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Innovative path dependence: Making sense of product and service innovation in path dependent innovation processes

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ABSTRACT

This paper analyses path dependence and path creation in firm innovation focusing on the effect of cognitive frames and organisational processes. A Northern European medical device firm is analysed through a detailed assessment of the structural and processual elements of cognitive path dependence. Cognitive schemas are analysed through development of ideal typical views on innovation and through an investigation of two specific innovation projects.

Drawing on sensemaking and actor network theory the paper adds to the literature in three respects. First, it provides a more systematic analysis than available in the existing literature of how cognitive frames enable and constrain firm innovation. Second, it presents an empirical analysis that contributes to a differentiation of the concept of path dependence, distinguishing between innovative path dependence and technological path dependence. Third, the paper analyses the timing of constraints and path dependence. In the cases studied the innovation approach frames the innovation problem and constraints in relation to technologies have an impact on the innovation processes later, after new technologies have been thoroughly researched.

The paper illustrates how the case firm is cognitively locked into an innovation path focused on generating ever-new product versions on different technological platforms, regardless of cannibalisation among the firm's different product versions. Despite the cognitive lock-in to an innovation path the firm is unconstrained in its choice of technological platforms and paths. Firms' innovation processes may thus simultaneously be characterised by unrestrained search processes and myopic behaviour.

1. Introduction

The influence of path dependency and technological trajectories on firms, industries, and nations constitutes a dominant explanation of the nature of economic and technological change. Technological trajectories provide a path whereby firms innovate within a specific technology in an attempt to improve the functional performance of a technology (Dosi, 1982). Path dependencies and constraints in relation to technologies develop over time and relate, for example, to the firm's core competences (Leonard-Barton, 1992) and its economies of scale and technical interrelatedness in industries, which create self-reinforcing innovation dynamics (Arthur, 1989; David, 1985). Technological trajectories driving and constraining the direction of firm and industry development are generally explained through economic inducements, technical limitations and institutional constraints (Andersen, 1998; David, 1985; Garud and Karnøe, 2003; Garud and Rappa, 1994; Klevorick et al., 1995; Mina et al., 2007; Ruttan, 1997).

Within the literature on innovation a renewed focus on the effect of cognitive frames as a carrier of path dependent behaviour is emerging (Kaplan and Tripsas, 2008; Tripsas and Gavetti, 2000). Although cognitive limitations have always been part of the literature on technological path dependence (Dosi, 1982; Nelson and Winter, 1982), it is rather surprising that the cognitive dimension has not been investigated in detail in subsequent publications. The literature often suggests that cognitive limitations constitute a basis of path dependence; however, the empirical processes by which cognitions shape innovation processes and create path dependence have not been systematically scrutinised. As Tripsas and Gavetti (2000) argue, "little theoretical attention has been devoted in this tradition to understanding how managerial cognition affects the adaptive intelligence of organisations" (Tripsas and Gavetti, 2000, p. 1147).

A related point is that extant literature has focused on technologies to the detriment of wider forms of innovation. For example, Langlois and Savage argue that "Most analyses of path dependency and lock-in have focused on technological systems in the narrow sense" (Langlois and Savage, 2001, p. 150). Furthermore, the literature on service innovation points to service as an important area being neglected in the academic literature, despite the fact

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that services account for more than 55% of consumer expenditure (Meyer and DeTore, 1999, 2001). In addition, there is a blurring of the boundaries between services and products with "a considerable number of trademark applications for new services" having been filed by manufacturing companies (Hipp and Grupp, 2005, p. 527). Similarly, Markides (1997) argues that strategic innovation – such as new distribution channels and services – is sometimes more important than technological innovation and Drejer (2004, p. 560) concludes that a "synthesis approach" is necessary.

The classic literature on technological trajectories and path dependence (David, 1985; Dosi, 1982; Nelson and Winter, 1982) establishes that firms may be constrained by their technologies. Alternatively, they may be constrained by their services, their strategies, or their business models (Markides, 1997; Prahalad and Bettis, 1986; Zajac and Bazerman, 1991). We offer a combined perspective that adds to these literatures through an investigation of the processes of cognitive path dependence incorporating technological, service and strategic innovation. Our paper therefore examines path dependence both in a technological sense (Dosi, 1982; Tushman and Anderson, 1990) and in the broader sense of an innovation approach. We define innovation approach as *model and a pattern of solutions on the basis of selected strategic and innovation problems, based on selected principles and approaches.* This definition builds on Dosi's (1982)[1] definition of a technological paradigm through its focus on cognition, and extends it by not focusing on technological innovation. Innovative path dependence occurs when a firm's innovation process follow a path shaped and constrained by its innovation approach.

The paper is also motivated by the literature on path dependence tendency to focus on "self-reinforcing mechanisms and neglecting reflexivity – the ability of actors immersed in specific trajectories to observe the results of their actions and deliberately try to alter the conditions in which they find themselves" (Araujo and Harrison, 2002, p. 8). Extant literature assumes that behaviour and technology behave relatively deterministically (Mahoney, 2000; Rycroft and Kash, 2002). This relatively deterministic focus may be problematic because if trajectories determine innovation decisions, then we may be assuming that organisations are totalitarian, meaning systems with neither descending voices nor negotiation. Have 25 years of scholarly debate about technological path dependency not influenced practice at all?

In this paper we therefore seek to extend and develop the cognitive perspective on path dependence through a synthesis with theories underlining the networked and processual nature of innovation (Callon, 1991). Analysing innovation as a network defined and shaped by intermediaries[2] opens up for an analysis of more reflexive and open search processes with multiple actors and organisational negotiation (Kidder, 1981; Garud and Karnøe, 2001; Weick, 2001; Mudambi and Swift, 2009). Hence, we add to the literature on cognitive path dependency through analysing the relational character of innovation cognitions instead of treating it as shaped and moulded by a hierarchy (Tripsas and Gavetti, 2000).

This paper seeks answers to two questions: How is path dependence sustained in networks where actors have diverse cognitive frames and in the face on reflexivity and negotiation? When does path dependence occur in such setting and what is the timing of constraints? These questions are examined in a case study of a Northern European medical device manufacturer. The paper provides empirical evidence that suggests that innovative and technological path dependence is two separate concepts but that both have a cognitive basis. Path dependent innovation processes are therefore more complex than often assumed and may be characterised by both innovative path dependence and technological path creation. Specifically we found that the innovation approach frames the innovation problem and constraints in relation to technologies have an impact on the innovation processes later, after new technologies have been thoroughly researched.

The paper is organised as follows. First, the perspective is developed through a synthesis of literatures on technological as well as general strategic and organisational forms of path dependence (Dosi, 1982; David, 1985; Cohen and Levinthal, 1990; Leonard-Barton, 1992) with cognitive and relational (Weick, 2001; Callon, 1991) perspectives. Second, the methods and analytical procedures in use are presented. Third, the empirical data are analysed firstly through developing ideal types of cognitive patterns in the organisation followed by an analysis of two cases of innovation processes. Finally, the discussion and conclusions are presented.

2. Interpreting innovation and technology

2.1. Literature review: path dependence, learning, and technological innovation

> "Technology, in this view, includes the "perception" of a limited set of possible technological alternatives and of notional future developments... Technological paradigms have a powerful exclusion effect: the efforts and the technological imagination of engineers and of the organisations they are in are focused in rather precise directions while they are, so to speak, blind with respect to other technological possibilities" (Dosi, 1982, p. 152).

In a cognitive perspective technological path dependence and technological trajectories are based on perceptions that indicate which types of puzzles product development should solve, and that determine which solutions are excluded. Nelson and Winter (1982, p. 36) have argued that limitations in cognitive abilities prohibit firms from achieving a complete and full understanding of the "economic world" and actors' subjective and cognitive models therefore constrain firm decision-making and actions. However, their primary interest was in theorising industry behaviour (Nelson and Winter, 1982, p. 36), making cognitive constraints an assumption rather than a study object. Tripsas and Gavetti (2000, p. 1148) argue that "by restricting and directing search activities related to technology development, managerial cognition influences the development of new capability". A cognitive perspective on technological path dependence is generally interested in analysing the complexity of technological change, specifically the ways in which "diverse technological frames are a source of variation in the era of ferment, that framing activities help drive the achievement of a dominant design when one emerges, and that the intertwining of technological frames and organizational architecture in the era of incremental change can explain why transitions are so difficult" (Kaplan and Tripsas, 2008, p. 791).

The literature on strategy (Zajac and Bazerman, 1991; Levinthal and Rerup, 2006; Gavetti and Levinthal, 2000) and organisational learning has also examined various forms of spurious learning or organisational path dependence. Prahalad and Bettis (1986) point to a dominant logic as an explanation for difficulties in executing diversification strategies. Spender (1989) argues that industries are characterised by shared cognitive schemas, called recipes that shape strategy making. Cohen and Levinthal (1990) argue that

[1] "In broad analogy with the Kuhnian definition of a 'scientific paradigm', we shall define a 'technological paradigm' as 'model' and a 'pattern' of solution of *selected* technological problems based on *selected* principles derived from natural sciences and on *selected* material technologies" (Dosi, 1982, p. 152). Our innovation approach has affinities with Spender's industry recipesthat are defined as "the business specific world view of a definable "tribe" of industry experts" (Spender, 1989, p. 7). However, we focus on firm-specific world views and world views/recipes in relation to innovation in a broad sense.

[2] Intermediaries are objects, things or structures that shape the relationships between actors in a network. Intermediaries are discussed further in section 2.2.