1-1-2013

Dynamicity and Performance in Adaptive Organizations

Alessandro Marino
University of Pennsylvania, amarino@wharton.upenn.edu

Dynamicity and Performance in Adaptive Organizations

Abstract
In this dissertation, I focus on the conceptualization and empirical investigation of organizational adaptation. Specifically, I intend to study how dynamic organizations evolve and under which conditions they successfully adapt to a changing environment. In essay 1 (with D. Levinthal), we develop a simulation model to clarify and explore some of the basic conceptual issues concerning the dynamics through which business practices locally adapt within an intra-organizational ecology of organizational level skills, knowledge, and capabilities subject to processes of mutation and selection. For essay 2 (with A. Prencipe), we designed and conducted a field project by collecting qualitative data: a mix of archival data, interviews and ethnographic field notes. The main goal is to investigate how organizational adaptation plays out under the pressure of various institutional forces. Our findings illustrate that institutional forces generate selective reactions within the ecology of existing organizational routines. Conversely, non-institutional forces adapt to the existing behavioral forms following a two-way dynamic process. In essay 3, I developed an empirical research design based on a panel data analysis to investigate the role of dynamic capabilities in boosting adaptation performance. This work examines some of the fundamental contingencies that impact the relationship between dynamic capabilities and organizational performance. Specifically, although prior experience in product adaptation is considered as a key driver of superior performance, its value is found to be highly conditional on both the level of focal activity - a recent adaptation effort on specific activities - and the intensity of the environmental changes.

Degree Type
Dissertation

Degree Name
Doctor of Philosophy (PhD)

Graduate Group
Management

First Advisor
Daniel A. Levinthal

Subject Categories
Business Administration, Management, and Operations | Management Sciences and Quantitative Methods

DYNAMICITY AND PERFORMANCE IN ADAPTIVE ORGANIZATIONS

Alessandro Marino

A DISSERTATION

in

Management

For the Graduate Group in Managerial Science and Applied Economics

Presented to the Faculties of the University of Pennsylvania

in

Partial Fulfillment of the Requirements for the

Degree of Doctor of Philosophy

2013

Supervisor of Dissertation

____

Daniel A. Levinthal, Professor of Management

Graduate Group Chairperson

____

Eric Bradlow, Professor of Marketing, Statistics, and Education

Dissertation Committee

Lori Rosenkopf, Professor of Management

Nicolaj Siggelkow, Professor of Management

Daniel A. Levinthal, Professor of Management

DYNAMICITY AND PERFORMANCE IN ADAPTIVE ORGANIZATIONS

To my Dad

ACKNOWLEDGMENTS

This dissertation would not have been possible without the support of Dan Levinthal. His enlightened and continuous mentorship has been a solid point of reference for my Wharton experience. Our discussions have fundamentally shaped my research agenda. I owe him a tremendous debt of gratitude for the effort he has produced to let me move on in my path from a doctoral student to a scholar.

I am also privileged to have Nicolaj Siggelkow and Lori Rosenkopf on my committee. They have both provided precious comments that drastically improved my chapters. Lori earlier and then Vit have also been vital compasses in my long walk through the doctoral program. I will be inspired by their work as coordinators if in the future I will be involved in a similar task.

I am also very grateful to David Hsu. I have had the privilege to develop a research project with him, which gave me the chance to interact with him for several years – an unbeatable learning platform for a doctoral student. I also thank my co-authors Paolo Aversa and Andrea Prencipe who gave me the tremendous chance to share ideas and perspectives with the purpose of developing common research efforts related to the dissertation. More in general, I am grateful to the doctoral students, faculty and staff in the Management department at Wharton for creating a productive and enjoyable research environment through a combination of classes, seminars and informal hallway conversations.

Special thanks also go to Marco Valente, Giulia Gambelli and Tommaso Giulini who, with different support, helped me collect crucial data for my research projects.

Finally, I thank my family for the continuous support in these years, and skype to have made all this support actually happen. I was lucky to have Emanuela at my side for several years in Philly – her help has been crucial for my experience. My Dad deserves special mention. He couldn't see me from this Earth completing the program, but, as usual, he managed to provide a tremendous support anyway, wherever he is.

To him I dedicate this dissertation.

ABSTRACT

DYNAMICITY AND PERFORMANCE IN ADAPTIVE ORGANIZATIONS

Alessandro Marino

Daniel A. Levinthal

In this dissertation, I focus on the conceptualization and empirical investigation of organizational adaptation. Specifically, I intend to study how dynamic organizations evolve and under which conditions they successfully adapt to a changing environment. In essay 1 (with D. Levinthal), we develop a simulation model to clarify and explore some of the basic conceptual issues concerning the dynamics through which business practices locally adapt within an intra-organizational ecology of organizational level skills, knowledge, and capabilities subject to processes of mutation and selection. For essay 2 (with A. Prencipe), we designed and conducted a field project by collecting qualitative data: a mix of archival data, interviews and ethnographic field notes. The main goal is to investigate how organizational adaptation plays out under the pressure of various institutional forces. Our findings illustrate that institutional forces generate selective

reactions within the ecology of existing organizational routines. Conversely, non-institutional forces adapt to the existing behavioral forms following a two-way dynamic process. In essay 3, I developed an empirical research design based on a panel data analysis to investigate the role of dynamic capabilities in boosting adaptation performance. This work examines some of the fundamental contingencies that impact the relationship between dynamic capabilities and organizational performance. Specifically, although prior experience in product adaptation is considered as a key driver of superior performance, its value is found to be highly conditional on both the level of focal activity – a recent adaptation effort on specific activities – and the intensity of the environmental changes.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

1 INTRODUCTION

1.1 Three Faces Of Organizational Adaptation: Selection, Variety, And Plasticity

The question of organizational adaptation is one of the most central lines of inquiry within the management literature. The reasons for this are quite fundamental. First, there is the argument emanating from Simon (1956) that in the presence of bounded rationality, search is a central mechanism by which intelligent action is identified. Second, organizations operate in environments that themselves are dynamic and, as a result, the problem of intelligent action is not something that can be resolved once and for all, but must be continually reconsidered.

Building on these motivations, discussions of learning and adaptation have a long tradition (Argote, 1999; Argyris, 1982; Cyert & March, 1963; Hedberg, Bystrom, & Starbuck, 1976; Huber, 1991; Levitt & March, 1988; March & Olsen, 1979; March & Simon, 1958). In recent years, a new line of inquiry under the label dynamic capabilities has been an important focus of attention with the strategy field (Helfat et al., 2007; Teece, Pisano, & Shuen, 1997). While much of this work is situated as an extension of the resource view of the firm (Barney, 1991; Wernerfelt, 1984), other strands take a process perspective and point to the importance of organizational mechanisms in linking and recombining activities within the organization as underlying a firm's dynamic capabilities (Eisenhardt & Martin, 2000). Central to both variants of these discussions of dynamic capabilities is some notion of *organizational plasticity*, the capacity for an organization to transform its resource and market position to further the pursuit of competitive advantage in a possibly changing environment.

An alternative perspective on organizational adaptation the draws on Campbell's (1965) work points to the process of *variation and selection within an organization* (Aldrich, 1999; Burgelman, 1991). Critical to a selection based argument is the question of what constitutes the units of selection (Freeman, 1975). Nelson and Winter (1982) provided a powerful answer to this question with their work on organizational routines and the link to routinized action patterns to the relatively stable heterogeneity in performance across firms. However, work that closely examines the enactment and re-enactment of routine based behaviors in practice, they noted a surprising degree of fluidity in what nominally constituted the same action pattern (Birnholtz, Cohen, & Hoch, 2007; Feldman, 2000). plasticity and the selectability of underlying traits define a space of intense potential interplays that has been absent in discussions of the possible virtues of more or less fungible organizational practices. For instance, Davis, Eisenhardt, and Bingham (2009) demonstrate the flexibility advantages of relative "simple" rules in dynamic environments. However, these rules are specified a priori and not emergent from some process of variation and selection.[1] If flexibility, or plasticity, possibly impedes the intelligent selection among more or less valuable stable traits, then a full treatment of the internal ecology of evolutionary dynamics of organizations makes consider this tension.

This issue of the more or less intelligent selection among a set of rules that vary in their plasticity is intimately related to the issue of the reliable replication of routine

[1] It is important to note in this context that the Davis et al. (2009) model considers the organization as having a single rule. Further, while possibly "simple" in that only a sub-set of elements in the rule are fixed, considerable intelligence is assumed in that these fixed rules in that it is assumed that the general orientation of the rule (proportion of 1's and 0's in the string characterizing the rule) correspond to the characteristic of the ideal behavior in the given environment.

behavior emphasized by Nelson and Winter (1982) and elaborated by other scholars (Rivkin, 2001; Szulanski, 1996; Zollo & Winter, 2002). The notion of a routine as having a quasi-genetic quality was critical in Nelson and Winter's argumentation as that provided a conceptual frame by which one could understand the persistence of distinct firm capabilities across time, and across the demography of entry and exits into various job positions within the organization. As Rivkin (2001) demonstrates, the more interconnected the set of behaviors the greater the risk of a less than faithful reproduction of those specific behaviors at a later time period. In a similar spirit, Zollo and Winter (2002) point to the important role of codification of behavior.

Thus, while plasticity has possible benefits in terms of the possibility of addressing particular and changed circumstances, it also entails possible costs in terms of reduced selectability of the underlying traits and less reliable action patterns. Plasticity can be viewed a kind of minimal, 0^{th} order, dynamic capability (Collis, 1994). Clearly, in the absence of plasticity there is no possibility of changed behavior. Certainly, the discussion of dynamic capabilities points to the capacity of some organizations to more effectively transform the resources and capabilities in response to and even in anticipation of possibly changed circumstances (Eisenhardt & Martin, 2000; Helfat et al., 2007; Teece et al., 1997). At the same time, scholars (cf., Helfat et al., 2007) have been careful to note that dynamic capabilities should not viewed in an axiomatic manner as leading to enhanced organizational performance. In this regard, it is important to note that variability in behavior is not simply a function of the plasticity of a given set of behaviors, but also in the variation in behaviors within the organization. Most models of organizational learning examine a path-dependent, reinforcement learning process of a single pattern of behavior (Lant & Mezias, 1992; Levinthal, 1997). As suggested by the work of March (1991) and central to the arguments of Campbell (Baum & Singh, 1994; Campbell, 1965), variability within the organization is also a critical form of variation, a form that can only be addressed by structures and conceptualizations that allow for some process of intra-organizational selection among an intra-organizational population of behaviors.

While only engaging in the question of dynamic capabilities in a highly stylized manner of considering actions that are more or less flexible, and in that sense dynamic, this dissertation intends to explore some of these tradeoffs, or implicit costs of flexibility. Further, viewing the organization as a complex, adaptive system points to the fact that it is the adaptability of the entity as a whole that is critical and that it can be problematic to isolate a particular behavior or capability and interpret the implications of the possible adaptability of this particular element for the organization as a whole. Indeed, this contrast is a central finding in March's (1991) model of exploration and exploitation. While fast learning enhances the performance of the individual actor, an organization composed of a population of fast learners yields lower overall organizational performance. In this sense, it is important to recognize that our focus should not be on the question of what might constitute more or less dynamic capabilities per se, but to what might constitute the properties of more or less dynamic organizations.[2]

[2] Of course, at a higher level of analysis of organization populations, there is a separate question of the adaptiveness of economic systems and to which that is enhanced by adaptation and resource allocation at the level of individual organizations or by the rise and decline of organizational populations.

As suggested by Figure 1, clearly elements of these ideas of intra-organizational selection, variation, and plasticity have been considered previously in the literature, though not always with these labels. For instance, the socialization process modeled by March (1991) in terms of actors' beliefs or culture by Carroll and Harrison (1993) effectively act as a selection process with certain beliefs and values reinforced and others diminished. Selection also effectively is represented by the decision rule, or "temperature" in a bandit model (Posen & Levinthal, 2012) where the likelihood of choosing what appears to be the more high performing action is tuned to shift the organization from being relatively exploitive or exploratory in its behavior. The variety present in the organization is importantly a function of its search behavior and whether relatively local or more distant options are considered (Levinthal, 1997; March & Simon, 1958). Variety may also be introduced in a less intentional manner via mutations (Bruderer & Singh, 1996; Davis et al., 2009). This issue of plasticity, under a number of different labels, has been central in the consideration of the question of organizational adaptation. Most commonly this has taken the form of the learning rate in a process of a reinforcement learning (Argote, 1999; Lave & March, 1975). However, as Davis et al., (2007) show, the value of flexibility can be considered quite apart from a process of reinforcement learning. As suggested above, while only capturing a facet of the notion of dynamic capabilities, certainly plasticity is an important, minimal element in that construct.

Insert Figure 1.1 About Here

1.2 Dissertation Structure

To engage the questions described in the prior section three essays that adopt heterogeneous research methodologies are developed according to the following structure.

1.2.1 Interplays Between Variation/Selection and Plasticity

Essay 1 provides a theoretical overview on the interplays between plasticity and variation/selection in shaping the evolutionary routines dynamics. Specifically, a highly stylized model that incorporates elements of intra-organizational selection among action patterns and the degree of plasticity of these action patterns is developed. As prior literature would suggest (Burns & Stalker, 1961), the model shows that in more dynamic environments a greater degree of plasticity enhances performance. However, even in rapidly changing settings, the level of plasticity associated with maximal organizational performance is relatively modest. Further, in the context of relatively intense internal selection processes, performance is generally enhanced by lower levels of plasticity.

1.2.2 Adaptation Under Institutional Forces

Essay 2 focuses on the understanding of the adaptive dynamics that are activated when organizations operate under the pressure of institutional forces. In this sense, this chapter deals with the interplays among different selective sources (i.e. the institutional environment and the internal routines reactions) and the tendency of organizational routines to become plastic by altering their state when exposed to institutional pressures.

Institutional theorists have defined a clear conceptual framework to predict organizational evolution. Specifically, normative, mimetic and professional pressures contribute to isomorphism, i.e. the emergence of common organizational practices across firms operating in the same field (DiMaggio & Powell, 1983). However, while institutional theories predict that organizations operating in similar fields tend to adopt similar practices, numerous studies have highlighted how the organizational reactions to these adoptions are not identical. Nonetheless, we know little on the mechanics and reasons underlying this spectrum of particular forms of adaptations to similar institutional pressures that organizations undertake. To investigate these aspects, a field study was conducted in a medium-sized firm and developed a grounded theoretical framework.

Our finding suggest the existence of a relationship between nature of the external forces that the organization experiences and the adaptive mechanism thorough which existing routines interplay with the dynamic pressures. Specifically, when the force is primary driven by technical ecomonic reasons – the non-institutional type – dynamic and mutual adaptation with existing practices is likely to occur. Conversely, if the main goal underlying the initiative is to gain legitimacy within the field, the organization will be forced to operate a selection either strongly in favor or against a substantial adoption of the practice while still complying with the institutional needs. As a consequence, there exists a plurality of firm specific sources of variability that define markedly idiosyncratic organizational dynamics under the pressure of institutional forces, thus supporting in substance the existence of behavioral polymorphism.

1.2.3 Variety, Plasticity and Firm Performance

Finally, Essay 3 examines the relationship between plasticity, variety and firm performance – a key aspect for organizational adaptation. Examining the possibilities and constraints of organizational change in response to environmental change has been a central topic in the organizations and strategy literatures. In recent years, this interest in understanding the intra-organizational mechanisms of change has coalesced around the concept of dynamic capabilities (Helfat et al., 2007; Teece et al., 1997). The general line of inquiry is linked to the idea that the organization can develop capabilities specifically dedicated to adaptation. More precisely, these studies suggest that stable properties of organizations facilitate efforts at effective change, as distinct from firm differences in capabilities associated with current performance.

In developing the theoretical underpinnings of the concept of dynamic capabilities, scholars have been careful to be agnostic as to the performance implications of dynamic capabilities, recognizing the dangers of making performance advantages of dynamic capabilities tautological (Helfat et al., 2007; Helfat & Winter, 2011). In particular, Helfat et al. (2007) suggest that the relationship between dynamic capabilities and performance is importantly contingent on factors associated with an organization's external and internal environment. However, the possible contingencies associated with the role of dynamic capabilities have not been well-developed either theoretically or empirically. On the other hand, the emergent body of empirical studies on dynamic capabilities has not generally been so circumspect. While the work has had to address the challenges of severe measurements issues (Kraatz & Zajac, 2001; Newbert, 2007), there seems to be a general consensus regarding the positive impact of dynamic capabilities on firm performance (Drnevich & Kriauciunas, 2011).

The present work examines some of the fundamental contingencies that impact the relationship between dynamic capabilities and organizational performance. This is done in the context of a focus on the dynamic capabilities specifically dedicated to adapting the characteristics of a firm's products to a changing environment, which prior researches have considered as a central domain for the understanding of the underlying phenomenon (Helfat et al., 2007; Teece et al., 1997).

A well-developed argument and finding in the literature on organization learning is the role of prior experience as an essential ingredient in capability development (Argote & Epple, 1990). Relatedly, a substantial consensus has developed within the literature on dynamic capabilities as to the key role that adaptation experience plays on the genesis and magnitude of dynamic capabilities (Barreto, 2010; Helfat et al., 2007; Winter, 2003; Zollo & Winter, 2002). However, scholars are beginning to turn their attention to the specific attributes of adaptation experience that impact a firm's adaptability (Danneels, 2008; Eggers, 2012; King & Tucci, 2002). This work further extends this line of research by taking a different direction. While adaptation experience is considered in its general form, its impact is considered in conjunction with the concurrent role played by what is termed as focal activity. Focal activity has two distinctive elements – focal in both a "temporal" and "spatial" sense. The former as it is not cumulative, as capabilities (and learning processes) are generally treated, but references a narrow band of recent adaptation activities. The latter as it is specific to the particular domain of activities that are subject to current change.

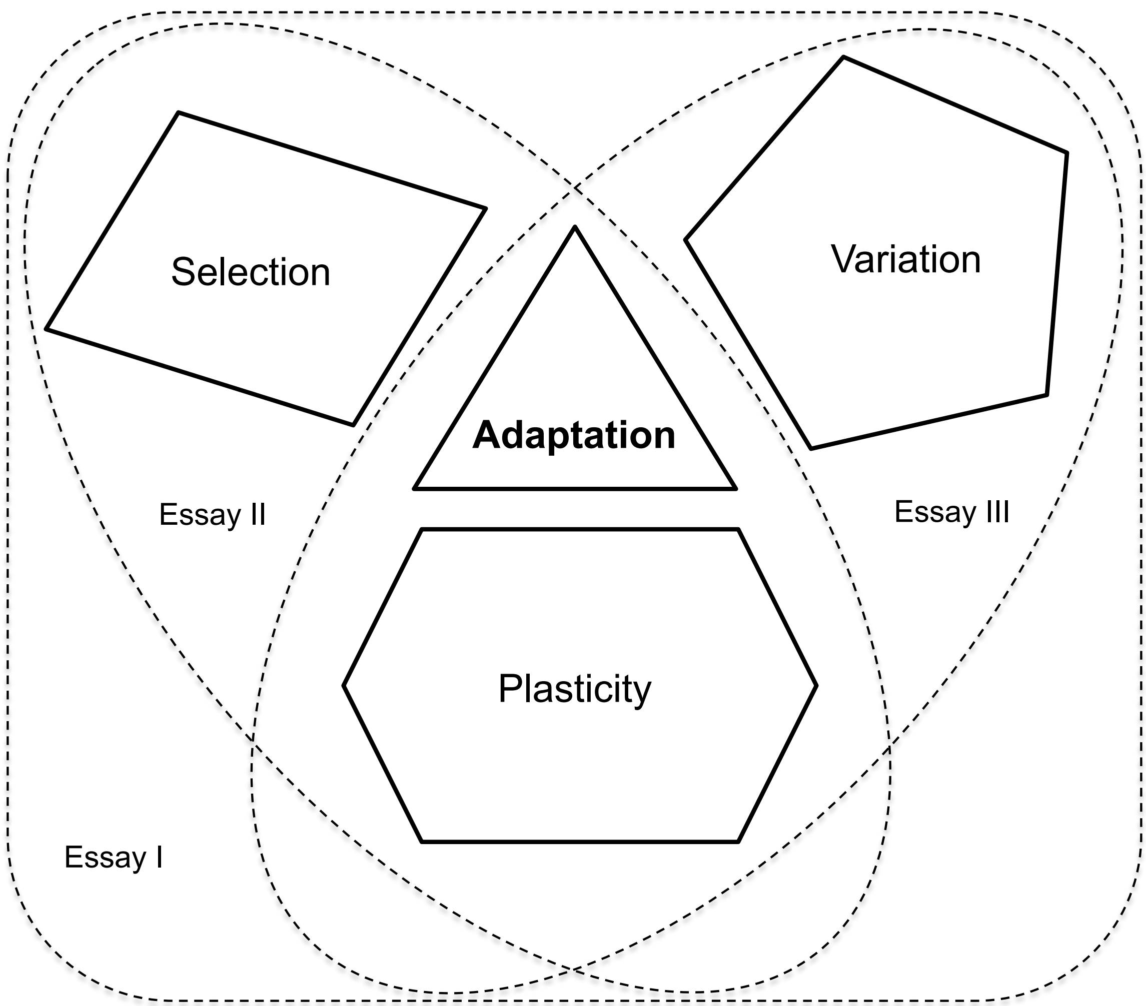
While adaptation experience constitutes a general source of knowledge that can facilitate a firm's future adaptation to changed circumstances, focal activity provides a twofold complementary support. First, it constitutes a form of maintenance of dynamic capabilities, which need to be activated to work timely and properly (Helfat et al., 2007). An organization may cumulate a considerable knowledge of adaptive processes. However, a lack of recent activation of specific adaptive processes may prevent their timely reactivation. In addition, focal activity stimulates the level of technical variety of an organization, i.e. the degree of heterogeneity in components, technologies, and more generally the set of technical elements related to a product's design. Prior studies built around the Darwinian paradigm of variation-selection-retention (Campbell, 1982) have stressed the importance of heterogeneity within organizations by highlighting its crucial role in defining their evolutionary paths (Aldrich, 1999; Baum & Campbell, 1999) or favoring technological recombinations (Fleming, 2001; Kogut & Zander, 1993) or integrations (Brusoni, Prencipe, & Pavitt, 2001). Therefore, to fully define the effects generated by product adaptation experience to firm performance, one should consider the contextual level of focal activity. The same reconfiguration mechanisms of a certain product generate quite different outputs depending on its recent exercise (Helfat et al., 2007) and on the characteristics of the existing resource base (Bharadwaj, 2000).

Further, the ultimate outcome of product adaptation process depends on the timing of change (Ahuja & Katila, 2001). In fact, the level of environmental dynamics existing at the time of change may largely alter the effectiveness of the adaptation effort (Drnevich & Kriauciunas, 2011; Helfat & Winter, 2011). Accordingly, while as per focal activity a set of more practiced capabilities and a broader array of reconfigurations may be useful with the presence of intense adaptive efforts, this may constitute a form of unnecessary exploration in periods of environmental stability (Ocasio, 1997).

In sum, this Essay helps define under which conditions product dynamic capabilities lead to superior firm performance. In this regard, the key role of prior experience and the moderating effects of focal activity and the intensity of environmental changes are investigated in a unique thirty-year panel of data related to the Formula One racing industry. It is argued that focal activity is either a positive or negative moderator of the relationship between adaptation performance and firm performance depending on whether the level of environmental dynamism is high or low, respectively. The following section further develops the theoretical background for the arguments and specifies an explicit set of hypotheses. These hypotheses are then tested and the main results are discussed.

1.3 Figures

Figure 1.1 The Three Faces of Organizational Adaptation



2 THE INTERNAL ECOLOGY OF ORGANIZATIONAL ADAPTATION

Daniel Levinthal and Alessandro Marino

Organizations carry out a wide class of practices, some at a strategic level such as mergers and acquisitions which may shape the very boundaries of the firm, others at a project or business unit level such as the development of new products or entering new markets, and still others of a more tactical sort, such as carrying out particular policies and procedures. We use the term practices as they can embrace both the fixed, quasi-genetic property ascribed to routine-based action and the possibly idiosyncratic behavioral expression of this "genetic" property. The expression of some fixed, quasi-genetic traits in a set of particular circumstances reflects both the accumulated wisdom from the prior history of experience, as well as a possible response to the particular circumstances the actor faces.

While the genetic basis of these practices serves as a point of reference for future reproductions, their concrete implementation requires a mix of ad hoc and intentional configuration toward specific purposes in specific circumstances. In other words, we consider as root or genetic behaviors (or hereinafter *genotype*) the organizational elements in a form that are reproducible over time. This may be in the form of a "decision premise" (Simon, 1947), a "simple rule" (Davis et al., 2009), or an existing pattern of behavior (Cyert & March, 1963; Nelson & Winter, 1982). Note that the formalization of the information associated with the organizational element is not a necessary condition of its genetic status. Consider the abstract representation of a managerial practice that the organization intends to replicate – it will contain a set of roughly defined instructional elements, but these elements will lack precise formalization or reduction to practice.

Indeed, in the early work of Nelson and Winter (1982) the notion of routine carried both the idea of a gene, an inheritable trait, and phenotype, the behavioral expression of that trait. Once one separates the construct of gene and phenotype, it becomes quite natural to recognize the possibly unique expression of "routine" action. Organisms, even if they share identical genetic structure but are subject to distinct environmental circumstances (imagine a plant subject to different degrees of sunlight, water, etc.), will take on distinct phenotypic forms. Adopting this perspective, we suggest that while organizations may inheritable traits or genes that pass from one "generation" to the next, such as genetic imprint does not deterministically characterize the organizational form or enacted behaviors.

Furthermore, not only is there a directional influence from genotype to phenotype, but there is also a reverse causality from realized phenotype to selection influences on the set of surviving genotypes. Consider the implications of this argument for the selectability of the genetic roots of routine behavior. The quasi-genetic basis of routine behavior provides a starting point for a process of subsequent adaptation and learning. Given that it is the learned behavioral patterns that are the basis of selection processes, then genetic bases that offer more or less favorable starting points for a process of adaptation should be differentially selected for. Thus, while the evolutionary process is not Lamarckian in that learned traits or patterns are not themselves inheritable, the learning dynamics importantly underlie the selection process. Within the biology literature, this mechanism is known as the Baldwin effect (Baldwin, 1896) and refers to the capacity of organisms to genetically assimilate across generations traits that prove to be more effective in forming the basis for fitter phenotypes.

This contrast between gene and phenotype is also helpful in conceptualizing what constitutes the plasticity of organizations. In this context, plasticity relates to the adaptation and change of a particular attribute of a behavior pattern. As typically conceived of in models of search and learning (cf., March, 1991; Levinthal, 1997), this is represented as a given attribute shifting from one value to another. Thus, the classic process of reinforcement learning that has been the central mechanism considered in the literature on organizational adaptation (Argote, 1999; Levitt & March, 1988) is present at the phenotypic level in terms of expressed behavior. While minimal in this regard, this characterization of plasticity has the attractive analytic property that its value is not presumed. That is, it is an open theoretical and empirical question as to whether varying degrees of plasticity are more or less valuable in enhancing organizational performance over time.

An organization *i* is thus conceived of as a collection of genotypes, each representing a stable underlying basis of a set of practices.[3] The number of distinct genotypes in each organization is indicated by *W*. An individual genotype *w* of the *ith* organization is coded

[3] The basic model structure, while novel to the organizations literature (though see Bruderer and Singh, 1996 and Davis, et al., 2009 for broadly related efforts), builds upon a substantial line of work in computational biology (Hinton and Nowlan, 1987; Holland, 1975; Mayley, 1996).

by a binary string of length N and is indicated by $GE_i(w)$ and the organization's collection of genotypic elements by $GE_i(w)$ [w=1,…,W].

2.1.1 Phenotypic Plasticity

From this starting point, a set of phenotypic forms is developed through a process of local adaptation.[4] However, not all the bits of a given phenotype may be subject to such adaptive dynamics. At time 0, the parameter p_l , ranging from 0 to 1, determines the probability that each bit of a genotypic string $GE_i(w)$ will be plastic or not during the process of phenotypic development. For those attributes which are specified as being non-plastic, the associated element of that genotype is treated as fixed. Therefore, its associated phenotype $PE_i(w)$ will be identical to the parent genotype over the process of local adaptation. Conversely, elements that are specified as being plastic will be subject to a process of local adaptation. The degree of plasticity p_l is similar to the level of "simplicity" of decision rules in Davis et al., (2009), where a rule is more or less simple as a function of the degree of possible perturbation of its expression. At a minimal level, the phenotypic plasticity of the elements that compose the practices characterizes the capacity to adapt associated with a given practice. This specific form of plasticity relates to the adaptation of a particular attribute of a pattern of behavior.

Specifically, from an initial setting of $GE_i(w)$ [w=1,…,W], each of the W associated phenotypes, indicated by $PE_i(w)$ [w=1,…,W], is obtained over time by

[4] We use the term phenotype to refer to the expression of an individual practice or routine and not to the organizational form as a whole.

performing a series of adaptation trials according to the mechanism described as follow. At the start of the adaptation process, a phenotype $PE_{i,t}(w)$ is generated by cloning the binary string representing the initial genotype $GE_i(w)$ (Mayley, 1996). Similar to Levinthal (1997), starting from this point, a new phenotype $PE_{i,t+1}(w)$ is obtained by flipping a single bit. Should the performance level obtained by the phenotype $PE_{i,t+1}(w)$ be greater than that associated with the prior phenotype $PE_{i,t}(w)$, then the change will be retained and the phenotype $PE_{i,t+1}(w)$ will constitute a starting point for a subsequent adaptation trial. Otherwise, the adaptation trial would fail and a new value of $PE_{i,t}(w)$ will be attempted at time $t+1$.

2.1.2 Internal Selection Environment

The series of adaptation trials continues until the organization carries out an *internal selection event* in which a new collection of practices is defined by respecifying a set of genotypic elements, call it $GE'_i(w)$ [w=1,…,W]. At each time step, the probability that an internal selection event occurs is equal to p_s. Higher levels of this parameter define an internal selection environment characterized by a stronger, more aggressive internal selection environment.

Internal selection occurs through differential replication of the existing set of genotypes $GE_i(w)$ [w=1,…,W]. While the phenotype may take on a possibly unique morphology, the assessment of the merit of the form will be attributed to the underlying genetic basis. Thus, while the performance of the phenotype is the basis for the differential selection among the set of behaviors, it is the genetic roots of that phenotype constituting the element that is effectively reinforced. Holland (1975), building on the work of Samuel (1959), has referred to such processes as credit assignment mechanisms. Therefore, this selection process privileges genotypes associated with superior fitness as the basis for replication. More precisely, the choice of the genotypic elements of $GE_i(w)$ [w=1,…,W] to replicate in the new set $GE'_i(w)$ [w=1,…,W] is determined by a stochastic mechanism according to which the probability of being selected for a specific string, $GE_i(w)$, is proportional to the fitness of the associated phenotype (Holland, 1975), call it $F(PE_i(w))$, obtained by the adaptation process at the time of the selection event (Mayley, 1996; Suzuki & Arita, 2007).

Given this calculation of phenotypic fitness, a proportionate selection rule is imposed based on the relative fitness of the various phenotypes (Holland, 1975; Wilson & Bossert, 1971). Accordingly, the probability of a given genotype of the old collection being replicated is equal to the expression:

$$\frac{F(PE_i(w))^{SP}}{\sum_W F(PE_i(w))^{SP}} \qquad (1)$$

While it is standard in the literature on evolutionary biology (Holland, 1975; Wilson and Bossert, 1971) to treat selection as strictly proportional to fitness, in the context of a model of intra-organizational selection it seems appropriate to allow for more, or possibly less, stringent selection criteria. Indeed, the intensity of internal selection, the degree to which higher performing practices are privileged in the internal selection process, is another important feature of the organizational context influencing the organization's evolutionary dynamics. In sum, an internal selection environment is characterized by both tuning its frequency of renewal (p_s) and its selection pressure (*SP*). Within this internal selection environment, the genetic elements that compose the most successful enacted practices diffuse at the level of the internal population (Warglien, 1995). Not only will these patterns of behavior diffuse, but the level of phenotypic plasticity itself changes as behaviors that are more or less plastic are selected for. Thus, the plasticity of the genetic elements constitutes in and of itself an inheritable trait of the practices.

The internal selection forces take various forms within the organizations. The policies for the diffusion of the best practices constitute a clarifying example. With the help of tools such as integrated databases and electronic knowledge sharing platforms, organizations attempt to systematize the diffusion of the most successful experiences within their boundaries (Hansen & Haas, 2001) and thereby change the demography of practices within the organization. These activities are often classified under the larger category of knowledge management and constitute what is now a fairly common managerial practice.

2.1.3 Practice Mutation

Change in the demography of practices is driven by a number of forces. First, as just noted, there is the differential selection within the organization over a set of practices. Second, any given practice may take a distinct phenotypic form as a consequence of its expression in a particular set of circumstances. Third, there may be some drift or mutation in what we are terming the genetic roots of a given practice. Codified knowledge is not a static property of an organization (Zollo & Winter, 2002) whether through unintended mutation or more deliberate efforts at change. With regard to the latter dimension, organizations display different levels of genotypic mutation depending on their tendency to experiment and generate novel genetic bases. As opposed to phenotypic plasticity, which captures the ability of the organization to adapt phenotypic forms based on their fitness with the external environment, these mutations operate directly on the gene and are not linked with the fitness of the associated phenotype. Accordingly, each bit of the newly generated genotypic string will mutate with a probability, p_m.

After each internal selection event takes place, a set of genotypic elements is specified and a new phase of phenotypic adaptation starts over following the same process described above.

The adaptive process defined in the model is comprised of a hierarchical structure formed by the following two distinct elements: internal selection, which defines the evolution of the collection of genotypic elements and the overall level of phenotypic plasticity over time, and the phenotypic adaptation process in which the agents enact and refine a phenotypic form from a given genotype, occurring in the periods of time between internal selection events. The phenotypic elements comprise the ecology of practices that are activated, completed, and evaluated over time within the organization (Burgelman, 1994). Episodically these practices are evaluated via a process of internal selection that redefines the organization's population of genotypes. Subsequently, a new set of practices is generated and a new process of phenotypic development begins. As a result, the evolution of the genotype follows a slower adaptive process, which is driven in an indirect fashion from the selection over the adaptive phenotypic forms, the set of organizational practices that have been developed.

2.1.4 Performance Values

The fitness of each phenotype *N*-tuple, $F(PE_i(w))$, is evaluated in the standard manner of *NK* fitness landscapes (Kauffman, 1993; Levinthal, 1997), where *N* denotes the number of elements in the string and *K* the level of interdependencies across the *N* elements. More specifically, the fitness contribution value of a bit at a certain location depends on the value of bits in *K* other locations. The contribution values associated with each possible combination of the bit's value and the others that affect it are defined by a random number drawn from a uniform distribution *[0,1]*. The overall performance of a string is then the average of all the contribution values. When *K* equals zero, each element contributes independently to the overall fitness of the string, and the landscape is smooth, whereas when K=N-1, the fitness landscape is maximally rugged.

NK fitness landscapes have been widely adopted in the field of computational biology to model the developmental mechanisms of phenotypic forms from underlying genotypes (see Suzuki and Arita (2007) and Mayley (1996) for representative examples). An alternative to this characterization of the payoff structure that might be used is a single spike payoff as in Bruderer and Singh (1996) or a plateau as in Davis et al. (2009) where some subset of the payoff space receives a positive reward and other regions nothing. The motivation for the use of *NK* structure in the current context is that it is consistent with a process of online learning where the evaluation of modifications of the phenotype is possible. In contrast, in Bruderer and Singh (1996) and Davis et al (2009), trials are offline in that organizations do not experience the payoff of intermediate phenotypic forms and phenotypic level adaptation, absent selection processes, is not present.

2.1.5 Summary of Focal Parameters

In sum, in our analysis, we focus attention on the following focal parameters and contextual setting. The parameter p_l reflects the capacity of the organization to dynamically adapt its set of practices by developing distinct phenotypic expressions of its genotypes. More formally, plasticity references the set of phenotypic elements that are candidates for possible adaptive trials.

The second focal parameter, p_m, refers to the tendency of an organization to randomly mutate its set of genotypes when an internal selection event occurs. All organizations start with the same initial condition in which half of the strings are homogenous, a randomly specified string is replicated $W/2$ times, and the remaining $W/2$ strings are specified at random. However, distinct settings are obtained by tuning the parameter p_m.

A third pair of focal parameters characterized the frequency of renewal and the pressure of the internal selection environment. The former is defined by the parameter p_s indicating the probability that at each step an internal selection event occurs. The latter, *SP*, refers to the exponent on the fitness value in the probability ratio determining the internal selection likelihood (see equation [1]). With respect to this parameter, it is standard in work on models of population ecology (Wilson & Bossert, 1971) and genetic algorithms (Holland, 1975) to treat selection as being strictly proportional to relative fitness (i.e., *SP*=1). However, it is reasonable to postulate that organizations, acting with some conscious discrimination among populations of practices, may be more discriminating than a process of pure proportionate selection would suggest. As a consequence, in our baseline setting, we take the fitness value for each phenotype, $F(GE_i(w))$ in equation [1], to a power, *SP* equal to either 1 or 10 to capture organizations with low and high selection pressure, respectively. Moreover, we investigate the case in which no selection occurs according to which at each internal selection event a perfect replication of the prior collection of genotypes is cloned, regardless of the fitness values obtained by each of the related phenotypes.

The configurations of organizations that emerge from the parameters illustrated above are analyzed at different levels of environment dynamism. Change in the environment is modeled as follows. At each step of the simulation, with probability equal to p_c, the fitness level associated with each bit that constitutes a phenotype is respecified by drawing a new value from a uniform distribution [0,1].

2.2 Analysis

While we examine the robustness of the model to the full set of parameters, the analysis highlights the impact of differences across organizations with respect to the focal parameters outlined above. Central among them is the level of phenotypic plasticity. We contrast the case in which organizations are inert (i.e. $p_l = 0$) and a setting in which organizations are capable of phenotypic development at various magnitudes (p_l = [0.25, 0.5, 0.75, 1]. We also vary the tendency of the organizations to engage in a random genetic mutation, examining the range of p_m [0, 0.025, 0.05]. The internal selection environment is explored at two levels of renewal frequency, p_s, [0.1 and 0.25] and the level of selective pressure in the internal selection environment is considered at a low (SP=1) and high level (SP=10). Moreover, we also consider the case of no selection according to which the prior set of genes is perfectly cloned at each internal selection event. Further, we explore these parameters under the two alternative environments: Stable (p_c=0) and Dynamic (p_c=0.05).

Organizations are modeled as being composed of 20 genotypes ($W=20$). In the beginning of the simulation, each organization displays a common level of heterogeneity in genotypes, with on average 50% of the genotypic strings being the same and the remaining 50% independently randomly generated. For organizations that are not inert with respect to plasticity, each period during the adaptation process one of the plastic elements is chosen at random and a one bit change in this plastic element is evaluated. If such a change improves phenotypic performance, it is adopted; otherwise, the existing phenotypic form is maintained.

The parameter p_s is roughly calibrated and explored at two representative levels in the analyses reported here for the following reasons. The parameter p_s is set so that the model operates as a hybrid between a pure genetic algorithm (Holland, 1975) and a typical "hill climbing" mechanism (Levinthal, 1997). Very frequent internal selection events (very high p_s) cause the structure to operate more like a pure genetic algorithm in which selection operates directly on genes with little phenotypic developments. Indeed, in the limit, the genotypic strings would be not only "starting points" but they are also "final points" as no phenotypic development would occur. On the other hand, very low levels of p_s characterize a setting of long periods of pure hill climbing mutations, resulting in a phenotypic search process that identifies a local peak in the fitness landscape and continues to remain there until, with the low probability p_s, there is an internal selection event.

The level of initial diversity in the genotype represents a partial substitute for the focal parameter indicating the rate of random mutations in genotypes (p_m). Indeed, both these parameters define the level of variety in the population of rigid genotypes. Given the tendency for some regression to the mean from any initial distribution of diversity, we focus on the parameter p_m , which determines the ongoing rate of mutation, as a more controlled way to manipulate the level of genotypic diversity.

In Table 1 a full set of experiments is reported.[5] In this table, the average fitness values over 1000 simulation steps are reported. Further, the reported values refer to

[5] While the results presented here provide extensive analysis of this parameter space, given space limitations, a technical appendix is available from the authors that provides supplemental analyses examining the robustness of the results to the non-focal parameters.

averages over 100 independent runs. In addition to the set of parameters defined above the configurations reported in Figure 1 are replicated at three levels of complexity, *K*. In contrast to other analyses based on the *NK* framework (Ethiraj & Levinthal, 2004; Lenox, Rockart, & Lewin, 2010; Levinthal, 1997; Rivkin, 2001; Rivkin & Siggelkow, 2003), the results are not terribly sensitive to the value of *K*. These other studies consider the organization as being composed of a single N-tuple. In contrast, here the organization is comprises a set of *W* N-tuples that are subject to a process of differential selection as well as change at the level of the individual level of behavior. As a result, the aggregate behavior is less subject to the pathology of being trapped the characteristics of a particular "starting point".

The trend defined by the intensity of mutation p_m indicates that a moderate degree of genetic robustness is indeed functional to superior selection processes especially when plasticity is absent. Nonetheless, greater mutation magnitudes have neutral or negative marginal impact.

To gain more insight on the role played by plasticity and selection, we set at K and p_m at intermediate levels, K equal to 3 and p_m equal to 0.025, and observed the average fitness levels. In Figure 2, these performance values are reported over a set of 100 independent runs obtained by varying the random seed for each run of the simulation. Given this sample of 100 organizational histories, also reported in Figure 2 in addition to the mean value, is the 95% confidence interval level of the range of realized values.

<u>Insert Table 2.1 and Figure 2.1 here</u>

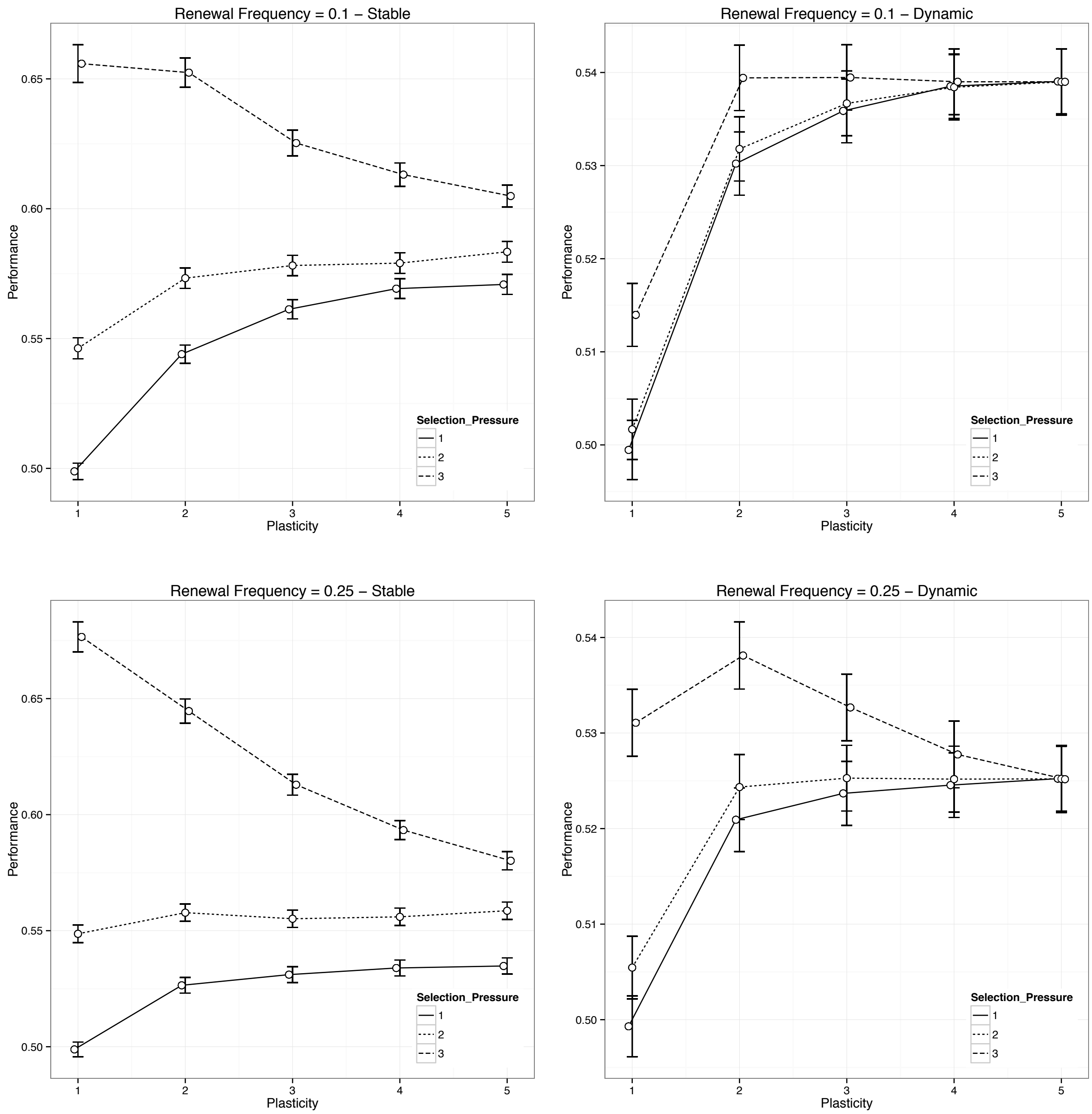
The results reported in Figure 2 clearly indicate that in stable settings plasticity and selection pressure are substitutes. In fact, when selection pressure is greater, higher plasticity is dysfunctional, whereas when selection pressure is lower or absent plasticity produces a beneficial effect. Moreover, if the frequency of renewal of the internal selection environment is greater this substitution effect is less symmetric and differential selection among relatively inert behaviors becomes the most effective mechanism of adaptation. High levels of plasticity obscure the force of differential selection. With frequent renewal/selection events, it is more effective for the behaviors remain inert and provide a stable and reliable basis for differential selection. In more dynamic environments, this main effect holds but tends to attenuate. Moreover, in this setting, a modest degree of plasticity is beneficial even in the presence of higher selection pressure especially if the renewal frequency is lower.

In supplemental analyses, the focus was shifted to identifying the configurations with maximal performance. These results, summarized in Figure 3, highlight that even in rapidly changing settings the level of plasticity associated with maximal organizational performing configuration of parameters guiding the intra organizational evolutionary dynamicss require minimal plasticity when the environment is more dynamic, or full rigidity when the environment is stable. Across a wide range of settings, a moderate tendency to mutate and maximal selection pressure are associated with maximal performance.

<u>Insert Figure 2.2 here</u>

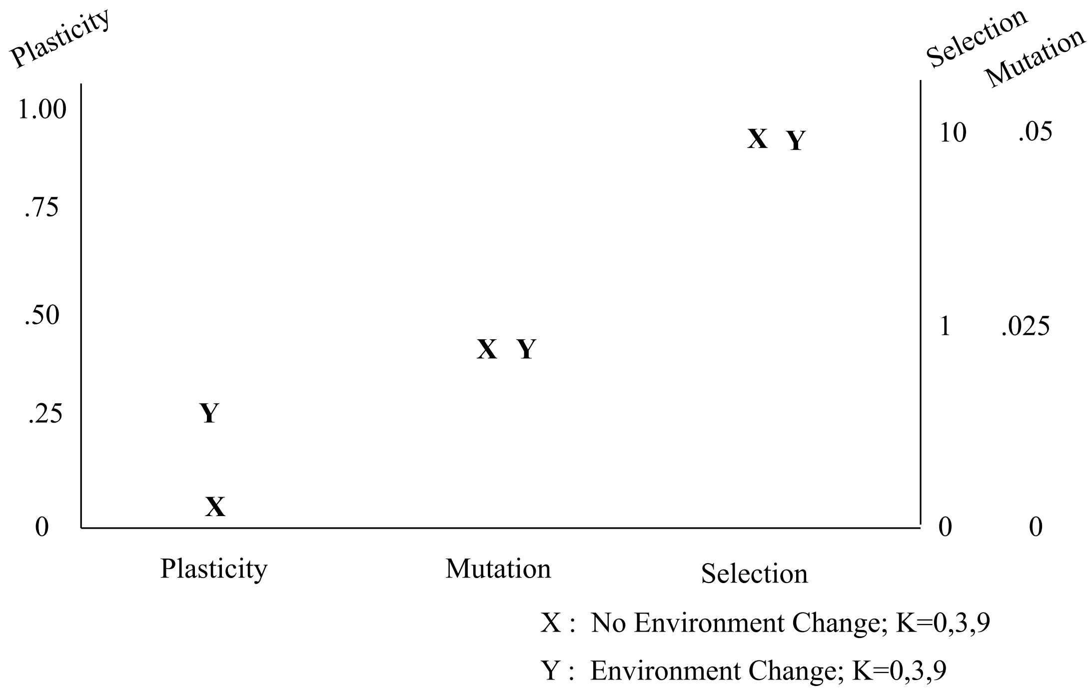
2.3 Figures

Figure 2.1 Graphical Summary of The Simulation Results



NOTES: The graphs report the averages performance over 100 independent runs. The vertical bars indicate the 95% confidence intervals. For each graph K=3, Random Mutation Probability = 0.025. On the x-axis prgressive numbers from 1 to 5 indicate levels of [0, 0.25, 0.5, 0.75, 1] of plasticity respectively.

Figure 2.2 Configuration of Maximal Performance



2.4 Tables

Table 2.1 Simulation Results

Renewal Frequency	Environment	K	Mutation															
Selection						***NO***					***1***					***10***		
Plasticity				***0***	***0.25***	***0.5***	***0.75***	***1***	***0***	***0.25***	***0.5***	***0.75***	***1***	***0***	***0.25***	***0.5***	***0.75***	***1***
0.1	***0***	0	***0***	0.502	0.524	0.538	0.545	0.551	0.535	0.550	0.559	0.559	0.550	0.565	0.586	0.584	0.581	0.550
			0.025	0.498	0.525	0.539	0.546	0.552	0.534	0.553	0.557	0.555	0.551	0.617	0.615	0.599	0.581	0.551
			0.05	0.499	0.525	0.538	0.546	0.552	0.523	0.545	0.552	0.552	0.550	0.598	0.601	0.591	0.575	0.551
		3	***0***	0.501	0.543	0.560	0.569	0.571	0.545	0.588	0.587	0.584	0.584	0.585	0.620	0.613	0.605	0.605
			0.025	0.499	0.544	0.561	0.569	0.571	0.546	0.573	0.578	0.579	0.583	0.656	0.652	0.625	0.613	0.605
			0.05	0.498	0.544	0.560	0.568	0.571	0.525	0.563	0.573	0.579	0.577	0.630	0.632	0.615	0.609	0.601
		9	***0***	0.500	0.560	0.572	0.576	0.580	0.561	0.580	0.589	0.592	0.587	0.599	0.616	0.606	0.606	0.601
			0.025	0.500	0.557	0.572	0.578	0.580	0.523	0.569	0.577	0.584	0.590	0.636	0.622	0.613	0.608	0.601
			0.05	0.499	0.557	0.572	0.576	0.579	0.511	0.565	0.576	0.580	0.584	0.600	0.604	0.600	0.605	0.605
	0.005	0	***0***	0.500	0.517	0.521	0.522	0.523	0.500	0.517	0.520	0.522	0.523	0.502	0.519	0.521	0.522	0.523
			0.025	0.500	0.517	0.521	0.522	0.523	0.501	0.517	0.521	0.522	0.524	0.508	0.524	0.525	0.525	0.523
			0.05	0.500	0.517	0.521	0.522	0.523	0.501	0.518	0.521	0.523	0.523	0.510	0.525	0.526	0.525	0.523
		3	***0***	0.500	0.530	0.536	0.538	0.539	0.500	0.532	0.536	0.538	0.539	0.499	0.532	0.537	0.539	0.539
			0.025	0.499	0.530	0.536	0.539	0.539	0.502	0.532	0.537	0.538	0.539	0.514	0.539	0.539	0.539	0.539
			0.05	0.500	0.530	0.536	0.538	0.539	0.502	0.532	0.536	0.539	0.539	0.516	0.540	0.540	0.539	0.539
		9	***0***	0.500	0.542	0.547	0.549	0.549	0.500	0.542	0.547	0.549	0.550	0.501	0.544	0.548	0.549	0.550
			0.025	0.499	0.542	0.547	0.549	0.549	0.502	0.543	0.547	0.549	0.550	0.516	0.547	0.549	0.549	0.549
			0.05	0.499	0.542	0.547	0.549	0.550	0.501	0.542	0.547	0.549	0.550	0.514	0.546	0.548	0.550	0.549
0.25	***0***	0	***0***	0.502	0.516	0.520	0.522	0.523	0.536	0.546	0.544	0.535	0.523	0.568	0.577	0.570	0.558	0.522
			0.025	0.501	0.516	0.520	0.523	0.523	0.540	0.545	0.541	0.532	0.523	0.624	0.610	0.590	0.561	0.523
			0.05	0.501	0.516	0.521	0.522	0.523	0.527	0.536	0.533	0.529	0.523	0.604	0.595	0.579	0.558	0.522
		3	***0***	0.500	0.525	0.533	0.532	0.537	0.560	0.562	0.560	0.563	0.555	0.599	0.597	0.589	0.589	0.579
			0.025	0.499	0.526	0.531	0.534	0.535	0.549	0.558	0.555	0.556	0.559	0.677	0.645	0.613	0.593	0.580
			0.05	0.499	0.526	0.532	0.534	0.535	0.528	0.545	0.548	0.550	0.550	0.643	0.620	0.601	0.595	0.582
		9	***0***	0.500	0.537	0.542	0.542	0.546	0.561	0.560	0.564	0.560	0.560	0.600	0.596	0.594	0.584	0.582
			0.025	0.499	0.537	0.542	0.544	0.545	0.526	0.549	0.552	0.557	0.558	0.649	0.611	0.602	0.600	0.587
			0.05	0.499	0.537	0.542	0.544	0.546	0.513	0.542	0.548	0.553	0.556	0.610	0.588	0.586	0.591	0.581
	0.005	0	***0***	0.499	0.511	0.513	0.513	0.514	0.500	0.511	0.512	0.514	0.514	0.500	0.512	0.513	0.514	0.513
			0.025	0.499	0.511	0.512	0.514	0.514	0.502	0.513	0.514	0.514	0.514	0.517	0.524	0.523	0.518	0.513
			0.05	0.499	0.511	0.513	0.513	0.514	0.503	0.513	0.514	0.514	0.514	0.521	0.527	0.524	0.520	0.513
		3	***0***	0.500	0.521	0.524	0.525	0.525	0.500	0.522	0.523	0.525	0.525	0.500	0.522	0.524	0.524	0.525
			0.025	0.499	0.521	0.524	0.525	0.525	0.505	0.524	0.525	0.525	0.525	0.531	0.538	0.533	0.528	0.525
			0.05	0.500	0.521	0.524	0.525	0.525	0.504	0.524	0.525	0.526	0.525	0.533	0.540	0.532	0.529	0.526
		9	***0***	0.500	0.530	0.533	0.533	0.534	0.501	0.530	0.533	0.534	0.534	0.501	0.531	0.533	0.535	0.535
			0.025	0.500	0.530	0.533	0.534	0.534	0.505	0.532	0.534	0.534	0.534	0.534	0.539	0.538	0.537	0.535
			0.05	0.499	0.530	0.533	0.534	0.534	0.504	0.531	0.533	0.534	0.534	0.528	0.538	0.537	0.537	0.534

3 ADAPTATION UNDER INSTITUTIONAL PRESSURES

Alessandro Marino and Andrea Prencipe

One of the most important characterizations of institutional theory consists in the identification of a set of forces that could generate isomorphism across organizations: firms tend to adopt similar forms, procedures, and practices under the effect of a set of social forces (DiMaggio and Powell, 1983). The main characteristic of these *institutional forces* is in their underlying main goal: gaining legitimacy within a certain field whose boundaries tends to be socially defined. Legitimacy may be gained under coercive, normative, or mimetic forces (DiMaggio and Powell, 1983). Within this theoretical stream, a variety of empirical studies found that attaining legitimacy is connected with efficiency gains either temporally – e.g. Tobert and Zucker (1983) – or simultaneously – e.g. Kennedy and Fiss (2009). Echoing Tobert and Zucker (1983), Westphal et al. (1997) argued that whereas early adopters customize administrative innovations for efficiency gains, late adopters follow mimetic processes for legitimacy purposes. Using framing theory, Kennedy and Fiss (2009) extended this line of work and found that economic and legitimacy motivations co-exist and simultaneously inform adoption decisions. In other words, organizations will tend to converge in their forms because of their common membership in the field under the pressure of legitimacy and as a result of a cost-benefit strategic decision process.

On the other hand, a pure efficiency reasoning is in line with such research traditions as evolutionary economics and the capability-based view that maintain that upon the pressure of technical forces linked with goals of efficiency and productivity, organizations tend to develop *polymorphism* as opposed to *isomorphism*. Both evolutionary economists and supporters of the capability-based view maintain that organizations either develop or possess unique non-imitable traits that shape their form and influence their performance (Nelson & Winter, 1982). Several empirical accounts indeed showed that organizations may be able to achieve and maintain a sustainable competitive advantage – a fact that suggests the emergence of distinct morphologies as per their different ability to determine organizational performance (Dosi & Marengo, 2000). Therefore, to date, the contrast between institutional theorists and strategists leaves an open theoretical question as to whether organizations that are exposed to strong pressures to gain both legitimacy and technical efficiency tend to develop in either isomorphic or polymorphic way.

Indeed, further studies on institutional dynamics indicate a promising direction to solve this tension. In fact, whereas in its original formulation institutional theory refers to a generic tendency to adopt common practices within organizational fields, successive studies stressed that given a commonly adopted practice the actual organizational responses and subsequent related behavior may largely diverge across organizations. Ruef and Scott (1998) underlined the importance of defining a multidimensional approach to investigate diversity in legitimation processes. Similarly, Oliver (1991) stressed that organizations may generate alternative responses to institutional processes and identified a set of typical reactions that occur within organizations when a practice is introduced under institutional pressure. These reactions differ, ranging from a pure acquiescence to a defiance of the incoming practice. For the purpose of this study, it is important to stress that this variety in reactions to the introduction of a new practice is likely to shape very different behaviors associated with the same practice adopted by different organizations. Take two organizations that react very differently to the adoption of a code of conduct for corporate social responsibility. Organization A may absorb the code by proactively adjusting its internal behavioral norms to reflect the prescriptions reported in the code. Organization B may undertake avoidance mechanisms that disguise nonconformity but allow the organization to gain legitimacy in the field. In such a scenario, the isomorphic tendency occurs only at the level of the adopted practices, but not with respect to the actual organizational behavior. In sum, these studies have implicitly suggested that indeed what is similar across the organizations is the tendency to adopt a certain practice but not how the practice is then concretely executed by the organization – an argument certainly against the existence of behavioral isomorphism.

Yet, while prior studies have defined a rich set of alternative organizational responses to similar institutional pressures, the underlying organizational mechanisms that generate such divergent responses have been left largely unexplored. Specifically, prior empirical studies that explored this misalignment provide little details on the dynamics that allow organization to absorb institutionalized practices. Westphal, Gulati and Shortell (1997) acknowledged the existence of a temporal gap between customization and conformity in regard of the adoption of TQM practices. They found an increasing tendency to conform for late adopters in comparison with pioneers, which displayed greater customization. However, their measure of conformity provides little understanding on the actual behavior that is linked with the adoption of an institutionalized practice as it refers to the number of different sub-practices adopted by an organization with respect to the complete TQM package. Similarly, Lounsbury (2001) in his study on staffing variation in schools highlighted the existence of a relationship between institutional pressure and organizational practice focused on a very specific organizational area. In sum, the mechanisms through which organizations adopt and / or modify their routines in conjunction with external pressures is to date a largely unexplored issue. This aspect keeps the puzzle at the base of this work substantially unsolved. In fact, should these different patterns of organizational reactions be similar within fields then would isomorphism still occur not only at the level of practice adoption but also with respect to its actual behavioral execution.

The purpose of this work is to solve this tension by bridging institutional theory with organizational accounts on structural and cognitive inertia. Specifically, we maintain that to understand how institutional forces translate in actual organization behavior one has to investigate the adaptive dynamics that routines engage under these pressures to change. In fact, prior research (Nelson & Winter, 1982; other) has identified organizational routines as stable, idiosyncratic constraints that somewhat limit, or nullify, organizations' ability to conform to adapt and would suggest an inability to respond to external institutional forces.

To investigate these issues, we designed and conducted a field study. Adopting a qualitative study approach in lieu of quantitative empirical design is particularly appropriate to conduct the present work. In fact, disentangling complex relationship as an important strength of a qualitative theory building approach. Dougherty (2002) suggests that "qualitative analysis characterizes [the] intricate webs [of causes, effects, processes and dynamics] so we can appreciate what a phenomenon is really like in practice, how it works and how it is affected by other patterns in the organization." Specifically, we conducted an in-depth analysis of a single case study by focusing on a medium-sized chemical firm probing into conflicts between institutional pressures and routine persistence to explain the underlying mechanisms related to the adoption of Information and Technology-based systems (hereinafter IT) vs. quality certifications (herein also called TQM systems), such as ISO9000. It is important noting that these two initiatives drastically differ based on the role that the goal of legitimacy plays in each set of practices as the former (IT systems) are initiatives that have a somewhat limited impact on the firm's level of legitimacy in the field whereas the latter are purposefully promoted for legitimacy reasons. More in general, we refer to pure institutional forces (hereinafter *institutional forces*) for which, regardless of the relevance of the technical reasons, the main driver of the practice adoption is associated with legitimacy reasons, and initiatives that are promoted for technical reasons and that have limited or absent legitimacy intention (labeled as *non-institutional forces*).

We argue that this contrast is crucial to develop an in-depth understanding of the mechanism whereby routines evolve by jointly translating external forces into actual behavior. Following exposure to institutional forces, established routines tend to persist to the extent that organizational actors develop a parallel behavior that is specifically functional to comply with the institutional rules in order to achieve the goal of legitimacy. Oliver (1991) defined this behavior as *concealing* in that organizations de-couple formal practices to comply with institutional forces from operational routines that keep informing actual organizational behavior. While our case study organization adopted the full 'safety and security certification'– and indeed ultimately translated this into an operational routine, they concealed other certifications – they formally complied with them, but kept their previous operational routines alive. Simply put, the organization reacted to these forces by selecting in or out the proposed practice into the actual behavior. Conversely, we found that the non-institutional IT-based tools were smoothly adopted to the extent that they informed the development of new operational routines. Oliver (1991) defined this behavior as *acquiescence*.

In sum, our main findings suggest that external pressures differ in their impact on the actual organizational behavior patterns – i.e. organizational routines – due to their inherent nature and, in particular whether these pressures are generated by what we termed as institutional or non-institutional forces. Our data reveal the mechanisms through which institutional and non-institutional forces stimulate either selective or plastic reactions of the existing organizational practices. More in general, the analysis of these emergent dynamics provides a general answer to our opening puzzle by supporting the existence of idiosyncratic firm-specific evolutionary outcomes across organizations exposed to similar institutional pressures.

3.1 Methods

3.1.1 Research Design

We use a case study because it combines multiple data sources to capture the interplay of diverse exogenous forces and organizational behavior (Yin, 1984). This research approach enables a detailed look at the dynamics at work in organizations undergoing change. Our research site, dubbed Alpha, is a world leading chemical manufacturer located in Italy. We chose Alpha as a "particularly revelatory" case (Eisenhardt & Graebner, 2007). Despite its dominant market position, Alpha's dimensions are moderate with about 120 employees and USD 150mln of turnover. We purposefully selected such a context to facilitate understanding of the phenomenon of routines dynamics under institutional pressures and abstract its general traits. As Smets et al. (2012: 878) contend, "organizational properties are important phenomena that influence how individuals experience institutional pressures and condition how practice improvisations extend to the field level". We posit that small and young firms as well as large ones are likely to be less suitable for this purpose. The former setting may embody a latent and informal evolutionary environment activated by the stamina of the management/entrepreneur who strives on daily basis to promote an efficient diffusion of the emergent best practices. On the other hand, in a well-established, large firm, the most visible morphology of the internal dynamic environment will likely refer to pre-determined and highly formalized knowledge management systems. In contrast, in a medium-sized firm in a growth stage both these families of internal evolutionary mechanisms are likely to be equally visible and discernable. In fact, such firms tend to experience several intermediate situations while passing from an unstructured family of practices – typical of a young organization – to a structured system, which will generally tend to prevail over time. For these reasons, this type of organization is particularly suitable for this inquiry. In this regard, the maintenance manager stated:

"Ours is an open system. It is not fully informal but we interact a lot and decide what to do. It is not fully structured as well. It's intermediate. This is not a multinational firm or a firm where I worked in which everything was formalized or a firm with ten employees. We are just in between." (Maintenance Manager).

Moreover, while some technological innovation in Alpha's production processes was introduced over the years, the main procedural blueprints have remained relatively stable. This aspect constitutes an interesting premise to investigate the evolution of behaviors under a moderately dynamic environmental setting with no major jolts that may alter the whole apparatus of patterned activities.

"We have improved from a technological standpoint all the basic processes. Well, in their essence they remained the same, but the accessories have been continuously updated. For example, in our latest plant investment plan, although we adopted some US patents, we used them to develop our own technology. I am talking about the new

hydrofluoric acid generator, which is composed by a fluidized bed reactor. This is not comparable with a brand new reactor generated by any other engineering firm, as it is the output of our own cumulated incremental experience. With our experience, we put together a sort of Formula one car, a competitive one. (Maintenance Manager)

3.1.2 Data Collection

We drew upon three data sources – observation, personal interviews, and archival materials – to identify the firm's organizational routines, capture their features, and assess their selective or adaptive changes in response to exogenous forces. To collect data, the first author spent approximately one month in our research site between May and September 2010. The data collection process was pursued in two major time blocks to allow reflections and refining of the study underlying research questions.

While we focused on a single case study we developed a very deep knowledge on the existing intra-organizational dynamics. In fact, in the field, we had full access to the firm's archives of documents and partial access to an electronic data room including a variety of the firm's internal documentation such as presentations of completed projects, marketing materials, board meeting minutes, market analysis, etc. To facilitate access to this material, the top management gave instructions to an employee to help the first author search the database and extract the relevant sources.

While in the field the researcher was allowed to join business meetings and take ethnographic notes on a daily basis. The meetings to which he had access were mainly focused on sharing updates among the managers of different departments and were organized on a case-by-case basis with no specific pre-defined agenda.

In addition, the researcher interviewed each manager of the firm with responsibilities to coordinate other workers, including the top management team. Overall, he conducted 41 personal interviews. Each interview lasted from a minimum of 30 to a maximum of 73 minutes and was structured as an open-ended conversation with a semi-structured setup. All the interviews were tape-recorded using a cutting-edge technology that allowed the researcher to take "smart notes" while tape-recording the conversations. These notes have the feature that the researcher after the interview could listen to what the interviewee was saying while a specific passage of the notes was written by "tapping" electronic pen onto the special sheets of paper where the notes were taken. This technique has the interesting property that the notes are easily associable with each specific part of the conversation, thus allowing the researcher to reconstruct each part of the interviewing experience with precision.

Subsequently, all the audio files of the interviews were transcribed to electronic files, in conjunction with the other notes and relevant archival material. Thanks to the various and rich material collected, we were able to rely on a broad set of data, which allowed multiple data triangulations. The two authors jointly discussed all the collected data. According to the Gioia methodology (Gioia, Corley, & Hamilton, 2012), one of the scholars acted as the "devil's advocate", openly challenging the validity of the other's ideas. Facts and considerations were presented only when reaching a sound fit between the scholars' collective interpretation and the external sources' information. Specifically, once an agreement on the coding method was reached, the data were coded via an iterative method of subsequent analysis (Glaser, 2008). To code the data we used a dedicated software program that helped us generate detailed reports based on the subsequent coding layers. The coding iterations were defined as follows. In a first iteration, the first author coded the data based on macro themes to map the narrative dedicated to the aspects of dynamic evolution of organizational routines. Subsequently, a second wave of coding was conducted to understand the different angles of routines dynamicity under the pressure of institutional and non-institutional forces. Finally, a third round of codes refined the nature of the different categories and shaped the emergent dynamics.

Our main interest was to describe the mechanisms responsible for the evolution of the organizational behavior when stimulated under the pressure of diverse exogenous forces. More precisely, our focus was on the evolution of the organizational dynamic mechanisms (i.e. the ways in which the organization modifies its routinized behaviors), under the force of two relevant exogenous changes, namely, the massive introduction of the IT systems and the adoption of the quality certifications.

In this regard, during the interviews we managed to avoid retrospective call biases. In fact, our analysis relates to very recent events, due to the fact that both these exogenous forces were still highly active when the interviews were conducted, although they began operating in the firm at different periods of time.

The next sections describe the findings linked with the qualitative data analysis. The quotes reported, translated in English from the text of the interviews originally collected in Italian, are representative extrapolation of the coded material functional to the illustration of the related themes.

3.2 The Case Study

3.2.1 The Origins: Emergence and Dynamics of Organizational Routines

In an initial stage of development, namely between the late sixties, when the firm was founded, and the early eighties the organization developed its routinized behavior from scratch. In fact, the first generation of workers and managers had relatively little experience in the chemical industry as many of them had worked in the mining sector or in other unrelated industrial segments. This feature was key to understand the dynamics of the initial development of the organizational routines. The heterogeneity of personal experiences across workers made the emergence of shared and common patterns of activities particularly complicated. Conversely, the emergence of dominant behavioral routines was based on the mutual experiential knowledge exchanges occurring in dyads or small groups that were repeatedly working on similar problems. As a result of this initial evolving process, the patterns of collective activities tended to cluster on several relatively small organizational units.

"When I became manager, I had to adapt to my workers because they were ten and I was alone. I just wanted to keep following the directions of the top management and understand the workers at the same time. Everything went smoothly. Clearly, each of the

managers of the shifts had a personal method. These methods are now consolidated over the years and the managers can even hang out with the workers for dinner. But initially when Alpha moved its first steps things were much more complicated." (Plant Purchasing Manager)

The specific nature of these clustered routines was thus shaped based on the initial imprinting that each leader gave to the business unit for which she or he was responsible. Impressively, from the data, it emerged that over the years the map of these behavioral clusters has been extremely persistent. In other words, the various routines were preserved over time by a system of continuous mentoring across subsequent generations of leaders of each business unit, but among them it never emerged a clearly defined dominant form across business units.

"Keep in mind that many years ago when everything began, we had no mentors that could explain to us what to do and how to do it. We, the veterans, started up and we have learned all we know by ourselves. Now life is definitely easier as the more experienced people train the rookies. Now life is easier thanks to this mentorship system" (Plant Purchasing Manager)

While the mentoring process has proved to function properly to transmit the established procedures and activities across leaders, it is interesting to note how the introduction of incremental innovations promoted by the leaders was not as fluid. The managers found several obstacles to updating the transmitted routines as the workers built barriers to change with the purpose of minimizing their learning effort. As the plant manager stated:

"I don't like to impose orders to my employees, but you have to do what is needed in one way or another. You already have in mind what the goal is and you know what is the way to fulfill it. But people resist and you spend hours or days trying to convince to change their habits, thus losing a lot of time. Therefore, at a certain point to just impose a change and then explain why that was the best solution in retrospect. Of course sometimes I make mistakes. Perhaps, occasionally I have been to bossy by imposing a decision rather than creating consensus around that choice. The best scenario is when I am able to raise questions and doubts so that the workers come to the same conclusion and become more flexible." (Plant Manager).

In sum, the heterogeneous set of prior experiences that characterized the first generation of Alpha's managers contributed to defining a multifaceted and clustered map of organizational routines, which were superordinate with respect to the formal organization. These behavioral forms were persistently transmitted though subsequent generations of leaders via a well-established mentoring system. At the same time, they became deeply ingrained in content and space as they showed rigidities both to the dynamic impulses induced by the leaders to update their structure and to "cross-border" diffusion across business units.

Nonetheless, unlike the minor dynamic impulses individually promoted by the managers, more pervasive and intense forces activated by the top management resulted in reflection and revision on the structure of the consolidated clusters of practices. We focus on two major interventions: One is the massive diffusion of the IT systems that begun during the nineties and the second the quest for the standard certifications during the last decade. While both these set of initiatives were strongly promoted by the top management team, they drastically differ in their underlying goals. In fact, whereas the former was activated with a mere intent to improve the internal productivity, the latter was mainly promoted to conform to the industry benchmarks in order to gain legitimacy.
The next two sections provide a description of these mechanisms.

The Nineties: The introduction of IT systems

Since the beginning of the nineties, the firm started a process of diffusion of Information Technology devices and procedures, which was still ongoing when the analysis was conducted in 2010. The main goal was to use the IT systems to improve efficiency and reduce the risks associated with possible procedural mistakes. All the organizational areas were interested by this pervasive changing process as the IT systems have a full application both in productive units to set and monitor the equipment and plants and in all the administrative structures of the organization under different forms, such as an accounting software or databases to support the maintenance activities as well as the modules of business intelligence for managerial decisions. To efficiently manage the transition, an IT function was added to the organizational structure. This function was mainly composed by an IT person who was in charge of helping the workers understand and use the software and to interact with the external firms in charge of co-designing, installing and maintaining the apparatus.

Inevitably, the IT systems had a quite major impact on the organizational routines that were, at the time the IT started developing, already consolidated according to the evolution illustrated in the prior section. Among all the micro activities that were updated as a consequence of the introduction of the IT systems, a main area deserves special attention. Beyond the obvious impact on the rapidity and amount of the internal communication to and from other business units and with colleagues of the same department due to the introduction of emails, the IT systems represented a pretext to review each procedure and to try to understand whether or not the systems could help smooth some micro tasks or reduce the workload through an automatically performed task. This review process was a crucial driver of dynamism for the organizational routines as it resulted in dedicated analytic attention to processes and tasks that were usually executed without deliberation. Most importantly, during this review process,each routine achieved customized modifications while increasing the overall uniformity of behavior. Take as an example the five units consisting of the production shifts in Alpha, each with a distinct leader who promoted a different behavioral form while oriented toward the same goal. The activity of the IT manager was twofold. To identify specific needs of each sub-unit and to homogenize the procedures across units. A shift may privilege an electronic template to manage the shift records whereas another shift may prefer to operate an electronic scan of a pre-defined hand-filled form. Nonetheless, both the shifts needed to adopt a delivery procedure that was able to work timely when requested by the production process. As the IT manager stated:

"Before the introduction of the IT systems everything was different. A system drives you to run a common procedure and above all it forces you to adopt a common behavior. If you don't have a system you have plenty of different behaviors and only one of them is right. The others are just likely to be wrong. Take the production shifts. We have five teams with five leaders. When I had to write the formal procedures I had to interact with five different lines of thoughts. I had to negotiate and mediate, but eventually I was able to find a sort of common ground across them. In essence, they kept doing what they were used to doing but this rough common procedures had a substantial influence, for instance to reduce the risk of incidents at the plant or to improve the efficiency of the maintenance." (IT Manager)

Further, not only have the IT systems been considered by the organization actors as a very flexible innovation tool that could adapt to their daily activities, but given their plastic nature and the direct support of the new function, they have eventually been perceived as a set of tools that could help solve concrete operating problems. The pipeline of pending requests for specific functionalities or IT tools has quickly become quite long since the IT function was created. This aspect turned the employees from users into creators of the system itself and made IT a fully integrated part of the daily activity.

"If you have an operating problem you can usually solve it by putting your hands on the software. We first analyze the problem together and then we submit it to the IT person who will then try to make the system find a solution for us. If it is possible, the solution is found internally. Otherwise the software firm has to be involved to help modify the system and find a suitable solution" (Administration Manager).

In sum, the introduction of the IT systems had the purpose of increasing efficiency and control of the firm's daily activities. To fulfill this objective all the organizational routines had to be revisited and restyled. The IT systems was seen as a crucial tool to initiate a process of routines restyle aimed to increase daily productivity This two-way iterative adaptation process has become part of continuous development of routines and IT systems in parallel.

"I joined the firm when it was in transition from one system to another. Therefore, I was deeply involved in this change. However, since then, things have never stopped mutating. We have been refining the system in order to meet the needs of everyone in our department. We are slowly evolving by adding more and more parts in the management software. (Administration Manager)

The Two Thousands: The Quest for Certifications

During the first decade of the two thousands another major set of practices was introduced under the force of external institutional pressures. Specifically, the firm intended to get aligned with its competitors by introducing the standardized certifications protocols. In only few years, the organization has produced a consistent effort to obtain these certifications. Specifically, Alpha obtained the environmental management system certification (ISO 14001), the safety management system (BS OHSAS 18001), the quality management system (ISO 9001), the certificate of excellence (Certiquality) and the organization modeling system based on the act 231 for virtuous firms. As for the IT systems, the implementation of the projects was assigned to a newly generated organization function, specifically designed for this task. The structure of each certification was quite similar. A firm that intends to obtain a certificate needs to comply with a specific set of moderately loose guidelines "the manual" and needs to be prepared to pass the checklist evaluations that the inspectors conduct during the visits to the plant. The manuals include practices that have a potentially pervasive impact on various organizational routines. Simply put, two main areas of important impact were the operating procedures – i.e. those that refer to the typical productive operating activity, such as the routines to manage the chemical reactions – and the security and safety procedures designed to prevent and manage accidents.

In regard of the former, unlike what occurred for the IT systems, the interaction between the manual and the established routines clashed. In fact, the organizational routines, instead of becoming more plastic became more rigid and employees were skeptical when these routines conflicted with the prescribed practices.

"If we want to talk about methodologies that are in the manuals that don't refer to security systems I'd better not answer as I would be quite rude. I just don't believe it. I don't believe it, because where people have developed their experience there has always been a continuous improvement. We don't need these things. Of course if these certifications have created some jobs fine.

We write our own rules and we fully respect them. We are those who decide what to do and what to write in our manual. Therefore, I cannot delegate someone else to monitor what I do, unless I have to apply rules that are defined from a third party. If I drive a car, I need a driving license but if I make the Law in my house it doesn't make sense that someone else comes here to control what I do.

If I write that a plant can only run from 0 to 100, but then in order to achieve a contingent goal I run it at 102, no matter what the operating manual states. (Production Shift Manager)

Nonetheless, despite the strong and diffused skepticism regarding the adaptation of the manuals, all the certificates were successfully obtained. Moreover, the manager in charge of implementing the certification system was genuinely convinced that the manual had in fact a full application.

“I think I have a methodology that allows me to face the problems. I have been refining this methodology on a day-by-day basis. During the years I found a fruitful terrain to develop my analytic approach. When we introduced the quality certification systems, we really diffuse a management method around. It is a very structured method. Since we have introduced it, people cannot take shortcuts anymore to execute a certain task. If you take a shortcut, you certainly overlook something that you may have needed. This is crucial to achieve your goals.” (Quality Manager)

This co-existence of elusive or indifferent reactions on the one hand and successful compliance on the other is itself the result of a learned practice that the organizational actors mastered. Specifically, the organizational actors showed limited interest and involvement in the operating innovations introduced by the quality manuals, but they were able to meet the goal to obtain the certificates. This dual behavior was not developed without a cost as the *dress code compliance* with respect to the certifications required a quite deep knowledge of the formal manuals and a prompt reaction to the demanding inspective visits.

We all know very well that we need to know these rules and adopt a certain behavior. Because when an inspection comes, everyone of us does his or her best to behave; but, even if we fail the certification, we do what we do anyway.” (Production Shift Manager)

Clearly, as per the content of the operating routines, we observed that some inspiration or incremental change did occur. However, in their essence, the existing procedures persisted. As mentioned earlier, this persistence occurred as the top management placed substantial importance to the goal of mere compliance for the purpose of obtaining the certificate – a goal that was indeed achieved.

Conversely, the set of prescriptions that were dedicated to security and safety found an actual and supportive implementation. Specifically, the workers used the manuals to update and consolidate their security and safety procedures with proactivity and willingness. In this case, the points of view of the security manager and of the adopters were convergent.

"See, I have a rather limited experience as I have joined the firm only one year and a half ago. What I noticed is that in this period of introduction of this new certification, people were initially very reluctant to change. However, they then become much more convergent. I mean not only the managers, but also the workers. I have clearly seen that all these people were willing to improve our security procedures". (Security Manager)

"Talking about security manuals, I cannot be more compliant. I even put my helmet and glasses on when I shower! I am joking, but working in our plant is not a joke. Security procedures that we know are effective must be strictly followed and in other cases we have to keep studying hard to see what we can do to reduce the risks." (Production Shift Manager).

Unlike the case of the generic operating routines that were developed upon solid bases of practical knowledge cumulated over twenty years of applications, the security procedures interplayed with the guidelines imposed by the certificates by becoming more plastic instead of becoming more rigid.

3.3 Discussion

To date, it is still an open theoretical question as to how organizational routines evolve under the pressure of institutional forces. In this work, we focused on two alternative types of forces and investigated through a grounded theory approach the emergent dynamic mechanisms in a medium-sized firm. Specifically, we studied the impact of IT systems and quality certification on the ecology of internal routines that the firm developed since its origins. These two forces were purposefully investigated to distinguish between initiatives that were primarily driven by direct economic reasons, such as to increase efficiency and productivity by introducing IT systems, and by reasons mainly linked with the gain of legitimacy within the organizational field, as for the case of quality certifications.

While both these forces had an effect on organizational routines, not surprisingly we found that established routines tend to resist to incremental updates proposed by middle management (Dosi, Nelson, & Winter, 2000; Szulanski, 1996). In fact, routines tended to preserve their core essence during their transmission from one manager to another via a mentorship system. Moreover, they also showed resistance to minor changes proposed by the leaders during execution.

IT systems and quality certifications indeed altered the existing behavior in a very distinct fashion depending on the nature of the routines subject to change when the forces started operating. Specifically, IT systems rapidly and pervasively diffused within the web of existing behaviors. The procedures defined by the software and the rules developed in-house engaged a process of reciprocal revision that ended up in a successful adaptation. On the other hand, the guidelines defined by the quality manuals had an opposing impact on the operating routines and on the security and safety procedures. Regarding the former, the organization showed a marked skepticism and a substantial indifference with respect to the rules. Nonetheless, the workers produced a dedicated extra effort to both successfully complying with the rules on the surface and, at the same time, to substantially retain the existing habits, which were considered as superior practices. However, as per the security and safety procedures, the organization showed strong flexibility by substantially altering the existing procedure to comply with the quality manuals. In other words, while the organizational actors were strongly motivated to redesign the security and safety procedures according to the prescriptions of the quality manuals, they showed a marked reluctance and skepticism toward altering the existing operational procedures that referred to core processes such as production, marketing or sales. Moreover, not only did the organizational actors show marked proclivity to retain the existing operating procedures, but they also learned the rules contained in the manual and developed a compliant behavior only for the purpose of obtaining the certificate.

These findings are foundational for a more general emergent theoretical apparatus on routines dynamics under the pressure of institutional forces. We found that the goals underlying the introduction of an institutionalized initiative ultimately drive the adaptive dynamics of internal organizational routines. When the initiative is mainly introduced for economic reasons, as in our case occurred for the IT systems, the organization comply with this goal by becoming more plastic. When legitimacy is the main driver at the base of the initiative the organization's alignment to this main goal leads to a different adaptive mechanism. In fact, routines react either by strongly reshaping their essence or by building barriers in altering the design of well-established behavioral forms. Either way, the main organizational goal is achieved although, in this latter case, the organization does need to produce an extra effort to comply with the institutional manuals, but at the same time favors the retention of the existing behaviors.

This word offers an interesting contribution for management theories as it sheds light on the mechanisms through which organizations develop their behavior under the pressure of external forces. Although institutional theorists have predicted the tendency of the organizations to develop clustered isomorphic forms, our findings suggest that this phenomenon may only occur on the surface. In fact, as originally suggested by Oliver (1991), we theorize that populations of firms that adopt institutionalized practices fail to adopt common behaviors. Conversely, we found that depending on the goal setting underlying the adoption of the initiatives undertaken, based on higher content of legitimacy under pure institutional forces and lower under what we termed as non-institutional, organizations respond by activating different evolutionary mechanisms. As a consequence, we theorize that there exist two sources of variability that influence the behavioral evolution of an organization under the pressure of institutional forces. On the one hand, at the managerial level, the configuration of the system of goals will influence the contextual nature of the initiative in a continuum between pure institutional and non-institutional driven by the content of legitimacy. On the other hand, at the organizational level, existing routines activate alternative adaptive mechanisms based on the underlying goal of the initiative. Pure institutional pressures forces to internal routines to activate internal selective mechanisms, whereas non-institutional initiatives increase the level of plasticity of internal practiced that engage a process of mutual adaptation.

A more general consequence is that this plurality of firm-specific sources of variability, in contrast with the argument of isomorphism, suggests the occurrence of behavioral polyphormism across individual organizations, regardless of their membership to a certain field. In fact, organizations, when exposed to pressures to introduce identical practices, eventually generate a highly idiosyncratic set of reactions thus defining a rather unique path of behavioral development.

<u>Insert Figure 3.1 About Here</u>

It is worth noting that our focus is on the impact of exogenous forces on the redesign of existing routines, rather than on the variability in the adoption of new innovation systems that organizations display. In fact, while several prior studies have investigated how organizations differently interpret the adoption of IT systems

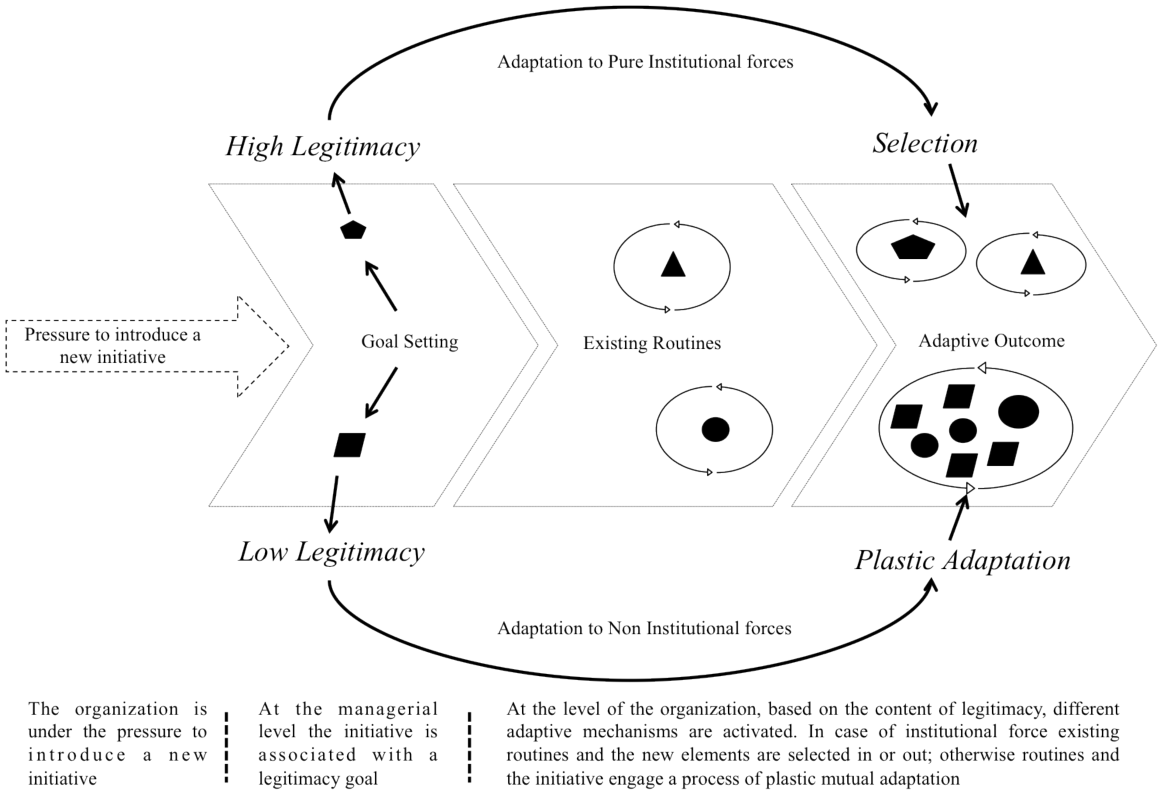
(Orlikowski, 2001; Orlikowski, 2000) or TQM practices (Westphal et al, 1997), we know precious little of the effect that these new systems have on the design of the existing organizational procedures. This distinction is subtle, but relevant. The former case refers either to the mere interpretation or sense-making that the organizations attribute to the new system, as for the case of TQM, or to the emphasis that different employees may display in the use of a different subset of functions than the IT systems allow. The latter points to the actual modifications in the existing procedures that these systems trigger once adopted.

Combining institutional theory and evolutionary perspective, our study also contributes to the research approach that – relying on Meyer and Rowan's (1977) idea of *decoupling* – looked at the interplay of intra-organizational dynamics and institutional changes (Smets, Morris, & Greenwood, 2012). Scholars investigated the influence of intra-organizational elements – such as interests and values (Edelman, 1990; Pache & Santos, 2010), "sense-making" role of occupational groups (Dobbin, 2009; Dobbin, 1992) – on the selection of organizational responses to institutional pressures. Our findings point out the nature of institutional forces – in terms of degree and content of legitimacy – as a key trigger of different organizational responses in terms of selective or adaptive behavior.

Should these elements find empirical support, they would represent a fruitful foundational terrain for further theoretical and empirical investigations on organizational adaptation and evolution.

3.4 Figures

Figure 3.1 Routines Dynamics Under the Pressure of Institutional and Non-Institutional Forces



4 DYNAMIC CAPABILITIES AND FIRM PERFORMANCE

Alessandro Marino

Organizations are complex compositions of elements such as people, projects, administrative structures, and rules (Cohen, March, & Olsen, 1972; Thompson, 1967; Weick, 1969). These heterogeneous elements may get recombined and may modify over an organization's lifetime, and so may the routines and capabilities that stem from them (Cyert & March, 1963; Nelson & Winter, 1982). Hence, adaptation entails the continuous reconfiguration of their related tangible expressions (such as artifacts or products). In the latest fifteen years, research on dynamic capabilities has investigated this phenomenon both theoretically and empirically. In this paper, the focus is on product adaptation as a specific subset of the larger domain of dynamic capabilities. More precisely, the focus is on the capacity of an organization to update, reconfigure, and develop its core products in order to meet the requirements of the changing environment (herein generally termed as *dynamic capabilities*). Indeed, the existing literature has considered product development as a key expression of an organization's dynamic capability (Danneels, 2002; Helfat & Raubitschek, 2000; Teece et al., 1997). Teece and Pisano (1994) define dynamic capabilities as "the subset of the competences/capabilities which allow the firm to create new products and processes and respond to changing market circumstances."

Researchers on dynamic capabilities identify and analyze the set of processes or capacities that enables the organization to reconfigure its resource base (Eisenhardt & Martin, 2000; Helfat et al., 2007; Teece et al., 1997). However, these authors are careful to be agnostic as to whether these capabilities are effectively beneficial for an organization. In fact, the definition of dynamic capabilities *per se* does not presume any wisdom or foresight as to which attributes are more or less valuable in determining future performance (Helfat et al., 2007). The present study attempts to identify the drivers that link an organization's dynamic capabilities with firm performance.

One important driver refers to the organization's level of prior experience in adaptation.[6] A strong consensus has emerged on the major role that adaptation experience plays in the continuous development of an organization's dynamic capabilities by increasing an organization's capacity to integrate, modify and extend its resource base. Helfat et al. (2007) characterize dynamic capabilities as a capacity to perform a repeatable and at least minimally reliable task. This implies that what distinguishes a dynamic capability from an ad hoc problem solving activity is the fact that the former entails some recurrent and enduring patterned actions. In the same spirit, Winter (2003) argues that these abilities are based on cumulative experiential learning. In other words, routinizing the organization's capacity to change favors future adaptive efforts. Therefore, these properties can be interpreted as capabilities in that they are learned, refined and cumulated over time by the organization. Similarly, Eisenhardt and Martin (2000) suggest that the learning processes at the base of dynamic capabilities are mostly repeated practice, past mistakes, and the pace of experience, whereas Zollo and Winter (2002) stressed the importance of multiple learning mechanisms for the genesis of dynamic capabilities. As a result, the concept of dynamic capability in and of itself

---

[6] Herein the labels prior experience in adaptation or adaptation experience are used interchangeably to refer to product adaptation experience.

suggests that a learning process is carried on by the organization to master adaptive behaviors or attributes. Experience allows the organization to store knowledge in patterned routines (Teece et al., 1997, p 520), which in turn enable the integration, extension, and reconfiguration of resources (Hargadon & Sutton, 1997; Helfat et al., 2007; Sull, 1999). Danneels (2008) defines dynamic capabilities as an second-order competence with respect to the purpose of learning new tasks. Therefore, instead of existing dynamic capabilities constraining their future expression, they are functional to their continuous development. In agreement with this view, Teece et al. (1997) posit that since the capacity to reconfigure and transform is itself a learned organizational skill – the more frequently it is practiced, the easier it is accomplished. In their study of alliances, Kale and Singh (2007) found that an experienced alliance function could boost future firm's alliance success by smoothing the errors in alliance learning processes.

Yet, to what extent dynamic capabilities developed by a long-standing adaptation experience will lead to superior firm performance at a specific point in time indeed depends on several contingent elements. On the one hand, alternative forms of adaptation experience may be differently relevant to this function depending on their fit with the task environment (Eggers, 2012). For instance, prior experience dedicated to adapting a specific subset of a product's components may be more relevant for future adaptations in that set of elements. However, in this work, the focus is on the most general expression of adaptation experience, which emerges from the past exposure of an organization to any type of changing event. The general expression of adaptation experience captures at the highest-level the notion of dynamic capabilities and reflects an enduring and robust capacity for organizational change. In other words, dynamic capabilities based on specific forms of experience are likely to be more functional for specific purposes of change. In contrast, those based on general prior adaptation experience have the interesting potential property that they are in principle independent of any particular task environment – an aspect that makes them potentially useful for adaptations of any kind. In sum, this research considers the role of a general prior experience in product adaptation (herein generally termed as *adaptation experience*) in influencing firm performance by developing a capacity to face any future product adaptation event.

On the other hand, other concurrent organizational factors may increase or reduce the value of adaptation experience depending on the characteristics of the task environment.[7] As noted above, critical to the concept of dynamic capabilities is the notion that adaptation can be interpreted as a process (or a procedure) that is understood, learned and refined. With respect to such mechanisms, it has been mentioned that adaptation experience plays indeed a major role. However, to fully understand the relationship between adaptation experience and firm performance, it is relevant to evaluate the intensity and nature of the recent adaptive activity that the organization has been undertaking. Consider an organization that has recently conducted an intense adaptation of a specific subset of product components A. Should the current adaptation task be centered on the same set of components A, the implications will be twofold. Firstly, the organization will rely on a set of adaptive capabilities that have recently been activated

[7] It is worth mentioning that firm performance are then also directly influenced by factors that are not directly related to the level of adaptation experience and dynamic capabilities such as the intensity of competition or the characteristics of the market demand (Helfat et al., 2007).

and maintained. In this regard, Helfat et al. (2007: 21) argue that "unlike in standard economic theory, capabilities often have the property that they function less well if they are not used. Capabilities incorporate the knowledge of individuals and teams of how to perform a task or set of tasks. Most knowledge that resides within an organization has the property that it is remembered by doing. Thus to maintain a capability and the knowledge that underpins the capability, an organization may need to use it". Secondly, this recent adaptation activity will capture a sense of flux and possible recent experiments and associated variety in the domain of technical elements that will need to be updated (i.e. components A). The amount of available technical solutions in an organization and their characteristics with respect to the environmental needs will then drastically influence the outcome of the adaptive process (Aldrich, 1999; Helfat et al., 2007; Makadok, 2001; Siggelkow, 2002). In sum, recent adaptation activity in domains associated with the current task environment (herein termed as *focal activity*[8]) may influence the adaptation outcome as it maintains relevant adaptive processes and stimulates the emergence of technical variety, which refers to the degree of heterogeneity in components, technologies, and in general all the technical elements that can be associated with a product's design.

Along these two dimensions of adaptation experience and focal activity four alternative complementary interactions can be defined. With the presence of adaptation experience a setting with greater concurrent level of focal activity will make the firm in

---

[8] As mentioned the term "focal" is both linked with the fit between the domain in which the adaptation activity has occurred and the domain of the ongoing change effort and with the temporal restriction for an immediately recent timeframe.

principle more adaptive, all other things being equal. Product adaptation experience provides crucial general guidelines for future product change whereas focal activity activates specific adaptation capabilities and stimulates technical variety. An organization may have a high level of recombinative (Kogut & Zander, 1993) or integrative (Brusoni et al., 2001) capabilities, but the impact of those capabilities depends on the “fodder” available for those recombinative or integrative efforts. In other words, adaptation experience allows the organization to design a change process based on solid foundations, but then the outcome of the process in terms of potentially suitable alternatives is larger with the presence of higher focal activity. Conversely, when the latter is low or absent, the organization is still knowledgeable on dynamic processes but the outcome may be suboptimal, as the adaptive process can generate a smaller set of potentially valid alternatives. On the other hand, when adaptation experience is weak, an organization with greater level of focal activity lacks solid adaptive guidance but it has activated processes that are in line with the present change effort and displays higher technical heterogeneity due to the recent adaptive activity in elements that are subject to current change effort. In the absence of both adaptation experience and focal activity, the adaptive process is naively designed with no specific guidelines and then executed in a relatively static and homogeneous organizational setting. See Figure 1 for a summary of the alternative states that a changing organization may display at a point in time based on its levels of adaptation experience and focal activity.

<u>Insert Figure 4.1 About Here</u>

Nonetheless, the concurrent presence of adaptation experience and focal activity does not necessarily produce net positive effects on firm performance. To fully capture the relevant facets of the phenomenon, an additional contingency has to be considered. An important distinction with respect to organizational adaptation efforts refers to the timing of adaptation (Ahuja & Katila, 2001), as the intensity of the changes needed may drastically vary at different points in time. Being adaptive is a property that has value when change is required. Elsewhere, the costs associated with dynamic capabilities and focal activity may outweigh the benefits (Helfat et al., 2007). In other words, depending on the magnitude of the changes in the environment, the sign of focal activity as a moderator of the relationship between adaptation experience and firm performance is likely to be different.

With the presence of fairly intense and rapid environment change, the co-occurrence of experience in product adaptation and focal activity tends to be synergic. In fact, in the case of a major adaptation effort, as the organization needs to quickly and drastically redefine its product, prior adaptation experience and focal activity will have mutually reinforcing joint effects. It has already been mentioned that the availability of recently maintained dynamic capabilities favors the execution of a prompt major adaptation effort (Helfat et al., 2007). Moreover, adaptation experience will be consistently more effective for the purpose of reconfiguring the existing product set if the organization has recently generated a high level of technical variety. In this regard, Iansiti and Clark (1994) highlight the finding that organizations with greater adaptation experience in product development generated superior performance in adaptation, which they termed *dynamic performance*, because of the superior capacity of these firms to integrate diverse knowledge bases. Consider an organization that displays considerable experience in changing the core characteristics of its products or services. In the event of an emergent need to redefine its main product, the company may find it useful to follow a specific sequence of actions to achieve the final goal, such as asking the marketing team to redefine the product specifications, submitting new functional blueprints to the production unit, and letting the marketing team test the prototypes and suggest incremental changes until a final version has been generated. However, this process will be effective if the marketing team – the department with the major responsibilities – is able to generate valuable alternative products plans in a timely fashion. This circumstance is favored if the marketing team has been developing in the recent past a heterogeneous set of different products and/or consistently different generations of similar products.

Heterogeneity will in fact increase the range of possible recombinations and redeployments associated with the team's dynamic capabilities. As suggested by Campbell (1960; 1982), variety is a crucial attribute that regulates the evolutionary mechanism. Rerup and Feldman (2011) show how routine evolution and learning unfold through heterogeneous trial and error processes. Other studies highlight that variety tends to favor organization learning (Cattani, 2005; Schilling, Vidal, Ployhart, & Marangoni, 2003). More specifically with respect to product adaptation, variety plays a central role by broadening the range of potential major reconfigurations that the organization can arrange within a narrow time horizon (Aldrich, 1999; Baum & Campbell, 1999; Fleming, 2001; Galunic & Rodan, 1998; Karim & Mitchell, 2000). Consider a company that adopts a new technology to produce a specific component. In the event that in a narrow time horizon the company needs to operate a major reconfiguration of the same component (or of a similar one), regardless of the company's prior product adaptation experience, the overall range of technologies from which it can reliably and promptly draw will have an enormous influence of its effective adaptive capacity. Take Apple as a concrete example. Since the launch of the iPod in 2001, the company has been able to achieve numerous successes by redeploying and recombining a consistent set of heterogeneous and innovative features that its products have developed across generations (e.g., the definition of the iPhone based on the new features developed for the iPod Touch and subsequently the production of the Ipad based on the combination of the characteristics of the iPod Touch and the new generations of MacBook).

Hypothesis 1 follows.

HP 1. All other things being equal, with the presence of higher environmental dynamism, the level of focal activity will positively moderate the relationship between adaptation experience and firm performance

On the other hand, a large set of studies on dynamic capabilities maintain that experienced dynamic capabilities not only are relevant in highly turbulent settings, but they also matter in moderately changing contexts (Eisenhardt & Martin, 2000). Helfat and Winter (2011) generalize this argument by highlighting that dynamic capabilities are developed regardless of the level of change that occurs in the external environment. Nonetheless, they note that the type of adaptive activities that are conducted is indeed different depending on the magnitude of the environmental changes. Unlike in a context of intense environmental change in a relatively stable setting, dynamic capabilities based on long-standing adaptation experience are likely to serve as enhancers of incremental fine-tunings to the existing set of resources. As a result, a recent adaptation activity will provide little beneficial maintenance for the purpose of incremental adaptation. Moreover, in a relatively stable setting, dynamic capabilities may efficiently drive incremental fine-tunings that follow a predictable path without benefiting from the presence of highly heterogeneous elements. In other words, technical variety associated with the presence of focal activity not only may not be needed but it may represents a source of unnecessary, distracting and costly experimentation (Drnevich & Kriauciunas, 2011; Ocasio, 1997; Zollo & Winter, 2002), as opposed to being a positive factor in exploiting existing operating capabilities. In sum, focal activity is expected to negatively moderate the effectiveness of product adaptation experience.

Hypothesis 2 follows.

HP 2. All other things being equal, with the presence of lower environmental dynamism, the level of focal activity will negatively moderate the relationship between adaptation experience and firm performance

4.1 Data And Methods

To test these hypotheses a longitudinal dataset in the Formula One (hereafter F1) racing industry was collected. The data trace the evolution of the technological developments that occurred in the whole population of F1 companies from 1981 to 2010. This time interval covers the entire "modern" history of the industry, as 1981 was the year the racing companies started developing their chasses in-house.

The F1 racing competition represents the pinnacle of the technological evolution in the sports automotive sector. A series of races take place during a yearly season in different circuits located worldwide. The races started during the 1920s in Europe but became popular worldwide after World War II. Until the 1970s, the F1 championship was attracting a limited amount of sponsorships. Subsequently, thanks to the growing visibility of the races (and the cars), F1 began to attract considerably greater resources. A major contributor to this development was the increasing television audience that the sport generated over time. The racing series provided a non-paralleled stage for advertisers, not only in traditional TV advertisements but also the opportunity to promote brands on the physical spaces at the racetrack, cars, and even on the racers themselves.

For the automotive companies involved in F1 racing the stakes associated with successful, or less successful competition in the racing circuit are quite high. First, the direct official prize money to the winners represents significant revenue for the F1 racing organizations. Second, the winners are able to generate a strong corporate image that may be exploited in adjacent markets through branding strategies. Third, the parent automotive companies that invest part of their budgets in the F1 cars may consider these investments large-scale R&D laboratories, given the intense efforts in technological developments that are required to compete successfully. The technological innovations are often imported back into the design and development production processes of the commercial vehicles produced for the mass market. Finally, the most successful F1 racing cars are able to attract much greater financial resources from their sponsors.

Apart from the central role played by activities associated with product development in this setting, this context offers a number of other attractive features. Unlike other business organizations, these companies operate in a very specific, controlled environment. In particular, the near-term shifts in the environmental setting that these companies may follow largely depend upon the sportive rules and technical regulations set by the institution that governs the F1 championship, the Fédération International de l'Automobile (FIA). This peculiar features allows for an explicit characterization of the nature and intensity of the evolutionary changes that these companies face. Consider the case of a major change in the technical regulations from one season to another. In such an environment, the companies must reconfigure themselves in order to adapt to the new rules in a very short time-frame. The changes in the regulations thus represent the shocks that modify the external environment in which these firms operate and trigger mechanisms of rapid adaptation.

Moreover, the articulation of the business cycle in this industry is particularly suitable for studying dynamic capabilities. In fact, Helfat and Winter (2011) warn that whether or not one is able to observe capabilities that promote change may depend on the granularity of observation as change typically fails to occur at regular time intervals. However, in F1 this general challenge is lessened as the seasonal structure of the sport sets apart moments of adaptive learning and reconfiguration of the main design. Specifically, the racing companies spend 3-4 months per year (typically from December to March) developing their new car model by adapting to the new regulations and pursuing their technological trajectories in their quest for enhanced performance. More precisely, the performance obtained in the prior years informs the decisions about which technical components to retain and reinforce and which to select out (e.g. a specific gear or breaking system or a set of aerodynamic components). On the other hand, during the championship season (typically from March to December), the teams focus on the intense exploitation of the existing cars that are taken as a given until a new model is developed. The enormous set of information collected during the sportive season then helps define the new car model evolution for the following season.

The data on F1 analyzed in the present work were collected from historical archives. The contemporary press releases of the official FIA regulations from 1981 to 2010 were invaluable for keeping track of the modifications that occurred in the technical regulations which constituted the external environment for the racing teams. To chart the technological development of each of the F1 racing teams, several secondary sources — mainly covering race accounts, commentary and elaborations of the specialized press and of scientific (and quasi-scientific) research articles — were analyzed. This effort was quite challenging because of the need to obtain a homogeneous set of information for a long time span. In addition, some companies did not leave a salient trace in the popular media. Among the sources containing relevant information were *Autosport Magazine, The Great Encyclopedia of Formula One, Who Works in Formula One 1993-2009,* and *Fomula One Technical Analysis 1989-2010.*

The resulting panel includes 345 team-year observations for a total of 49 racing companies over 30 years. The panel is unbalanced given that only a few F1 racing teams in existence in 1981 were able to survive the whole reference period. In addition, several teams were born subsequent to 1981. On average 10-15 teams were active each season. The dataset reported no missing values on the covariates for each team-year observation.[9]

4.1.1 Measures

Firm Performance. The dependent variable was calculated as follows. Initially, the best time per lap[10] obtained by the cars of each team — typically two cars for each team[11] — in each race of each season was collected. These values were then divided by each respective race's average time per lap across teams. To generate a scale that assigned higher values to better performers the reciprocals of these ratios were then

[9] Since many of the measures of the independent variables computed in the following analysis were based on variations between years, the observations related to the first year of each company's appearance were used only as initial reference points and did not directly enter the regression analyses. As a result, the sample used in the following analysis decreased to 293 observations.

[10] The time per lap is computed by dividing the total time obtained in a specific race by the number of laps completed.

[11] The cars produced by each team are almost identical at the beginning of each season, except for some minor customizations that are specific to each driver, such as the pilot seats. Then, in race after race, the differences across each team's car may increase as a result of diverging configurations in specific components.

taken. Therefore, this index assigns for each race a value higher than 1 to the teams that performed better (faster) than the average time per lap, and *vice versa*. Finally, the annual value of the variable for each team was computed by averaging across the races of the season.

To adjust for skewness of the resulting distribution, the STATA 11 procedure *bcskew0* was applied in order to obtain a Box-Cox transformation with lambda equal to 4.363.[12] The transformed variable fully satisfied the normality requirement. This measure was chosen and refined after several discussions with industry experts, and it is intended to best represent the performance of a team's technological potentials. Nonetheless, as robustness, several alternative measures of performance were tested, such as the average classifications of each car, the number of points obtained during the championship season and the average lap time obtained by each car for each race. All these measures were correlated with the measure used in the analysis and produced consistent results.

4.1.2 Independent Variables

The measures for the independent variables and the controls were coded using the archival materials. First, in conjunction with a panel of industry experts, a set of criteria were specified to code the degree of change in both the F1 cars and in the environment. The coding itself was carried out by three coders working independently. These individual coding outputs were compared and yielded a level of inter-rater agreement

[12] The resulting variable was obtained by calculating the following power expression: (performance^4.363-1)/4.363.

above 0.9. This result was largely expected given the high level of objectivity of the coding process. The few diverging values were carefully reviewed and the variables recoded after agreement was reached on the most appropriate evaluation. Three independent variables and three controls were obtained. The coding process was completed in a period of three months.

Change in the Technical Regulations. The intensity of the changes in the regulatory body was coded by capturing the disruptiveness of the changes imposed by the technical authority, the FIA, from one season to another. As a first step the body of rules was divided into six subareas that exhaustively represent all the possible topics associated with the full set of technical rules: chassis, engine, tires, mechanics, electronics and aerodynamics. In order to obtain a yearly measure of disruptiveness, the following procedure was conducted. A score of disruptiveness ranging from 0 to 3 was first attributed to the rule changes occurring in each subarea depending on the expected impact on the status quo. With the absence of any rule change in a subarea, a score of 0 was assigned. In case of a pool of more incremental changes in the regulations in an area that alters the status quo of a prior set of rules in a limited way, a score ranging from 1 to 2 was assigned. In case of major changes in the technical rules of an area, a score of 3 was assigned. To obtain an overall score of disruptiveness, the average of the scores associated with each of the seven subareas was then computed. These scores were obtained by analyzing the official technical regulations released by the regulatory authority on a yearly basis. To further double-check the actual expected disruptiveness of the technical rules, the comments that the specialized press published immediately after the communication of the new regulations were also considered. The tone and the emphasis of the experts were useful for capturing the more subtle characteristics of each technical rule. These articles were in general very detailed and provided clear evidence of the type of change that occurred in each year.

Adaptation Experience. The operationalization of this variable must incorporate the cumulative general experience in product adaptation that a company has obtained until period *t-1*. Therefore, the first step is to obtain an index of yearly level of generic change for each organization's products. The F1 racing organizations compete in the races by internally producing their own prototypes. Each subsequent generation of a car's model includes elements of discontinuity with respect to the prior prototype. However, the degree of dissimilarity may substantially vary across subsequent models. A measure of the degree of dissimilarity across subsequent prototypes (herein labeled d_{ik} for year t and company k) was obtained by reconstructing the history of each model of each car produced by each team after decomposing the car's components into the six subareas consistent with the areas for which the FIA regulations are defined: chassis, engine, tires, mechanics, electronics, and aerodynamics. More precisely, for each of these types of components the coders evaluated, on a scale from 0 to 3, the changes from one model of car to the subsequent model by adopting the following rules. An intermediate value was assigned for incremental modifications of the components, whether a technological fine-tuning (assigned a 1) or a more consistent adjustments (assigned a 2). A value of 3 was assigned in the presence of major discontinuity in the model of the car in comparison with the prior model. A grand index of change at the level of the team was computed by averaging across the values of change for each component of each new car prototype.[13] In the great majority of cases each team produced only one model of car each year. Situations when a team produced more than one model per year were accounted for by coding the changes operating in all the models for that year, comparing each model's components and the model's components of the prior year and taking the maximum across these values of technological change.

Because this index captured the differences from one model to the next, the very first model produced by each team in its history has been used as a reference point of observation. Nonetheless, this loss of data produced no relevant reduction in the statistical power.

The values of d_{ik} thus represent the intensity of the changes that a team *k* implements to its cars, typically in the periods between the end of each season and the beginning of the next, when a new model of car is presented (i.e., in year *i*). Accordingly, to capture the level prior experience in adaptation for each year *i* and organization *k,* the following expression was obtained:

$$AE_{ik} = \frac{\sum_{t=0}^{i-1} [\delta_{ik}]}{\Phi_i},$$

[13] As mentioned in the prior sections this work considers a general form of adaptation experience by cumulating each type of prior exposure of an organization to a change effort. Nonetheless, other forms of experience were tested, such as the prior adaptation experience on specific subsets of components, without obtaining any significant result in the analysis.

where AE_{ik} represents the cumulative product adaptation experience for year i and a company k, and d_{ik} is the average level of changes in the car produced by company k for year i with respect to the prior generation, and F is a discount factor calculated for each year i. [14]

Focal Activity. The level of focal activity refers to the recent adaptation activities operated in the set of components that are subject to change in the current year. Therefore, on the one hand, focal activity is reflected by the intensity of the changes occurring in the very latest product generation. Then, for the measure to capture the level of adaptation activity that is concretely functional to the adaptation efforts occurring at time i the following adjustment is required. Consider the six sets of components that define an F1 car (i.e., chassis, engine, aerodynamics, mechanical, electronics and tires). If, during the latest product development (i.e., at year $i-1$), an organization generated a higher adaptation activity in a group of subsets of components that are not subject to regulatory changes in the current year (i.e., at year i), then there will be little theoretical foundation as to why this adaptation activity can affect the relationship between adaptation experience and performance. For instance, there will be little plausible usefulness in displaying a very heterogeneous shelf of aerodynamic appendices if, for example, the organization has to design a completely new electronic gear control. For this

[14] As a baseline experience was discounted by a factor equal to the square root of the age of experience because it represents a gradual but nonetheless substantial decay in the organization's knowledge. Consistent with Baum and Ingram (1998) and Kalnins and Mayer (2004), a no discount factor provided similar results, whereas the extremes of linear and quadratic discount factor provided no significant results. This aspect suggests that adaptation experience depreciates at the moderate rate of the square root of age.

reason, it is important to compute the level of focal activity associated with the components subject to regulatory change. More formally, the following expression is computed:

$$FA_{ik} = \frac{\sum_{h=1}^{m} \alpha_{i-1,k}^{h}}{m},$$

where FA_{ik} represents the degree of focal activity for a generic year i and a company k, m is the number of types of components typically distinguishable in F1 (set to 6, namely chassis, aerodynamic, mechanical, electronics, engine and tires), and α_{ik}^{h} is obtained as follows:

$$\alpha_{i-1,k}^{h} = \begin{cases} \delta_{i-1,k}^{h} & reg_{i}^{h} > 0 \\ 0 & otherwise \end{cases},$$

where δ_{tk}^{h} is the level of changes occurring at year t in company k with respect to the set of components of type h and reg_{tk}^{h}, a discrete variable equal to 0(1) in case of absence (presence) of changes imposed by the regulations in year t for the set of components of type h.

4.1.3 Controls

To control for possible alternative time-variant variables, three controls were generated. The decisions to replace the drivers and the chief engineers were coded for each team-year observation (labeled as *Change Drivers* and *Change Engineers*, respectively). The intensity of these changes ranged from 0 to 2, with the value of 2 indicating the full replacement of the two-person team and a value of 1 for the replacement of a single driver. Moreover, for each year *i,* a variable labeled *Supplemental Development* was coded to capture the changes to the car that were not triggered by a technical regulation. This variable captures the extent to which an organization tends to proactively modify its cars with respect to the prior generations beyond the changes imposed by the regulations in year *i*.

Moreover, fixed effects for organization and year were introduced. In this setting, the importance of this technique is twofold. First, it produces standard errors that adjust for dependence due to repeated measures of organizations over time. In addition, it helps control for all stable characteristics of the racing teams. In this industry, each team can be easily associated with a specific group of organizations that share a common likelihood of success in the sportive competitions. Therefore, it is crucial to account for several team-level time-invariant characteristics, which may largely account for achieving average superior performance thus preventing the identification of the specific effects produced by the independent variables on firm performance (as previously mentioned in footnote 3). These variables include the average budget levels of the racing companies, the reputation and general capability of a team, which implies the ability to attract the best human capital available or more generally to collect the most valuable tangible and intangible resources. As a result, the introduction of team fixed effects is particularly appropriate to single out the differential impact of the central independent variables (adaptation experience, focal activity and changes in the technical regualtions) on the whole performance of the firm with relatively limited confounding effects.

Table 1 reports a summary of the main descriptive statistics and correlations associated with the dependent and independent variables and the controls.

Insert Table 4.1 About Here

4.2 Results

To test the hypotheses the following dynamic panel data model with fixed effects and three-way interaction development was defined:

$$Y_{i,k}=b_0+b_1Y_{i-1,k}+b_2AE_{i,k}+b_3FA_{i,k}+b_4AE_{i,k}FA_{i,k}+b_5CAE_{ik}CTR_i+b_6FA_{i,k}CTR_i+b_7AE_{i,k}FA_{i,k}CTR_i+b_8DR_{i,k}+b_9CE_{i,k}+b_{10}SD_{i,k}+G_k+F_i+e_{i,k} \quad (1)$$

with $i=1,\ldots,T$ (years); $k=1,\ldots,N$ (organizations); Y = Firm Performance; AE = Adaptation Experience; FA = Focal Activity; CTR = Changes in the Technical Regulations; DR = Change in the Drivers; CE = Change in the Engineers; SD = Supplemental Development; and G_i and F_t = organization and year fixed effects, respectively.[15]

Estimating equation 1 requires special attention for endogeneity, unobserved heterogeneity and reverse causality for the following reasons. Firstly, the presence on the

[15] Note that the main effect for changes in the technical regulations was omitted due to collinearity with the fixed effects.

right-hand side of a lagged value of the dependent variable and of the fixed effects gives rise to the dynamic panels bias by making the coefficients estimated by ordinary least square biased and inconsistent (Nickell, 1981). Secondly, the independent variables AE, FA, and CTR may not be purely exogenous as they can be correlated with the error terms in future time periods. Therefore, to account for these issues, a GMM estimator was used (Arellano & Bond, 1991). Specifically, since the persistence of the dependent variable could cause weak instruments problems the two-step System-GMM estimation technique was preferred to the Difference-GMM (Arellano & Bover, 1995; Blundell & Bond, 1998). This estimator treats the model as a system of equations in which the variables are instrumented with lagged variables. More precisely, by adopting a conventional approach reported in the Stata Module xtabond2 (Roodman, 2005), year dummies were treated as exogenous and used as instruments, the independent variables and the control as predetermined and the lagged dependent variable as endogenous. Due to the large number of panels the high resulting number of available moments conditions was a potential source of overfitting bias (Baltagi, 2005). Therefore, as suggested by Roodman (2005) the number of instruments was taken as close as possible to the number of groups. More precisely, it was selected the least number of instruments that were able to pass the Sargan test.[16]

[16] To reduce the number of instruments generated only one lagged period was considered for each variable's instruments (a lag distance of 2 periods for the variables treated as endogenous and of 1 period for the variables treated as predetermined). Moreover, the function *collapse* was used to generate one instrument for each variable and lag distance, rather than one for each time period, variable, and lag distance.

Table 2 reports the coefficients, significance levels, the number of instruments, the results of Wald, Arellano-Bond of type 1 and 2 and Sargan tests.[17] Models 1 to 4 refer to the four-step moderated regression analysis. For each model the Sargan test reports not significant coefficients thus indicating the presence of suitable instruments.[18] Similarly, the results of the Arellano-Bond tests indicate the absence of first and second order autocorrelation.[19] Step 1 is reported in Model 1, in which only the controls are included. The results show that a higher tendency to change the team of engineers is associated with higher firm performance. A positive trend in the performance is indicated by the positive and significant coefficient of the lagged dependent variable. In Model 2 (Step 2), where only the main effects of the independent variables are added, the results show insignificant coefficients for both the independent variables and the performance trend, thus suggesting the absence of a significant direct effect of adaptation experience on firm performance. In step 3 reported in Model 3, in which all the two-way interaction terms are included, the coefficients for the main effects and the interaction terms are not significant and the lagged performance coefficient drastically increases and shows significance at $p<0.1$. Model 4 is the fourth step dedicated to testing the hypotheses. This full model provides relevant findings as all the variables except for the intensity of the changes in the team of drivers report statistically significant coefficients. Most

[17] The robust standard errors were conventionally computed by applying the Windmeijer correction (Windmeijer, 2005).

[18] Recall that the Sargan test has a null hypothesis that the instruments as a group are exogenous.

[19] In the context of GMM estimation the AR(2) result is the more relevant test. In fact, applied on the residuals in first differences is used to detect AR(1) in the underlying levels variables. AR(1) is generally expected although in this analysis it is not detected.

importantly, the Model 4 shows that the coefficient of the three-way interaction term is positive and significant (B = 0.722, $p<0.05$). This element suggests the occurrence of a relevant moderation effect.

To gain more insight and probe the three-way interaction term, several additional analyses were conducted according with the conventional approaches (Aiken & West, 1991; Bauer & Curran, 2005; Cohen, Cohen, West, & Aiken, 2003). In Figure 2, the graphs report the 95% confidence bands, and the region of significance of the simple slopes between Adaptation Experience and Firm Performance at representative levels of the moderators Focal Activity and Change in the Technical Regulations.[20] The graphical analysis fully support the effects predicted in Hypotheses 1 and 2. To further assess the three-way moderating effects of both moderators, a supplemental table was generated. The values, reported in Table 3, clearly indicate that both focal activity and the changes in the technical regulations are relevant moderators of the relationship between adaptation experience and firm performance. More precisely, the figures in the table indicate that the role of focal activity as a moderator depends upon the intensity in the environmental changes according to the mechanism indicated in Hypotheses 1 and 2. It is interesting to note that with the presence of a stable regulatory body (see Figure 2, Panel a.), at very low levels of focal activity the simple slope between adaptation experience and performance is positive whereas it is increasingly negative as focal activity becomes larger. Conversely, when technical regulations change is intense the opposite holds. In

[20] Figure 1 reports the actual ranges of observed values of the moderator Focal Activity to show that the regions of significance do include those values.

fact, the sign of the simple slope between adaptation experience and performance is negative at lower values of focal activity and positive when the latter are higher.

Insert Table 4.2, Figure 4.2 and Table 4.3 About Here

4.3 Alternative Explanations

The results reported in the prior section indicate support for the hypothesis that the level of change occurring in the technical regulations plays a major moderating role in defining the most successful adaptation systems. However, one can question whether external shocks in this industry are in fact purely exogenous, thus raising doubts of possible alternative reasons that may explain some firms' performance variations. More precisely, one may conjecture that the nature of the changes in the technical regulations may favor certain companies and displace others for reasons that have no association with their focal activity. In this section, some possible alternative explanations are anticipated and examined using the qualitative and quantitative dataset.

A first broad alternative explanation is that the changes in the technical regulations may have contrasting effects on each organization. In other words, one could image that the technical rules may define a zero sum game with two possible states — in state s1, team A benefits and team B suffers, and vice versa in state s2. However, the qualitative data coded during this work show little evidence in support of this argument. Consider the possible areas of the car to which the technical regulations may apply: the aerodynamics, the overall design, the engine, the mechanical parts, the electronics and the tires.

The aerodynamic design refers to the parts of the car that generates the “downforce,” that is, the force that pushes the car down onto the track. This aspect is crucial when the car needs to follow a non-linear direction. The downforce prevents the car that is turning from spinning or losing speed. The overall design of the car refers to all the other specifics that cannot be classified as aerodynamic. For example, the chassis of the car is subject to regulations in terms of minimal weight required. The mechanical parts refer to all the elements that contribute to transforming the energy generated by the engine in motion — for example, the transmission, the gearbox and the braking system. Not all components of a F1 car are mechanical. A wide variety of technologies are based on sophisticated electronic devices that help the car (and the pilot) to control the processes that create motion. One example of sophisticated electronic technology is the launch control, which improves the ability of the car to react efficiently at the grid.

Table 4 reports the detailed account of the main changes in technical regulations between 2001 and 2009. The data show that the subset of areas to which the regulations apply is extremely variable in its composition and magnitude over time. Because of the complex nature of the F1 cars, any subsequent technical change that affects a different set of components of a following model will generate unique interdependent effects on the other cars’ components’ optimal set-up (Levinthal & Warglien, 1999; Rivkin & Siggelkow, 2003). These peculiar characteristics falsify the hypothesis of the existence of simple dichotomous states in the expected effects of each wave of technical rules. The most plausible scenario emerging from the observed phenomenon is that the subsequent waves of technical regulations generate a sequence of rather uncorrelated states – s1, s2, …, sn – in which each organization will define a highly idiosyncratic evolutionary path. To put it simply, although it may happen that at time 1 the regulator introduces rule A and then at time 5 reverses it, as a result of the multifaceted nature of the technical changes and the complex nature of F1 cars' prototypes, the characteristics of the world at time 1, s1, will largely differ from those at time 5, s5, with respect to each different team.

Insert Table 4.4 About Here

Although this section has shown that the nature of the changes in the technical regulations in combination with the characteristics of the F1 cars fails to produce straightforward effects on each team in each following wave of change, the regulatory authority may in fact purposefully aim to alter the status quo for the sake of a superordinate interest. More specifically, the technical regulations might be designed to either favor or penalize a specific subset of teams. The data show that the FIA mainly defined the regulations in pursuit of four ultimate goals: 1) increased safety; 2) increased entertainment; 3) reduced costs; and 4) increased revenues.

The first goal obviously refers to the adoption of the most advanced procedures and innovations to increase the pilots' safety. The history of F1 is sadly characterized by many fatal accidents that shocked the community of fans and practitioners.

The remaining goals are all related to economic issues. Specifically, the FIA strives to increase the number of overtakes during the races (instances in which a leader in the race is overtaken by another vehicle). Overtaking stimulates the audience's interest and increases the race's entertainment value. Moreover, it is in the interest of the FIA to keep the costs of the teams under control in order to increase competition. Finally, the regulator occasionally imposes specific physical modifications in the cars to enlarge the spaces dedicated to sponsorships with the goal of increasing revenues. The data reported in Table 5, which indicate the reasons behind each regulatory change, reveal a quite heterogeneous mix of rationales associated with the technical changes that occurred between 2001 and 2009. Although it is plausible to argue that the impact of the safety regulations and those oriented to maximize the sponsorships are substantially neutral across teams, the subset of technical regulations specifically designed to avoid situations where one company displays a robust and continuous leadership deserves special attention. These regulations may theoretically be designed to disrupt the advantages of one or more F1 companies in order to increase entertainment value.

To explore this issue, in Figure 3 the following indexes are plotted. The solid line represents the magnitude index of the technical changes, previously adopted as a regressor, whereas the dashed line refers to a concentration index of the organizations' performance, computed as follows. First, a normalized relative percentage ratio between each annual value of the index and the highest value of the index in the sampling period (1982-2010) was computed, thus obtaining a zero-one indicator. Then, an index of concentration of the teams' performance was calculated by adopting the following normalized concentration ratio C, for each season, t, included in the sample:

$$C_t = \frac{\left(\sum_{i=1}^{N_t}\left(\frac{x_{it}}{X_t}\right)^2 - \frac{1}{N_t}\right)}{1 - \frac{1}{N_t}},$$

where x_{it} indicates the performance of each i^{th} organization in season t, X_t is the sum of the annual performance of all the organizations in season t and N_t is the number of organizations in season t. Finally, the annual values of C_t were normalized by computing the ratios with the highest value of the index in the denominator. This comparison should help interpret the evolution of the technical regulations with respect to the general purpose of increasing the entertainment value of the sport by indirectly reducing the concentration of the performance distribution of the racing teams.

Insert Figure 4.3 About Here

The trends reported in Figure 3 suggest no systematic association between level of concentration in the teams' performance distribution and the magnitude of the external shocks. Nonetheless, a triangulation of this information with the qualitative data generated a more precise analysis of the more consistent shocks, which occurred in 1983, 1994, 1998, 2004 and 2009. The shock in 1983 was articulated with the purpose of defining the "rules of the game" of the modern F1 sport. Clearly, in this case there was no specific intent to favor or penalize any subset of teams, as they had all started developing brand new capabilities within a short period of time[21] and no leading team was dominating the scene. As shown in Figure 3, the shocks that happened around 1994, 1998 and 2004 were not preceded by periods of intense concentration in the sportive performance (although the concentration in the performance started increasing after 2000), and were mainly reacting to a few tragic fatal accidents in the mid-nineties by increasing safety.

On the other hand, the shock of 2009 may be classified as one that was purposefully intended to break a rapidly increasing concentration in the teams' performance, as shown in Figure 3. The content of this technical rule change, reported in detail in Table 4, which the experts judged as the most radical since 1983, mainly referred to the ban of some crucial aerodynamics parts of the car that constituted an important advantage for the teams that dominated the scene. Regardless of the actual effects that they generated for the leading teams, the presence of these changes fails to alter the validity of the empirical results, as they influence only one wave of observations in the set of repeated measures. In other words, they may only possibly generate spurious results with respect to the data collected in 2009. To check for the robustness of the results to this exclusion, the analysis was repeated by excluding the year 2009, obtaining no relevant variations in the findings for both the estimates of the coefficients and their statistical significance.

---

[21] From 1981 on, the racing teams began developing their chassis in-house.

In sum, in this section the nature of the changes in the technical regulations in F1 from 1982 to 2010 were investigated to show that although they may in at least one case be driven by goals that unequally penalize the racing teams, this consideration fails to substantially constitute a plausible alternative explanation for the study’s empirical findings.

4.4 Figures

Figure 4.1 Alternative Characteristics of a Changing Organization at a Specific Point in Time Given Different Levels of Adaptation Experience and Focal Activity

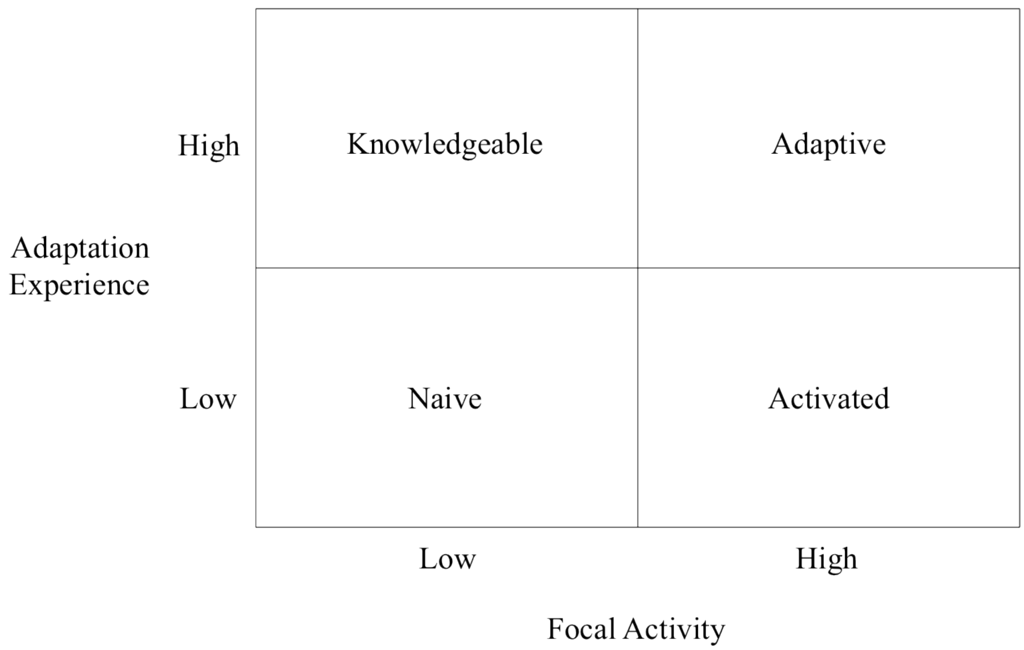
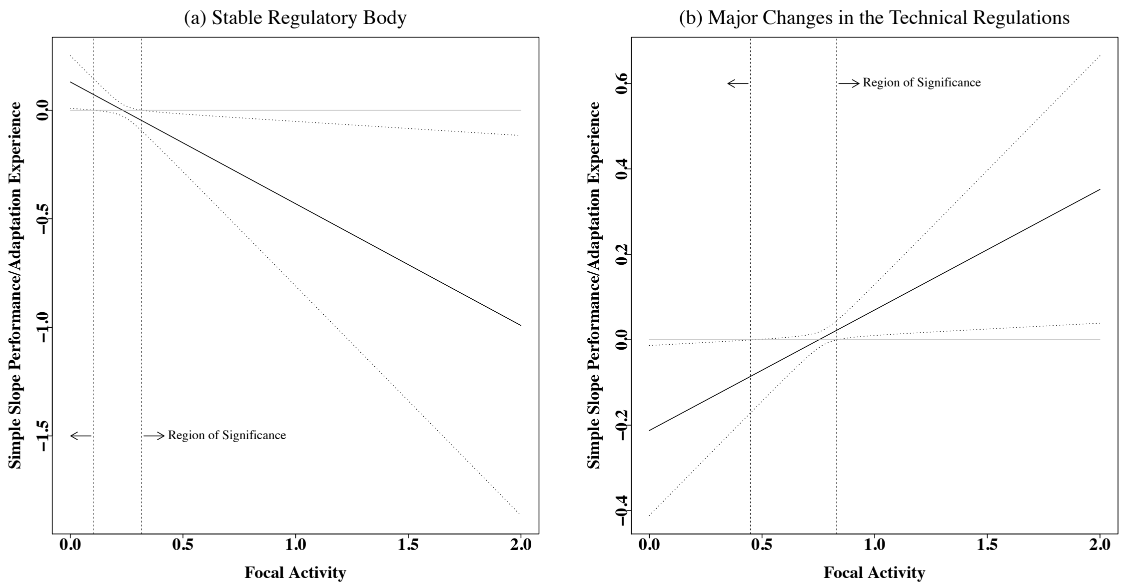
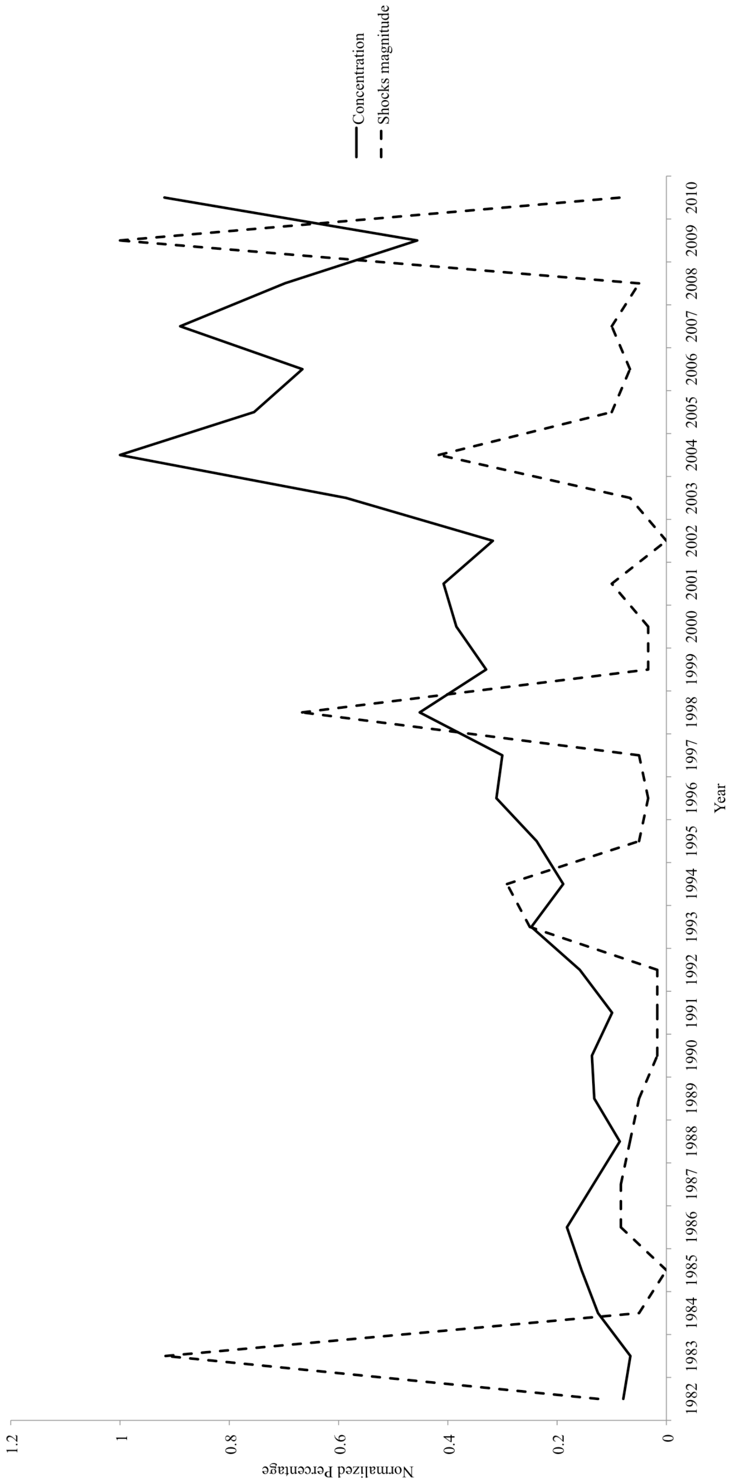


Figure 4.2 Three-Way Interaction Effect among Adaptation Experience, Focal Activity and Magnitude of Change in the Technical Regulations



NOTE: In each figure the y-axis indicates the simple slopes of the relationships between Adaptation Experience and Performance, whereas the x-axis refers to the level of the variable Focal Activity. Each graph reports the estimation lines, the 95% confidence bands within the range of the values of the moderator Focal Activity observed in the dataset (between 0 ad 2). Panels a and b refer to representative low and high values of the moderator Magnitude of Change in the Technical Regulations, respectively.

Figure 4.3 Comparison between Aggregate Concentration in the Formula 1 Teams' Performance and the Magnitude of Changes in Technical Regulations between 1982 and 2010



4.5 Tables

Table 4.1 Means, Standard Deviations and Correlations

Variable	Mean	s.d.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Performance	0.02	0.36	1						
2. Change Drivers	1.00	0.67	-0.17	1					
3. Change Engineers	0.62	0.73	-0.12	0.09	1				
4. Supplemental Development	0.77	0.43	0.07	-0.17	0.07	1			
5. Adaptation Experience (AE)	5.84	2.56	0.06	-0.09	-0.07	0.17	1		
6. Focal Activity (FA)	0.52	0.44	0.02	0.01	-0.01	-0.03	0.24	1	
7. Change in the Technical Regulations	0.62	0.46	-0.07	0.04	-0.01	-0.07	0.13	0.68	1

Table 4.2 Results of Two-Way System GMM Models Estimation

	(1)	(2)	(3)	(4)
Intercept	0.019** (0.007)	0.043† (0.025)	0.062 (0.073)	0.466* (0.233)
Performance_{t-1}	0.459* (0.228)	0.361 (0.301)	1.41† (0.86)	23.29* (10.31)
Supplemental Development	0.004 (0.006)	-0.001 (0.010)	0.051 (0.063)	0.543* (0.245)
Change Drivers	0.004 (0.003)	0.004 (0.003)	-0.011 (0.012)	-0.025 (0.015)
Change Engineers	0.006* (0.002)	0.008*** (0.002)	0.006 (0.056)	0.020* (0.009)
Adaptation Experience		-0.003 (0.002)	0.006 (0.011)	0.179* (0.084)
Focal Activity		0.004 (0.011)	0.347 (0.298)	3.921* (1.772)
Adaptation Experience × Focal Activity			-0.004 (0.006)	-0.681* (0.306)
Adaptation Experience × Change in the Technical Regulations			-0.015 (0.010)	-0.293* (0.138)
Focal Activity × Change in the Technical Regulations			-0.364 (0.290)	-4.06* (1.843)
Adaptation Experience × Focal Activity × Change in the Technical Regulations				0.722* (0.327)
Firm Fixed Effects	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES
Wald (χ^2)	18,397***	4,009.84***	5,416.64***	8,707.58***
# Instruments	36	45	54	48
AR(1)	-2.37*	-1.39	-1.28	-0.59
AR(2)	0.73	-1.16	-1.02	-0.51
Sargan	2.19	12.75	9.53	4.60

N =293; standard errors in parentheses; † $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4.3 Simple Slopes of Adaptation Experience on Product Performance at Various Levels of Focal Activity and Magnitude of Change in the Technical Regulations

	0	*0.25*	*0.5*	*1*	*1.5*	*1.75*	*2*
0	0.18*	0.01	-0.16*	-0.5*	-0.84*	-1.01*	-1.18*
0.25	0.11*	-0.02	-0.14*	-0.39*	-0.65*	-0.77*	-0.9*
0.5	0.03	-0.05	-0.13*	-0.29*	-0.45*	-0.53*	-0.61*
1	-0.11	-0.1*	-0.09*	-0.07*	-0.05	-0.04	-0.03
1.5	-0.26*	-0.16*	-0.06	0.14*	0.34*	0.44*	0.54*
1.75	-0.34*	-0.19*	-0.04	0.25*	0.54*	0.69*	0.83*
2	-0.41*	-0.22*	-0.03	0.36*	0.74*	0.93*	1.12*

NOTE: The table reports the simple slopes between Performance and Adaptation Experience at various combinations of levels of the moderators Focal Activity (Columns) and Magnitude of Change in the Technical Regulations (Rows). A star next to the reported values indicates that the simple slope is statistically significant at 95%.

Table 4.4 Detailed Account of the Main Changes in Technical Regulations Between 2001 and 2009

	Type of Change	Area of Change	Expected Consequences	Reason
2001:				
50mm increase in front wing height	Major	Aerodynamics	Reduction of the downforce – reduction of the car's speed	Increase entertainment (more overtaking) – Increase safety
New safety tests on chassis and new side intrusion requirement	Major	Mechanical	Increases in the cars' weight in some unwanted places and increase in the height of the centre of gravity – reduction of the car's performance	Increase safety
Reintroduction of the traction control to the F1 grid	Major	Electronic	Increase the control over the link between the driver's foot and the engine throttle to prevent any reduced-load tires from spinning	Increase equity across constructors
2002:				
High visibility rain light increased in size by 50%	Incremental	Design	Increase visibility	Increase safety
50% wider wing mirrors	Incremental	Design	Increase control	Increase safety
2003:				
Ban on traction and launch control	Major	Electronic	Ban of the electronic devices introduced in 2001	Cost reduction and increase entertainment
2004:				
Rear wing can only use two upper elements, and endplates are now 10cm longer	Incremental	Aerodynamics	Increase wing's efficiency	Increase revenues from sponsors (increase space on the cars to introduce sponsorship)
Engine covers are now mandated to extend to a specific height and width ahead of the rear axle	Incremental	Design	Little loss in flow to the rear wing and some negative effects when the car slides	Increase revenues from sponsors (increase space on the cars to introduce sponsorship)
No automated gearshifts and launch control	Incremental	Electronic	More responsibility for the pilots to control the car	Increase entertainment
One engine per driver per weekend	Major	Engine	Increase of the engine's reliability and consequent reduction of engine's power – reduction of the car's speed	Cost reduction – Increase entertainment

(Continued)	Type of Change	Area of Change	Expected Consequences	Reason
2005:				
Raise of the front wing, lower the diffuse tunnel height and move the rear wing forward	Incremental	Aerodynamics	Reduction of 25% of the downforce – speed reduction	Increase entertainment value
2006:				
New engines. From V10 to V8 of 2.4 liters	Major	Engine	Power loss and reduced fuel consumption and cooling	Increase entertainment value – Cost reduction
2007:				
Rear impact structure	Incremental	Mechanical	Increase the strength of the structure	Increase safety
Addition of slot gap spacers to the rear wing	Incremental	Aerodynamics	Slight reduction of the downforce and of the car's speed	Increase entertainment value
2008:				
Introduction of a single engine electronic control system	Major	Electronic	Reduction of the electronic controls in F1 through the adoption of a single standardized electronic system. Alters the car's power delivery	Increase entertainment value – Cost reduction
Gearbox life regulation (four race weekend)	Major	Mechanical	Increases the need for more reliable gearboxes	Increase entertainment value – Cost reduction
Specification of dimensions and weights of the gearbox	Incremental	Mechanical	Standardization of the gearbox's dimensions	Increase entertainment value – Cost reduction
2009:				
Introduction of KERS (Kinetic Energy Recovery Systems)	Major	Mechanical	Generation of supplemental energy for the braking system to be used to increase performance when needed	Increase entertainment value
Removal of all the aerodynamic add-ons	Major	Aerodynamics	Reduction of the downforce	Increase entertainment value

5 CONCLUSION

This section concludes by summarizing the main results of the three chapters and discussing the main contributions. The image of organizations as being driven by relatively stable routine-driven behavior and being the subject of competitive selection pressure at the population level is a theoretically and empirically powerful perspective. However, it is important to extend our evolutionary models at the organizational level in at least two dimensions. One is to incorporate the fact that considerable heterogeneity is typically present within an individual organization regarding organizational practices. In addition, it is critical in an evolutionary account to distinguish between the genetic encoding associated with a given practice and the expression of that practice in a given context. In at least a stylized manner, Essay 1 has introduced both these elements.

Organizational performance in a direct sense is a function of the realized behaviors in which the organization engages. What we termed as phenotypic plasticity has the virtue of allowing for a greater range of action. However, we observe that these dynamic organizations display reduced effectiveness in selecting their underlying genotypes. As a result, such organizations rely on an inferior set of standard practices. Thus, the basis of superior performance entails a tension between plasticity's positive rule in offering near-term flexibility in action and its long-term consequences for the quality of the underlying genetic basis of organizational practices. In a stable environment, the net effect of these forces is to favor intra organizational evolutionary dynamics in which the individual behavior patterns are relatively inert, but there is fairly intense differential selection among them. In dynamic environments, the tradeoff between the flexibility benefits of plasticity and its negative implications for the quality of the genetic basis of behavior shifts, with some degree of plasticity being valued; however, the ideal level of plasticity appears to be relatively modest.

The question of what constitutes the characteristics of an adaptive organization is quite naturally a central issue for management theorists who strive to understand the possibilities and pathologies of organizational change. In particular, the issue of the plasticity of organizations has surfaced in recent years within the strategy literature in the context of discussions of dynamic capabilities (Teece et al., 1997), stable properties of organizations that facilitate efforts at effective change, as distinct from firm differences in capabilities associated with current performance. Our findings show that plasticity for adaptation may not be evolutionary beneficial under specific conditions and, in particular, that plasticity reduces the selectability of the underlying, stable traits of the organization. In addition, the analysis points to the fact that in our interest as a field in considering the adaptive benefits of phenotypic plasticity, we have tended to neglect the role that genotypic diversity plays in fostering robustness. The mechanisms of variation-selection-retention put forward by Campbell (1965) do not rely on the adaptability of a particular component of organizational behavior but rather a basic Darwian process of differential selection. Mechanisms that support an ongoing level of internal variation, such as turnover, slack, and local experimentation, facilitate organizational adaptation in a manner quite distinct from the plasticity. It is important to recognize the role of variation in fostering overall organizational adaptation and the ways in which plasticity of lower-level elements may work against sustaining this diversity.

More generally, it is important to recognize that organizational adaptation is a collective property. As such, the implication of the adaptability of any particular facet of organizational behavior is, in general, ambiguous with respect to the adaptiveness of the collective. In this sense, to understand organizational evolution, one should keep the focus on the interrelated attributes of the (possibly) dynamic organization rather than on some specific subset of capabilities. Organizations are complex systems. Their robustness and adaptability is a function of the interplay of multiple factors guiding their evolutionary dynamics. Beyond the particular results or the model and analysis, the hope is that Essay 1 serves to highlight the importance of engaging the rich internal ecology of organizational evolution and to provide a useful conceptual framework for examining these issues.

To date, it is still an open theoretical question as to how organizational routines evolve under the pressure of institutional forces. In Essay 2, we focused on two alternative types of forces and investigated through a grounded theory approach the emergent dynamic mechanisms in a medium-sized firm. Specifically, we studied the impact of IT systems and quality certification on the ecology of internal routines that the firm developed since its origins. These two forces were purposefully selected to distinguish between initiatives that were primarily driven by direct economic reasons, such as to increase efficiency and productivity by introducing IT systems, and by reasons mainly linked with the gain of legitimacy within the organizational field, as for the case of quality certifications.

IT systems and quality certifications indeed altered the existing behavior in a very distinct fashion depending on the nature of the routines subject to change when the forces started operating. Specifically, IT systems rapidly and pervasively diffused within the web of existing behaviors. The procedures defined by the software and the rules developed in-house engaged a process of reciprocal revision that ended up in a successful adaptation. On the other hand, the prescriptions defined by the quality manuals had an opposing impact on the operating routines and on the security and safety procedures. Regarding the former, the organization showed a marked skepticism and a substantial indifference with respect to the rules. Nonetheless, the workers produced a dedicated extra effort to both successfully complying with the rules on the surface and, at the same time, to substantially retain the existing habits, which were considered as superior practices. However, as per the security and safety procedures, the organization showed strong flexibility by substantially altering the existing procedure to comply with the quality manuals. In other words, while the organizational actors were strongly motivated to redesign the security and safety procedures according to the prescriptions of the quality manuals, they showed a marked reluctance and skepticism toward altering the existing operational procedures that referred to core processes such as production, marketing or sales. Moreover, not only did the organizational actors show marked proclivity to retain the existing operating procedures, but they also learned the rules contained in the manual and developed a compliant behavior only for the purpose of obtaining the certificate.

Our finding suggest the existence of a relationship between the goal underlying the external forces that the organization experiences and the adaptive mechanism thorough which existing routines interplay with the dynamic pressures. Specifically, when the force is generated mainly for technical reasons – the non-institutional type – dynamic adaptation with existing practices is likely to occur. Conversely, if the legitimacy goal prevails the organization operates a selection either strongly in favor or against a substantial adoption of the practice.

Finally, in Essay 3 I investigate the evolution of a population of organizations from the initial development of the industry to the present day. The main goal was to study whether and under which environmental conditions product dynamic capabilities lead to superior firm performance. The findings complement and extend prior literature on adaptation experience and dynamic capabilities (Danneels, 2008; Eggers, 2012; King & Tucci, 2002) by showing that prior experience in product adaptation is predictive of higher firm performance only under specific circumstances. In fact, interaction analysis reveals that the level of focal activity and the intensity of the environmental change significantly moderate this relationship.

The data show that when the change in the environment is intense, the level of focal activity positively moderates the effectiveness of prior product adaptation experience. On the other hand, when the environment is stable, the sign of this moderation becomes negative. More precisely, in this data, the analysis suggests that product dynamic capabilities based on greater adaptation experience are associated with superior firm performance, all other things being equal, either when the environment requires an intense change and focal activity is present or when the environment is stable and focal activity is absent. Interestingly, in the remaining circumstances the role of adaptation experience is found to be detrimental. This suggests that the contextual levels of environmental dynamism and focal activity may turn the advantages of experienced dynamic capabilities into costs.

These findings offer important contributions to the literature on dynamic capabilities as they help clarify when dynamic capabilities based on general long-standing experience may effectively produce beneficial effects for an organization – an open issue in the current literature. The analysis suggests that the development of capabilities that drive more effective product reconfigurations is neither a necessary nor a sufficient element to boost performance. Specifically, the results show that possessing dynamic capabilities based on a long-standing adaptation experience is not an unambiguous advantage. In fact, if these capabilities are recently maintained and the necessary variety is generated within the organization, prior experience efficiently drives relevant adaptation efforts. Conversely, if recent focal activity is absent, then adaptation experience may lead to misleading adaptive processes and thereby produce a negative impact on firm performance (Haas & Hansen, 2004). On the other hand, if the required adaptation effort is minimal, focal activity is hurtful as it activates adaptive processes that are distracting and not central for the task environment. Interestingly, adaptation experience is found to have positive effects on performance when changes in the environment are incremental and focal activity is absent. This finding supports the suggestion proposed by Helfat and Winter (2011) that dynamic capabilities are indeed useful even to handle settings with limited environmental dynamism.

Moreover, Essay 3 offers a reconciliation on the contrasting views among the foundational contributions on dynamic capabilities, which on the one hand acknowledge the existence of commonalities in dynamic capabilities across firms, as originally argued by Eisenhardt and Martin (2000), and on the other hand the possibility of an impact of dynamic capabilities on competitive advantage, as suggested by Teece et al. (1997) and Makadok (2001). In fact, this study finds that contingent factors such as the level of focal activity and the concurrent environmental dynamics play a major moderating role, according to a mechanism that, in this dataset, is common across organizations. At the same time, prior experience in adaptation represents a central firm-specific source of capability development that organizations cumulate and use in distinct ways to undertake adapting efforts.

One broader implication related to the analysis of an organization's focal activity as a possible moderator for successful adaptation is that it points to the importance of studying the organization at specific points in time as opposed to attempting to isolate long-standing and enduring capabilities or attributes of the organization. Focal activity is a contextual property of the organization. An organization may display different levels of focal activity at different points in time. Therefore, all other things being equal, the expected results of an adaptation effort of the same organization may vary across two distinct moments of its evolution. Focusing on specific organizational change processes in isolation, such as processes of internationalization, corporate acquisitions, or product development, risks confounding their relevant effects on performance by overlooking important contextual moderating variables, which may have both organization specific and time varying qualities.

Essay 3 has limitations in that it investigates a general form of adaptation experience while other more specific types of experience may produce different effects. However, since more specific forms of experience may, in turn, be subject to effects that are contingent to specific circumstances, focusing on general adaptation experience allows for the isolation of adaptive processes that are at the base of an enduring and universal capacity to address changing environments – a central issue at the base of the concept of dynamic capabilities. Moreover, this empirical setting has limitations in that it refers only to a single industry, which may reduce the generalizability of the results; however, the setting has unique characteristics that make it particularly suitable to capturing the underlying phenomenon.

Evolution in complex organizations is the product of multiple contingencies; highlighting one facet in isolation of others has other important inherent limitations. Robust empirical evidence suggests the important moderating role of focal activity and environmental dynamism in influencing the impact of prior experience in product adaptation and in this way the work points to a more contextualized understanding of the role of dynamic capabilities and adaptation.

Indeed, organizational dynamicity includes a complex set of interrelated mechanisms, adopting multiple methodological and conceptual approaches is thus imperative to make progress in the understanding of the whole phenomenon. Together, the three essays of this dissertation point to this direction by relying on different methods and complementary perspectives.

6 BIBLIOGRAPHY

Ahuja, G., & Katila, R. 2001. Technological acquisitions and the innovation performance of acquiring firms: A longitudinal study. ***Strategic Management Journal***, 22(3): 197-220.

Aiken, L. S., & West, S. G. 1991. ***Multiple Regression: Testing and Interpreting Interactions***. Thousand Oaks, CA: Sage Publications Inc.

Aldrich, H. 1999. ***Organizations evolving***. Thousand Oaks, CA: Sage Publications Ltd.

Arellano, M., & Bond, S. 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. ***The Review of Economic Studies***, 58(2): 277-297.

Arellano, M., & Bover, O. 1995. Another look at the instrumental variable estimation of error-components models. ***Journal of econometrics***, 68(1): 29-51.

Argote, L. 1999. ***Organizational learning: Creating, retaining, and transferring knowledge***: Kluwer Academic Publishers.

Argote, L., & Epple, D. 1990. Learning curves in manufacturing. ***Science***, 247(4945): 920.

Argyris, C. 1982. ***Reasoning, learning, and action: Individual and organizational***: Jossey-Bass San Francisco.

Baldwin, J. 1896. A new factor in evolution. ***The american naturalist***, 30(354): 441-451.

Baltagi, B. H. 2005. ***Econometric Analysis of Panel Data***. New York: John Wiley & Sons.

Barney, J. 1991. Firm resources and sustained competitive advantage. ***Journal of management***, 17(1): 99-120.

Barreto, I. 2010. Dynamic capabilities: A review of past research and an agenda for the future. ***Journal of Management***, 36(1): 256-280.

Bauer, D. J., & Curran, P. J. 2005. Probing interactions in fixed and multilevel regression: Inferential and graphical techniques. ***Multivariate Behavioral Research***, 40(3): 373.

Baum, J. A. C., & Campbell, D. T. 1999. ***Variations in organization science***: Sage Publ.

Baum, J. A. C., & Ingram, P. 1998. Survival-enhancing learning in the Manhattan hotel industry, 1898-1980. ***Management Science***: 996-1016.

Baum, J. A. C., & Singh, J. V. 1994. ***Evolutionary dynamics of organizations***: Oxford University Press, USA.

Bharadwaj, A. S. 2000. A resource-based perspective on information technology capability and firm performance: an empirical investigation. ***MIS quarterly***: 169-196.

Birnholtz, J., Cohen, M., & Hoch, S. 2007. Organizational character: On the regeneration of camp poplar grove. ***Organization Science***, 18(2): 315.

Blundell, R., & Bond, S. 1998. Initial conditions and moment restrictions in dynamic panel data models. ***Journal of econometrics***, 87(1): 115-143.

Bruderer, E., & Singh, J. 1996. Organizational evolution, learning, and selection: A genetic-algorithm-based model. ***The Academy of Management Journal***, 39(5): 1322-1349.

Brusoni, S., Prencipe, A., & Pavitt, K. 2001. Knowledge specialization, organizational coupling, and the boundaries of the firm: Why do firms know more than they make? ***Administrative science quarterly***, 46(4): 597-621.

Burgelman, R. 1991. Intraorganizational ecology of strategy making and organizational adaptation: Theory and field research. ***Organization Science***, 2(3): 239-262.

Burgelman, R. 1994. Fading Memories: A Process Theory of Strategic Business Exit in Dynamic Environments. ***Administrative Science Quarterly***, 39(1).

Burns, T., & Stalker, G. M. 1961. ***The Management of Innovation***: Tavistock Publications, Ltd.

Campbell, D. T. 1960. Blind Variation and Selective Retention in Creative Thought as in Other Knowledge Processes. ***Psychological Review***, 67: 380-400.

Campbell, D. T. 1965. Variation and Selective Retention in Socio-Cultural Evolution. In H. R. Barringer, G. I. Blankstein, & R. W. Mack (Eds.), ***Social Change in Developing Areas: A Reinterpretation of Evolutionary Theory***. Cambridge, MA: Schenkman.

Campbell, D. T. 1982. Evolutionary Epistemology. In H. C. Plotkin (Ed.), ***Learning, Development, and Culture: Essays in Evolutionary E***. Chichester: UK: Open Court Publisher.

Carroll, G., & Harrison, J. 1993. Evolution among competing organizational forms. ***World Futures***, 37: 91-110.

Cattani, G. 2005. Preadaptation, firm heterogeneity, and technological performance: A study on the evolution of fiber optics, 1970-1995. ***Organization Science***: 563-580.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. 2003. Applied multiple correlation/regression analysis for the social sciences: Hillsdale, NJ: Erlbaum.

Cohen, M., March, J., & Olsen, J. 1972. A garbage can model of organizational choice. ***Administrative science quarterly***, 17(1): 1-25.

Collis, D. J. 1994. How valuable are dynamic capabilities? ***Strategic Management Journal***, 15: 143-151.

Cyert, R., & March, J. G. 1963. ***A Behavioral Theory of the Firm***. Englewood Cliffs, N.J.: Prentice Hall.

Danneels, E. 2002. The dynamics of product innovation and firm competences. ***Strategic management journal***, 23(12): 1095-1121.

Danneels, E. 2008. Organizational antecedents of second‐order competences. ***Strategic Management Journal***, 29(5): 519-543.

Davis, J., Eisenhardt, K., & Bingham, C. 2007. Developing theory through simulation methods. ***Academy of Management Review***, 32(2): 480.

Davis, J. P., Eisenhardt, K. M., & Bingham, C. B. 2009. Optimal Structure, Market Dynamism, and the Strategy of Simple Rules. ***Administrative Science Quarterly***, 54: 413-452.

DiMaggio, P., & Powell, W. 1983. The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. ***American sociological review***, 48(2): 147-160.

Dobbin, F. 2009. ***Inventing equal opportunity***: Princeton University Press.

Dobbin, F. R. 1992. The origins of private social insurance: Public policy and fringe benefits in America, 1920-1950. ***American Journal of Sociology***: 1416-1450.

Dosi, G., & Marengo, L. 2000. Some elements of an evolutionary theory of organizational competences. ***The Theory of the Firm: Critical Perspectives on Business and Management***, 4: 50.

Dosi, G., Nelson, R., & Winter, S. 2000. ***The Nature and Dynamics of Organizational Capabilities***: Oxford University Press.

Dougherty, D. 2002. Building Grounded Theory: Some Principles and Practices. ***Companion to Organizations***: 849-867.

Drnevich, P. L., & Kriauciunas, A. P. 2011. Clarifying the conditions and limits of the contributions of ordinary and dynamic capabilities to relative firm performance. ***Strategic Management Journal***, 32(3): 254-279.

Edelman, L. B. 1990. Legal environments and organizational governance: The expansion of due process in the American workplace. ***American Journal of Sociology***: 1401-1440.

Eggers, J. P. 2012. All experience is not created equal: learning, adapting, and focusing in product portfolio management. ***Strategic Management Journal***, 33(3): 315-335.

Eisenhardt, K., & Martin, J. 2000. Dynamic capabilities: what are they? ***Strategic management journal***: 1105-1121.

Eisenhardt, K. M., & Graebner, M. E. 2007. Theory building from cases: Opportunities and challenges. ***Academy of management journal***, 50(1): 25-32.

Ethiraj, S., & Levinthal, D. 2004. Hoping for A to Z While Rewarding Only A: Complex Organizations and Multiple Goals. ***Organization Science***, 20(1): 4-21.

Feldman, M. 2000. Organizational routines as a source of continuous change. ***Organization Science***: 611-629.

Fleming, L. 2001. Recombinant uncertainty in technological search. ***Management science***: 117-132.

Freeman, J. 1975. The Unit Problem in Organizational Research, ***Annual Meeting of the American Sociological Association***. San Francisco.

Galunic, C., & Rodan, S. 1998. Resource recombinations in the firm: knowledge structures and the potential for Schumpeterian innovation. ***Strategic management journal***, 19(12): 1193-1201.

Gioia, D. A., Corley, K. G., & Hamilton, A. L. 2012. Seeking Qualitative Rigor in Inductive Research: Notes on the Gioia Methodology. ***Organizational Research Methods***.

Glaser, B. G. 2008. Conceptualization: On theory and theorizing using grounded theory. ***International Journal of Qualitative Methods***, 1(2): 23-38.

Haas, M. R., & Hansen, M. T. 2004. When using knowledge can hurt performance: The value of organizational capabilities in a management consulting company. ***Strategic Management Journal***, 26(1): 1-24.

Hansen, M., & Haas, M. 2001. Competing for attention in knowledge markets: Electronic document dissemination in a management consulting company. ***Administrative Science Quarterly***, 46(1): 1-28.

Hargadon, A., & Sutton, R. I. 1997. Technology brokering and innovation in a product development firm. ***Administrative Science Quarterly***: 716-749.

Hedberg, B. L. T., Bystrom, P. C., & Starbuck, W. H. 1976. Camping on seesaws: Prescriptions for a self-designing organization. ***Administrative Science Quarterly***: 41-65.

Helfat, C., Finkelstein, S., Mitchell, W., Peteraf, M., Singh, H., Teece, D., & Winter, S. 2007. ***Dynamic capabilities***: Blackwell Pub.

Helfat, C. E., & Raubitschek, R. S. 2000. Product Sequencing: Co-evolution of Knowledge, Capabilities, and Products. ***Strategic Management Journal***, 18(5): 961-980.

Helfat, C. E., & Winter, S. G. 2011. Untangling Dynamic and Operational Capabilities: Strategy for the (N)ever-Changing World. ***Strategic Management Journal***, 32: 1243–1250.

Hinton, G. E., & Nowlan, S. J. 1987. How learning can guide evolution. ***Complex Systems***, 1(3): 495-502.

Holland, J. 1975. ***Adaptation in natural and artificial systems***: Ann Arbor MI: University of Michigan Press.

Huber, G. P. 1991. Organizational learning: The contributing processes and the literatures. ***Organization science***, 2(1): 88-115.

Iansiti, M., & Clark, K. B. 1994. Integration and dynamic capability: evidence from product development in automobiles and mainframe computers. ***Industrial and corporate change***, 3(3): 557-605.

Kale, P., & Singh, H. 2007. Building firm capabilities through learning: the role of the alliance learning process in alliance capability and firm−level alliance success. ***Strategic Management Journal***, 28(10): 981-1000.

Kalnins, A., & Mayer, K. J. 2004. Franchising, ownership, and experience: A study of pizza restaurant survival. ***Management Science***, 50(12): 1716-1728.

Karim, S., & Mitchell, W. 2000. Path Dependent and Path-Breaking Change: Reconfiguring Business Resources Following Acquisitions in the US Medical Sector, 1978-1995. ***Strategic Management Journal***, 21(10/11).

Kauffman, S. A. 1993. ***The Origins of Order: Self-organization and Selection in Evolution***. New York, USA: Oxford University Press.

Kennedy, M. T., & Fiss, P. C. 2009. Institutionalization, framing, and diffusion: The logic of TQM adoption and implementation decisions among US hospitals. ***Academy of Management Journal***, 52(5): 897-918.

King, A. A., & Tucci, C. L. 2002. Incumbent entry into new market niches: the role of experience and managerial choice in the creation of dynamic capabilities. ***Management Science***: 171-186.

Kogut, B., & Zander, U. 1993. Knowledge of the firm and the evolutionary theory of the multinational enterprise. ***Journal of International Business Studies***, 24(4): 625-645.

Kraatz, M. S., & Zajac, E. J. 2001. How organizational resources affect strategic change and performance in turbulent environments: theory and evidence. ***Organization Science***, 12(5): 632-657.

Lant, T. K., & Mezias, S. J. 1992. An organizational learning model of convergence and reorientation. ***Organization science***, 3(1): 47-71.

Lave, C. A., & March, J. G. 1975. ***An introduction to models in the social sciences***. New York: Harper & Row.

Lenox, M. J., Rockart, S. F., & Lewin, A. Y. 2010. Does interdependency affect firm and industry profitability? An empirical test. ***Strategic Management Journal***, 31(2): 121-139.

Levinthal, D. 1997. Adaptation on Rugged Landscapes. ***Management science***, 43(7): 934-950.

Levinthal, D., & Warglien, M. 1999. Landscape design: Designing for local action in complex worlds. ***Organization Science***: 342-357.

Levitt, B., & March, J. 1988. Organizational learning. ***Annual review of sociology***, 14(1): 319-338.

Lounsbury, M. 2001. Institutional sources of practice variation: Staffing college and university recycling programs. ***Administrative Science Quarterly***, 46(1): 29-56.

Makadok, R. 2001. Toward a synthesis of the resource−based and dynamic−capability views of rent creation. ***Strategic management journal***, 22(5): 387-401.

March, J. G., & Olsen, J. P. 1979. ***Ambiguity and choice in organizations***: Universitetsforlaget.

March, J. G., & Simon, H. A. 1958. ***Organizations***. New York: Wiley.

Mayley, G. 1996. Landscapes, learning costs, and genetic assimilation. ***Evolutionary Computation***, 4(3): 213-234.

Meyer, J. W., & Rowan, B. 1977. Institutionalized organizations: Formal structure as myth and ceremony. ***American journal of sociology***: 340-363.

Nelson, R. R., & Winter, S. G. 1982. ***An Evolutionary Theory of Economic Change***. Cambridge, MA: Belknap.

Newbert, S. L. 2007. Empirical research on the resource−based view of the firm: an assessment and suggestions for future research. ***Strategic Management Journal***, 28(2): 121-146.

Nickell, S. 1981. Biases in dynamic models with fixed effects. ***Econometrica: Journal of the Econometric Society***: 1417-1426.

Ocasio, W. 1997. Towards an attention−based view of the firm. ***Strategic management journal***, 18(1): 187-206.

Oliver, C. 1991. Strategic responses to institutional processes. ***Academy of management review***: 145-179.

Orlikowski, W. 2001. A situated change perspective. ***Organizational improvisation***: 185.

Orlikowski, W. J. 2000. Managing use not technology: a view from the trenches. ***Mastering Information Management. London: Prentice-Hall***.

Pache, A. C., & Santos, F. 2010. When worlds collide: The internal dynamics of organizational responses to conflicting institutional demands. ***Academy of Management Review***, 35(3): 455-476.

Posen, H. E., & Levinthal, D. A. 2012. Chasing a moving target: Exploitation and exploration in dynamic environments. ***Management Science***, 58(3): 587-601.

Rerup, C., & Feldman, M. S. 2011. Routines as a source of change in organizational schemata: The role of trial-and-error learning. ***The Academy of Management Journal***, 54(3): 577-610.

Rivkin, J. W. 2001. Reproducing Knowledge: Replication Without Imitation at Moderate Complexity. ***Organization Science***, 12(3): 274.

Rivkin, J. W., & Siggelkow, N. 2003. Balancing Search and Stability: Interdependencies Among Elements of Organizational Design. ***Management Science***, 49(3): 290-311.

Roodman, D. 2005. An Index of Donor Performance-Revised August 2005. ***Available at SSRN 984250***.

Ruef, M., & Scott, W. R. 1998. A multidimensional model of organizational legitimacy: Hospital survival in changing institutional environments. ***Administrative Science Quarterly***: 877-904.

Samuel, A. 1959. Some Studies in Machine Learning Using the Game of Checkers. ***IBM Journal of Research Development***, 31: 211-229.

Schilling, M. A., Vidal, P., Ployhart, R. E., & Marangoni, A. 2003. Learning by doing something else: Variation, relatedness, and the learning curve. ***Management Science***: 39-56.

Siggelkow, N. 2002. Evolution toward Fit. ***Administrative Science Quarterly***, 47(1): 125-159.

Simon, H. A. 1947. ***Administrative Behavior. A Study of Decision-Making Processes in Administrative Organization***. New York, NY: The Free Press, Macmillan.

Simon, H. A. 1956. Rational choice and the structure of the environment. ***Psychological Review***, 63(2): 129-138.

Smets, M., Morris, T., & Greenwood, R. 2012. From Practice to Field: A Multilevel Model of Practice-Driven Institutional Change. ***Academy of Management Journal***, 55(4): 877-904.

Sull, D. N. 1999. Why good companies go bad? ***Harvard Business Review***, 77: 44-52.

Suzuki, R., & Arita, T. 2007. The dynamic changes in roles of learning through the Baldwin effect. ***Artificial Life***, 13(1): 31-43.

Szulanski, G. 1996. Exploring internal stickiness: Impediments to the transfer of best practice within the firm. ***Strategic management journal***, 17(WINTER): 27-43.

Teece, D., & Pisano, G. 1994. The dynamic capabilities of firms: an introduction. ***Industrial and corporate change***, 3(3): 537.

Teece, D. J., Pisano, G., & Shuen, A. M. Y. 1997. Dynamic Capabilities and Strategic Management. ***Strategic Management Journal***, 18(7): 509-533.

Thompson, J. 1967. ***Organizations in action***. New York, NY, US: McGraw-Hill.

Tolbert, P. S., & Zucker, L. G. 1983. Institutional sources of change in the formal structure of organizations: The diffusion of civil service reform, 1880-1935. ***Administrative science quarterly***: 22-39.

Warglien, M. 1995. Hierarchical selection and organizational adaptation. ***Industrial and Corporate Change***, 4(1): 161.

Weick, K. E. 1969. ***The social psychology of organizing***. Reading, Mass.: Addison-Wesley Pub. Co.

Wernerfelt, B. 1984. A resource-based view of the firm. ***Strategic management journal***: 171-180.

Westphal, J. D., Gulati, R., & Shortell, S. M. 1997. Customization or conformity? An institutional and network perspective on the content and consequences of TQM adoption. ***Administrative Science Quarterly***: 366-394.

Wilson, E., & Bossert, W. 1971. ***A primer of population biology***. Sunderland, MA: Sinauer Associates.

Windmeijer, F. 2005. A finite sample correction for the variance of linear efficient two-step GMM estimators. ***Journal of econometrics***, 126(1): 25-51.

Winter, S. G. 2003. Understanding dynamic capabilities. ***Strategic Management Journal***, 24(10): 991-995.

Zollo, M., & Winter, S. G. 2002. Deliberate learning and the evolution of dynamic capabilities. ***Organization science***: 339-351.