research: Design and Methods, fourth ed. Sage, Los Angeles.
Zott, C., Amit, R., 2010. Business model design: an activity system perspective. Long Range Plan. 43 (2–3), 216–226.
Zott, C., Amit, R., Massa, L., 2011. The business model: recent developments and future research. J. Manag. 37 (4), 1019–1042.