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Epistemic Mirroring: understanding the interdependence between a firm's governance of internal relations and its interpretation of the digital ecosystem architecture

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Developmental paper

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Abstract

The mirroring hypothesis asserts a symmetry between how a firm organizes its activities and tasks internally (division of labour) and how technologies are logically partitioned into subcomponents and modules. Yet digital artifacts can violate fundamental properties of physical modular systems, such as the impossibility to univocally allocate functionalities to the various modules, due to their agnostic and generative nature. Although an increasing amount of works is starting to question the usefulness of classic modularity theory to understand how firms take decisions and organize their activities internally, there is still a scant literature on the topic. In this work we draw upon the mirror hypothesis, and complement it with the insight provided by the IT governance literature. By doing so, we suggest that a company's epistemic interpretation of the modular nature of a digital system depends on the dynamics of its internal decision-making process, reflecting formal and informal patterns of authority among its actors. Our study is evidenced by an extensive case study of the roll-out of an advanced technology by a large global multinational. In this was we study whether, and how, is it possible to establish interdependence between the way in which a firm makes sense of, and resolves, the conflicting goals and objectives of its internal actors and the way in which it interprets and conceives of the architecture of the digital ecosystem it is part of. We term this epistemic mirroring.

Keywords: Mirror hypothesis, Digital innovation, IT governance, Modularity, Epistemic Mirroring.

1. Assumptions, goal of the work and research question

There is no objective interpretation of a technology and of its architecture. Similarly, there is no objective and univocal ways to arrange activities within a firm. A variety of works adopting a variety of perspectives have documented how every company will adopt its own epistemic frames to recognise and evaluate opportunities, and therefore to interpret the new trade-off between architecture and organization (Brusoni, 2005; Brusoni & Prencipe, 2011; Chakravarty et al., 2013; Eggers & Kaplan, 2013; Fayard et al., 2016; Foss et al., 2013; Gavetti, 2005; Helfat & Peteraf, 2015; Tripsas & Gavetti, 2000).

We bring these two traditions together, with the intention to show how an organization's peculiar epistemic interpretation of the architecture and functionalities of a digital ecosystem may depend on the specific way in which a firm resolves its internal tensions between different parts and actors of the organization.

Our research is guided by the intuition that the way in which complex (and ambiguous) technological ecosystems are rationalised and interpreted may depend on the way a firm deals with the internal tensions and organizes its internal decision-making process emerging from the inherent ambivalent ontology of digital artifacts (Kallinikos et al., 2013) that can be simultaneously employed in a variety of use cases, and be interpreted as stable infrastructures for value exploitation, and as dynamic enablers of generative innovation. In this sense, the architectural and logical organization of technology should reveal (and reflect) the way in which the firm addresses and resolves possible tensions and inconsistencies among its various organizational elements.

By so doing we complement and extend both the IT governance literature and the modularity literature. On the one hand, we use the intuitions developed by the modularity literature to link a firm's internal organizational structure to its interpretation of the architecture of the digital ecosystem. On the other hand, we use the intuitions developed by the IT governance literature with respect to the role of inter-organizational tensions (vertical and horizontal) to provide a possible explanation of the way in which firms may idiosyncratically link their understanding of the modular architecture of the technological ecosystem to their specific mechanisms to address, and cope with, the tensions that inevitably emerge among their various actors and divisions.

Our research question is: *how is a firm's management of its own internal (architectural and governance) tensions interdependent with the way it interprets, and makes sense of, the tensions emerging in the external digital ecosystem?*

The hypothesis of the research is therefore that tensions and misalignments between actors operating within a firm are such only in relation to the potential tensions emerging between elements in the external technological ecosystem. We suggest that when digital technologies (and digital ecosystems) are involved, the mirroring hypothesis concepts may be replaced by a novel theory dealing with **epistemic mirroring** which takes into account epistemic interdependences between the architecture of complex digital ecosystems and the structure and management of complex organizational tensions (see also Puranam et al. (2012)). By doing so we respond to the call for further research on the way in which the concept of modularity should be reinterpreted in light of the "ambivalent ontology" of digital artifacts (Constantinides et al., 2018; Henfridsson et al., 2014; Yoo, 2012).

2. Background: two complementary interpretations of technology-organization alignment and the digital problem

The managerial, organizational, and information system (IS) literature has examined the symmetry and parallelism between how a firm organizes its tasks and activities and how it organizes, and defines the technical architecture of its technology and its production processes. There are at least two main strands in the literature discussing this type of symmetries or alignments.

The IS literature has discussed the importance of the alignment between a firm's strategy, goals and objectives, and the governance and organization of its IT assets and infrastructures (Bharadwaj et al., 2013; Gerow et al., 2014; Queiroz et al., 2018; Reynolds & Yetton, 2015; Weill & Ross, 2004; Wilkin & Chenhall, 2010; Wu et al., 2015). According this stream of literature, a firm's internal organization of information technology (IT) assets should reflect the firm's strategy, goals and operation within its context.

The second main stream concerns modularity. The so-called mirroring hypothesis asserts that there can be a univocal correspondence between the technical dependencies between tasks and the way in which an organization organizes its activities and defines its boundaries (Baldwin, 2008; Baldwin & Clark, 2000; Burton & Galvin, 2018;

Cabigiosu & Camuffo, 2012; Colfer & Baldwin, 2016; Langlois, 2002; MacCormack et al., 2012; Sanchez & Mahoney, 1996). According to the various studies conducted on the topic, the way in which technology and artifacts are decomposed into modules can "mirror" the way in which tasks are allocated to actors and labour is divided among economic agents.

The two streams are complementary; the former deals with governance issues (the partitioning and allocation of decision-making rights), while the latter deals with architectural and organizational issues (partitioning and allocation of technological components and tasks) (Tiwana & Konsynski, 2010; Tiwana et al., 2010). However, the former only focuses on the firm (see the critique from Ciborra (2000)), while the latter provides a theoretical perspective to explain the codetermination and coevolution of the internal dimension of the firm and the broader external technological ecosystem (Baldwin, 2008; Cabigiosu et al., 2013; Jacobides, 2005; Jacobides et al., 2006; Langlois & Robertson, 1995).

Both steams reveal how, in dynamic situations where technology does not have a stable employment and univocal nature, an excessive focus on (static) alignment (Chakravarty et al., 2013; Gregory et al., 2015; Reynolds & Yetton, 2015), or mirroring (Brusoni, 2005; Brusoni & Prencipe, 2001, 2011; Brusoni et al., 2001; Colfer & Baldwin, 2016; Furlan et al., 2014; Stan & Puranam, 2017), is deceptive, if not detrimental.

These dynamic issues become especially prominent in a digital context, where the layered modularity of digital platforms and infrastructures decouples the underlying stable infrastructural element from the contingent uses and services provided over it and, by doing so, it enables generativity, the exploration of novel opportunities, and it supports organizational agility (Chakravarty et al., 2013; Sambamurthy et al., 2003; Tiwana & Konsynski, 2010; Woodard et al., 2013; Yoo et al., 2012; Yoo et al., 2010; Zittrain, 2008). As a result, both streams of literature have unveiled the paradoxical dual natures of modularity (Colfer & Baldwin, 2016) and alignment (Sabherwal et al., 2019), which are at the same time a positive force of stability, competitive advantage and exploitation, as well as a potential detrimental drivers of inertia, path dependency, and resistance to change and opportunity exploration (Brusoni & Prencipe, 2001; Brusoni et al., 2001; Fayard et al., 2016; Gregory et al., 2015; Stan & Puranam, 2017).

This dual nature creates well-known tensions and conflicts among the various actors of the firm that have to be managed and governed. Some scholars have even started to question whether the mirroring hypothesis, and the standard concept of modularity more generally, can still hold in a platformized environment where technological artifacts are ontologically and functionally agnostic and can be seamlessly re-deployed to a variety of different (unforeseen) uses as novel opportunities emerge. (Colfer & Baldwin, 2016; Constantinides et al., 2018; Henfridsson et al., 2014; Sorkun & Furlan, 2017).

With the only exception of the digital platform literature, which has discussed the interplay between platform governance and platform architecture (Boudreau, 2010; Parker et al., 2016; Tiwana, 2013; Tiwana & Konsynski, 2010; Tiwana et al., 2010), to our knowledge very little work have contextualised the architecture-governance mirroring by looking at the patterns of decision making authority within a multi-division firm (in line with the IT governance literature).

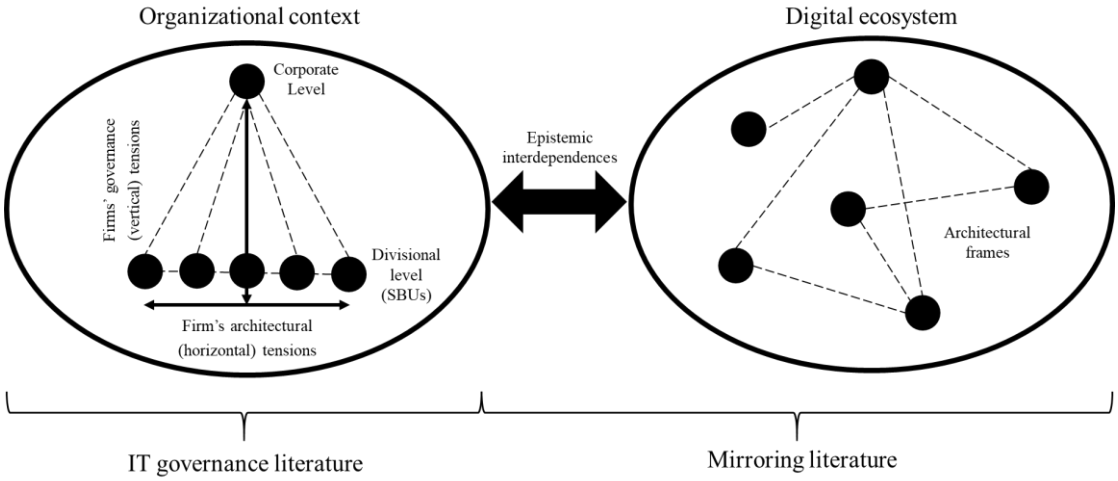

Figure 1. Conceptual framework: epistemic interdependence between a digital ecosystem architecture and a firm mechanisms to deal with its internal tensions

3. Case study and data

Our hypotheses will be tested through a case study of British Telecom (BT) in the deployment of its 5G technology in its attempt to become the leading 5G operator in the UK. The choice of both BT as a firm, and the 5G technology as a digital ecosystem is particularly appropriate and it particularly suits our research goals for two reasons.

On the one hand BT is a multidivisional corporation that includes a variety of actors and divisions, with heterogeneous and potentially overlapping interests, goals, and

interpretations of the technology. BT is a multi-brand, vertically integrated company that owns infrastructures and offers retail services, and that includes R&D and technology divisions as well as strategy and marketing ones. Given its diversified nature, BT presides over different elements, layers and modules of the 5G ecosystem. For this reason, we expect different actors within BT to have different understandings of 5G, depending on their role and on their cognitive interpretations of 5G. When taking decisions, these actors may be motivated by different goals and may be interested in different aspects and dimensions of 5G. For example, marketing people within the consumer-retail may be interested in 5G speed or power, while actors dealing with public and corporate clients may be more interested in security and robustness. In contrast, internal technology people may be interested in energy efficiency and long term investments, while finance people focus on OPEX and returns on investment.

On the other hand, 5G is a modular technology that relies on an ecosystem of different and separate components, and that involves the interactions of a variety of components and technological elements in order to address a variety of goals characterised by a variety of performance requirements. Not only 5G is a general-purpose technology (Bresnahan & Trajtenberg, 1995; Helpman, 1998) that can be used for a variety of purposes, services, use cases and application contexts (Brown, 2016), but it also offers a broad scope of performance requirements, in function of the specific class of use cases it is designed to address.

As a result, in the same way in which there is no single BT, it is also possible to conclude that there is no “single 5G", but a variety of 5G technologies servicing a variety of applications, and that each actor within the ecosystem will develop its own interpretation of the technology based on: (i) its role within the ecosystem, and (ii) the specific application space controlled. There is no single way to interpret 5G.

In sum, not only is BT internal decisions-making structure (governance) prone to inconsistencies and misalignments, but 5G requires the trade-offs of a variety of requirements and functionalities due to its foundational and general-purpose nature.

To test our hypothesis, we have begun our qualitative research through semi-structured interviews of various actors responsible for the development and deployment of 5G within BT. We have currently completed 6 interviews, and planning to achieve around

30. We are also planning to complement these with internal documents provided by the company.

Ven though the present research deals with a single case study, we believe that the example is general enough to derive broader implications for practitioners even beyond 5G. In a world where digital technologies are increasingly foundational and where business models are increasingly platform-based, firms have to learn how their internal formal and informal organizational structures prevents them from perceiving and catching opportunities outside their industry and expertise. This becomes vital as industries' classifications become increasingly blurred, and competitive pressures is increasingly emerging from incumbent operating in other industries and markets.

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