# Impact of growth opportunities and competition on dynamics of capability development

**Abstract**

Developing organizational capabilities and resources is tightly connected with a firm's performance in competitive markets. Therefore setting investment priorities among production, product development, brand name, internationalization, and many other capabilities and resources should be understood in the context of competitive pressures and growth opportunities a firm faces. Building on resource based view, this study examines firm level capability development as it relates to market level dynamics of competition and growth through simulation experiments. Investing in capabilities that enhance performance in the short-run become superior to investing in long-term initiatives as the former strengthens the reinforcing loop between performance, available effort, and capability development; providing growth opportunities and competitive edge. Moreover, in strategic competition, firms are forced to further ignore long-term capability building in favor of survival. We explore how tradeoffs between short-term and long-term investments depend on different firm and industry characteristics. These results provide a complementary explanation for the persistence of myopic organizational decisions that does not rest on discounting, short-term managerial incentives, decision biases, or learning arguments. The results also point to another mechanism through which market competition may disfavor firms with highest long-term performance potential.

**Keywords**: resource based view, capability, dynamics, simulation, competition, firm performance

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Understanding how firms allocate their efforts between developing different types of capabilities and resources is central to developing the resource based view of strategy. Firms should develop operational capabilities such as production, as well as dynamic capabilities such as R&D and process improvement, in order to grow and survive. Such tradeoffs are increasingly at the heart of executives' challenges: should the company invest in green technologies, internationalization, marketing, production, maintenance, or another capability or resource? Development of capabilities is a dynamic process that impacts firm's performance and survival in competition. Therefore the cost-benefits of allocating organizational effort between different capabilities are not limited to firm-level considerations, but are intricately linked with market level forces. This paper investigates how the acquisition of dynamic and operational capabilities is interwoven with market performance and competitive pressures. We model a firm as a bundle of two capabilities and investigate the effort allocation between these two to analyze how successful allocation policies depend on firm and market structures. This study therefore provides one of the first formal frameworks connecting capability development tradeoffs at the firm level with its performance ramifications at the market level.

## 1- Dynamics of capability development in organizations

As one of the central perspectives in strategy, the resources based view (RBV) maintains that heterogeneity in firms' performance is largely the result of heterogeneity in capabilities and resources of the firms (Barney 1991; Peteraf 1993). Therefore allocation of organizational effort between developing different types of capabilities and resources is at the heart of strategy. Organizational capability can be defined as one or a group of routines that provide a firm the option of producing specific outputs or changing other routines (Nelson and Winter 1982; Winter 2000). Literature distinguishes between two types of capabilities. Operational capabilities are defined as those that allow a firm to accomplish its goal and make a living, and dynamic ones as those routines that operate to modify and change the other capabilities (Henderson and Cockburn 1994; Teece, Pisano et al. 1997; Eisenhardt and Martin 2000). Production, sales, and customer service routines are examples of operational capabilities and product development and maintenance qualify as dynamic ones. Capabilities and resources are different in their nature: the former consists of routines and the latter of assets not tradable in factor markets (Winter 2003). However, given similarities in their dynamics, we use resources and capabilities interchangeably for the purpose of this paper.

It is well recognized that resources and capabilities are dynamic concepts with inertia, therefore their accumulation and depletion processes are central to firms' performance (Penrose 1959; Dierickx and Cool 1989; Henderson 1994). While operational capabilities directly contribute to performance, the dynamic ones only impact the rate of change or productivity of operational capabilities, thus their influence on performance comes with a significant delay. This delay is at the heart of short-term vs. long-term tradeoffs managers face. For example investing in production (operational capability) pays off faster than product development, which only impacts performance through making future investments in *production* more fruitful. Studies of long-term vs. short-term tradeoff often find long-term effort investment to be associated with dynamic capabilities (e.g. TQM and product development) while short-term focus is concerned with operational capabilities (e.g. production and sales). Similar distinction can be made for resources that directly impact performance (e.g. brand name) vs. those that impact performance with a significant delay (e.g. an assay screening technology upstream in drug development process).

Despite the significance of understanding the dynamic tradeoffs in developing different capabilities, the research in this domain is sparse. A few studies have started to address the dynamics of building a resource or capabilities (Helfat 2000) by providing a theoretical framework for capability dynamics (Helfat and Peteraf 2003) and investigating the role of managerial cognition (Tripsas and Gavetti 2000) and situational effects (Ahuja and Katila 2004) in capability evolution. These studies have been concerned with understanding in detail the evolutionary processes underlying the development of a single capability.

Studies on learning curve's impact on firms' strategy also inform our understanding of capability development (Spence 1981; Ghemawat and Spence 1985; Fine 1986; Cabral and Riordan 1994). These have described the optimal production and pricing strategies to maximize the benefits of learning curve effects in competitive markets. More close to this paper, Pacheco-de-Almeida and Zemsky (2007) investigate how the timing of resource development and time-compression diseconomies impact the competition between an innovator firm and an imitator. While these studies consider some aspects of market competition they do not study the interaction and competition between multiple capabilities.

Another stream of research concerns the tradeoffs in developing long-term vs. short-term capabilities at the firm level. Researchers have observed that in the competition between capabilities that pay off in the short-term vs. those that benefit the firm in the long-run, often the former wins. For example reactive maintenance is chosen over preventive maintenance (Allen 1993), process improvement is ignored in favor of meeting production goals (Repenning and Sterman 2002), and emergency health-care gets more attention than preventive medicine (Homer and Hirsch 2006). The major theoretical explanations for these observations include discounting of future rewards (Loewenstein and Prelec 1992), agency problems where managers are rewarded for short-term performance (Levinthal and March 1993), learning biases due to dynamic complexity (Sterman 1989) and delays (Rahmandad 2008), and exploration-exploitation tradeoffs that lead to competency traps (Levinthal and March 1981; Herriott, Levinthal et al. 1985; Levitt and March 1988). However, focus on short-term capabilities may not always be the result of a bias. Studying the tradeoff between investing in knowledge acquisition about the current process versus improving the process itself, Terwiesch and Xu (2004) find that under time pressure, when initial knowledge level is low, and demand is growing, investment in process improvement is not beneficial for semi-conductor manufacturers.

Overall, previous research has studied some pieces of the capability development puzzle. However, these pieces have largely excluded two potentially important pieces required for an integrative view. First, previous studies have excluded the endogenous growth (or decline) in the effort pool available for capability investment, which depends on the performance of the firm. This consideration can change the priority of different types of capabilities. For example, given a fixed stream of effort to invest in capability development, a software company may be better off investing significantly in process improvement capability. However, that investment might be better utilized in the fast-payoff coding capability if it allows the firm to grow quickly and thus expand the effort stream available and enable future growth, as well as, investment in process improvement. Effort endogeneity brings the none-equilibrium growth and decline dynamics to the center of analysis and therefore, given the additional complexity, calls for the use of simulation rather than analytical models. A second element that influences the balance between different types of capabilities is the impact of competitive pressures on the viability of long-term capabilities and resources. Under competitive pressures, survival may require a focus on short-term capabilities. Even though large investments in long-term capabilities may promise a high reward, a firm may not be able to sustain required investments under competitive pressures. As Levinthal and March (Levinthal and March 1993) point out:

*"An organization cannot survive in the long run unless it survives in each of the short runs along the way, and strategies that permit short-run survival tend to increase long-run vulnerability"*

In this paper we analyze, through simulation experiments, the impact of endogeneity of effort and competitive pressures on the allocation of resources between dynamic and operational capabilities. We show how the relative value of different capabilities is a function of competitive pressures and growth opportunities in a market, and therefore appropriate investment in a capability should be defined contingent on competitive dynamics. The reinforcing feedback between capability development, performance, and capability investment, favors resources and capabilities that start to payoff faster. Competitive pressures further strengthen the value of a focus on short-term. Firms that lag in developing short-term capabilities will lose market share and fall into a deadly spiral where diminishing revenue reduces available effort for capability investment, and that further weakens the firm. Therefore acting strategically firms may have to ignore long-term capabilities. We analyze the impact of different market and firm structures on these dynamics to provide a more nuanced understanding of capability development dynamics.

We first draw on the literature in resource based view to build a generic model of allocating organizational effort between different types of capabilities (Section 2). We then consider the link between organizational performance and the available effort and show how the best allocation policy for an organization shifts as a result of this link (Section 2.2). Next we include the competition between multiple firms and show under what conditions this consideration can change the nature of the trade-off between short term and long-term capabilities (Section 2.3). We discuss the implications of alternative industry and firm structures in Section 3. Contributions to understanding organizational decision making, resource allocation, and strategy are discussion in Section 4.

## 2- Tradeoffs in the development of operational and dynamic capabilities in a firm

We first model a firm as the bundle of two capabilities and investigate the tradeoffs in allocating the organizational effort between them. We then extend this model to include endogenous increase in available effort and competitive dynamics. For example consider an electronic manufacturer. The capability to produce specific products is the central operational capability for this firm. Short-term performance depends directly on the strength of this capability. In response to natural erosion of this capability the firm can introduce new products and production processes that distinguish it from the competition and allow higher margins. Thus successful investment in the production depends on another capability of the firm: the ability to design new products, which we identify as a dynamic capability. Figure 1 provides an overview of the model for a single firm.

<Figure 1>

The operational capability ($C_O$) determines firm's performance. The latter is defined here as firm's profit stream and depends, beyond operational capability, on the productivity (*p*) of this capability in generating revenue beyond variable production costs (net sales), the fixed cost of production (*c*), the costs of operating dynamic capabilities ($C_D$), and the cost of efforts invested in operational and dynamic capabilities (*R*). Variables in capital letters can change through time but for simplicity we have dropped the time index. To avoid mixing discounting effects with unique contributions of this research we use a discount rate of zero:

$$\Pi = C_O.p - R - C_D.c_{CD} - c \qquad (1)$$

Organizational capabilities and resources are made of routines and assets that change only gradually and through accumulation processes (Dierickx and Cool 1989; Henderson 1994). Two stocks, $C_O$ and $C_D$, represent the operational and dynamic capabilities (or analogues resources). Each capability includes an inflow (*I*) and an outflow (*O*) that regulates its speed of change:

$$\frac{dC_O}{dt} = I_O - O_O\,; \quad \frac{dC_D}{dt} = I_D - O_D \qquad (2)$$

Capability outflow represents the gradual erosion of the capability as organizational assets erode, skills are lost or outdated, and competition catches up by imitation or innovation and renders specific routines trivial (and thus their contribution to revenue equal their costs). The larger the stock of a capability, the higher is the amount of routines and assets that are subject to erosion or competitive imitation. The parameters $d_O$ and $d_D$ represent the average life of each type of capability and depend on market dynamism, barriers to entry, imitability of the capability, and level of competition.

$$O_O = \frac{C_O}{d_O}\,; \quad O_D = \frac{C_D}{d_D} \qquad (3)$$

Increase in capabilities and resources is captured by the inflows and includes diverse activities such as investment in hard assets, bringing together the factors of production, training the individuals, and giving them time to form effective processes. Here organizational effort (e.g. employee time, money, etc. all expressed in dollars/month) invested in the development of capabilities and resources are represented as *R*. Investment should be distinguished from the efficiency of investment in capabilities. Development of any capability or resource requires some sort of investment. However organizations may vary in their efficiency in transforming investments into organizational capabilities. Variables $e_O$ and $e_D$ capture investment efficiency.

$$I_O = R_O.e_O\,; \quad I_D = R_D.e_D \qquad (4)$$

Theory defines dynamic capabilities as those capabilities used for change and modification of other capabilities (Eisenhardt and Martin 2000; Winter 2003). Therefore the efficiency in change and creation of operational capabilities is a function of the dynamic capabilities. For example a strong product development capability would enable a firm to leverage its investment in new production capacity more effectively by building production facilities that produce higher-margin, more attractive products. We assume that gains in efficiency come at decreasing returns: routine formation is slow and there are limits to the speed of the installation of physical assets and the development of human capital. On the other hand dynamic capabilities are not a necessary requirement for development of operational ones. Operational capabilities can also be built through ad-hoc problem solving procedures (Winter 2003). Ad hoc problem solving refers to non-routine activities of organizational members to address a problem at hand without the utilization of a repeated pattern or procedure. For example, a firm can substitute product development capability by acquiring a start-up with a new product. We assume such ad-hoc problem solving processes to have an efficiency of $e_{ah}$ in producing new operational capabilities and that firms choose the more efficient approach between utilizing dynamic capabilities and ad-hoc problem solving. Therefore the efficiency in transforming organizational effort investment to operational capabilities can be summarized as:

$$e_O = Max(e_{ah}, g(C_D)) \quad \text{where } g(0)=0,\ g'(.)\geq 0, \text{ and } g''(.)\leq 0 \qquad (5)$$

Function *g(.)* represents the efficiency in producing operational capabilities through the application of dynamic ones. In the absence of any dynamic capability such efficiency is zero ($g(0)=0$). An increase in the dynamic capability does not decrease the efficiency of using this capability ($g'(.)\geq 0$), yet diminishing return on dynamic capabilities prevail: $g''(.) \leq 0$. Capabilities beyond first-level ones are not considered in this study, thus $e_D$ represents ah-hoc problem solving processes used to create dynamic capabilities, and is constant.

The critical decision for the managers in this firm is how to allocate organizational effort between the operational and dynamic capabilities. Fraction *f* of total effort is allocated to investment in dynamic capabilities, leaving the rest to be invested in operational ones:

$$R_O = R.(1-f)\,; \quad R_D = R.f \qquad (6)$$

***2-1-Capability development tradeoffs with fixed effort***

By controlling *f*, managers balance between the direct investment in operational capability and the investment in efficiency of increasing this capability. Finding performance, $\Pi$, after capability acquisition is complete, as a function of the firm's decision variable, *f,* we can analyze the tradeoffs of investing in operational vs. dynamic capabilities. Analyzing this steady-state performance function we conclude for the general model above that (See the e-companion, S1, for details): 1) There is at least one local performance peak at $f$=0. 2) Only one other (potentially local) performance peak may exist, where moderate investments in dynamic capabilities are encouraged. Three potential parameter settings can be identified as a result (see Figure 2), in two of which all the effort is best invested in operational capabilities (b and c). Such firm structures pose an easy problem for managers: focusing on short-term operational capability is performance maximizing. Discounting, managerial incentives, and learning dynamics only reinforce the focus on operational capabilities. A more relevant case is when modest investment in dynamic capabilities is beneficial (case a). Such firms need to balance their investment in operational and dynamic capabilities to achieve peak performance. In the rest of the analysis we focus on firm structures of this type (Figure 2-a).

<Figure 2 >

Even under these conditions a policy of investing no effort in dynamic capabilities is locally stable: Investment in dynamic capabilities should be large enough to build these routines to a level that they can outperform ad-hoc problem solving. Low levels of investment are going to be counterproductive because they waste efforts that otherwise would be used to extend operational capabilities. Incremental increases in investment in dynamic capabilities will *reduce* performance before they can increase it. Therefore such moves, even if potentially fruitful, may be hard to implement. This simple formulation provides a mechanism to explain the common observation that organizations investing very little in dynamic capabilities have a hard time recovering from this equilibrium (Repenning, Goncalves et al. 2001; Morrison 2005).

While equilibrium performance is important economically, transient performance provides the signals that guide management's decision making and adaptation of strategic action. Investment in operational capabilities pays off relatively fast through the accumulation of income-generating routines and resources. Dynamic capabilities take a longer time to pay-off because their impact is indirect and only through increasing the speed of the creation of operational capabilities. Therefore changing investment policy in favor of dynamic capabilities would typically entail a short-term decline in performance, before any potential gains through increased efficiency in building of operational capabilities is realized. These worse before better dynamics are well documented and are among the main learning traps that lead to dominance of short-term focus when long-term capabilities are valuable (e.g. Repenning 2001; Repenning and Sterman 2002; Morrison 2005). See e-companion S3 for a demonstration of these learning traps.

### *2-2-Capability development when effort availability depends on performance*

Previous studies of capability development have investigated the development of a specific capability without considering how capability development, by changing performance, impacts available effort to be invested in the capability. For example the impact of performance on number of maintenance personnel, design engineers, or production and process improvement personnel are not endogenously included. However, in practice the financial resources, assets, and manpower available for investment in capabilities largely depend on the organization's performance. In the absence of capital markets the relationship is direct for a firm: only a fraction of net revenue is available for investment. A weaker relationship exists for the organizational units where performance evaluation of the unit impacts its future budget.

Efficient capital markets could weaken the relationship by considering not only the firm's performance, but also its current capability position, in extending available organizational effort through loans and external investments. However, the information asymmetry between the management and investors is highest when it comes to assessing the organizational capabilities. In fact these asymmetries threaten the viability of some venture capital markets (Amit, Glosten et al. 1990). In absence of reliable information on firm capabilities, investors use existing customer base, previous track-record of entrepreneurs, and financial performance of the firm to assess the viability of an entrepreneurial firm (Fried and Hisrich 1994). Moreover, past performance, through financial statements, provides the main signal to capital markets in selection among multiple alternative investment options (Healy and Palepu 2001). Therefore capital markets reinforce an indirect link between performance and effort availability. Finally, under-developed capital markets in many parts of the world leave many firms with few options other than financing their own capability development. As a result the relationship between performance and available effort is at the heart of firms' growth. Investments in different organizational resources and capabilities such as sales force, brand name, product development teams, manufacturing capability, and employee skills contribute to the building of organizational capabilities and therefore profitability. Profitability in turn drives capital market interest and availability of funds, and thus future investment in those capabilities, completing different reinforcing loops that fuel organizational growth (Sterman 2000).

Endogenous effort creates a reinforcing loop where higher performance increases available effort and thus investment in capabilities. Higher capabilities increase the performance even further. We capture endogenous effort by modifying the formulations so that the effort available to the firm is a function of its performance. Specifically, a fixed fraction (*b*) of organizational net revenue is invested in organizational capabilities:

$$R = (C_O.p - C_D.c_{CD} - c).b \qquad (7)$$

The new formulation describes a firm in an untapped market with large growth opportunities. The firm can, for example, grow by investing in its production and product development capabilities, where the former contributes to the organizational growth directly (by producing more products, all sold in this growing market) and the latter contributes by increasing the number of product lines the firm is active in.

Given the unlimited, competition-free market, the organization can grow fast and reach very high performance levels. Figure 3 reports the results of this experiment (parameters reported in e-companion, S2). Sales logarithm for firms with different effort allocation policies (*f*) is reported. Performance with fixed effort is also reported for comparison. Besides faster growth rates, two qualitative differences emerge in comparison of these results with the performance as a function of fixed effort. First, the peak for performance has shifted to the left, towards policies that prefer higher investment in operational capabilities. Second, the local performance peak at *f*=0 no longer shows-up.

< Figure 3>

Organizational performance is a function of operational capability (eq. 1) and therefore depends on the two factors that dynamically change the level of this capability: effort invested to build this capability and the efficiency of those investments. Where additional investment in the dynamic capability increases performance through increasing the efficiency of investment in operational capabilities, allocating effort to operational capability has the double benefits of growing the performance, as well as, growing the available effort faster. Thus, the "short-term focused" policy of shifting investment towards operational capability has a second benefit of providing a quick opportunity for growth, not available through the "long-term" policy. The growth in the pool of effort available to the organization will increase the later investment in both capabilities. Therefore by reducing the delay in the reinforcing feedback of organizational growth (Performance➔Investment➔Capabilities➔ Performance), policies that are more short-term oriented become more attractive. The net impact is a shift in the best policy from investing 23% of organizational effort in dynamic capability, to investing only about one third of this fraction (*f*=0.08). While the exact extent of the shift depends on the parameters used, sensitivity analysis points to the generality of result: considering dependence of organizational effort on performance reduces the attractiveness of investment in capabilities and resources that payoff with longer delays, e.g. dynamic capabilities.

The second impact of the endogenous effort relates to the peak at *f*=0. Under fixed effort, ad hoc problem solving processes can beat dynamic capabilities because the size of dynamic capability is limited by the total available effort. Therefore at small investment levels, dynamic capability does not contribute to the efficiency of developing operational capability and only wastes the allocated effort. This leads to a region around *f*=0 with negative return on dynamic capability. In contrast, in the case of endogenous effort, as long as the growth loop dominates (*f*<0.5 in our setting), available effort will continue to grow and eventually dynamic capability will dominate ad-hoc problem solving. Thus, over the long-run in an unlimited market $f$=0 is dominated by policies that promise a minimum fraction of investment in the dynamic capability.

Figure 3 also suggests that some learning traps may persist in this setting. Such traps are in the form of observing initially higher growth rates for ultimately poorer policies. For example, after 5 months, the most myopic firm ($f=0$) has the highest growth rate but in 15 months the firm with $f$=0.07 is the leader. However, these traps are weaker in this case compared to the fixed effort. Here a firm observes a positive growth rate in all allocation policies with $f$>0.5. In contrast, the traps observed in the case of fixed effort include worse before better dynamics, where the manager should undergo a temporary decline in performance to benefit from most efficient policies. Given that growth and decline in performance send qualitatively different signals to decision makers, we expect such learning traps to be less salient in growing markets. Numerical experiments show that worse before better dynamics are harder to observe in the endogenous effort setting: most (but not all) short-term declines in performance trigger a death cycle of reduced investment, lower capability, and performance decline from which the organization can not recover. Under these conditions the name of the game is “who can grow faster?.” Smart managers can slow down their short-term growth in order to build their dynamic capabilities and have higher long-run growth. However, managers are well advised not to completely sacrifice growth in order to build dynamic capabilities. Such sacrifice may not pay off as the supposedly short-term decline in performance leads to lower levels of effort for investment in both capabilities. This loss overshadows the benefits expected from the sacrifice.

***2-3-Capability development under competition***

Managers often face their toughest challenges in competition. Their benchmark is not the isolated firm’s performance or growth potential, rather, how their firm survives and excels in the competition. Capability development is therefore best understood in this context, where survival and future performance and growth should compete.

We model the competition of $N$ identical firms in a market with constant demand. The previous firm level equations remain largely unchanged, with the minor modification that all equations will require an index (*[j]*) to identify the $j^{th}$ firm in the market. To enable controlled comparisons, similar parameters are used for all the firms, except for the allocation fraction, *f*, which is the policy parameter of interest. Equations 8-11 describe the market aggregation and competition processes. We assume that firm *j*'s operational capability determines its potential output (*PO[j]*). The real sales, however, is determined by the distribution of total demand among different firms according to their potential outputs. Using an explicit demand curve adds more complexity but would result in similar dynamics. If total market size (*M*) is bigger than the sum of the potential outputs for firms, then all firms sell their potential output (*S[j]=PO[j]*). Otherwise, their market-shares are proportional to their potential output. Market size is selected so that initially market is in equilibrium. Formally:

$$PO[j] = C_O[j].p \tag{8}$$

$$S[j] = Min(PO[j], M.\frac{PO[j]}{\sum_{i=1}^{i=N} PO[i]}); \quad M = \sum_{i=1}^{i=N} PO_{Initial}[i] \tag{9}$$

$$R[j] = (S[j] - c - C_D.c_{CD}).b \tag{10}$$

$$\Pi[j] = (S[j] - c - C_D.c_{CD}).(1-b) \tag{11}$$

Equations 10 and 11 replace 7 and 1. For this analysis we use a controlled experiment in which the N firms are identical, the market starts from equilibrium, and every firm starts with the same capability endowment ($f_{initial}$=0.5). At time zero the firms switch to different allocation policies, and simulation traces the market share gains and losses of different firms as a function of their policy. Two mechanisms for selection of allocation fraction are analyzed: uniform competition and strategic competition.

<u>*2-3-1- Uniform Competition*</u>

In the uniform competition, we compare the final sales of *N*=101 firms, each switching to a constant policy of *f[j]=j*/100 (*j*=[0,1,…100]) at time zero, independent of what other firms do. We report the sales (*S[j]*) at different point in time as a function of allocation fraction, *f[j]* (See Figure 4). The basic mode of behavior in this setting is the transfer of market share between firms with different growth potentials. Starting from the same initial conditions, firms that switch to low-growth-potential policies lose market share to firms that can aggressively expand their potential output. In fact, over the long-run, a single firm will dominate the market.

<Figure 4>

Again the significant shift in the optimum allocation policy compared to the fixed effort case (from 23% to 8%) is visible. The driving mechanism is somewhat similar to the endogenous effort case. The firms that can harness the fastest growth rates take market share away from the slow-growing ones, therefore allowing themselves to grow and benefit from the larger effort pool. The growth benefits of short-term policies make them more attractive. In this case firms that can not grow fast enough lose market share and are driven out of the market. The strategy that dominates is similar to the one in the no-competition case with endogenous effort. The firm that can grow the fastest in unlimited market can take market share away from the other firms in a competitive market and thus dominate. However, this result hinges on the large number of firms with inefficient policies ($N=101$), that allows the firms with largest long-term growth to build enough capabilities early on, before entering a head-to-head competition with more short-term-focused competitors. If fewer firms are in the competition, or more firms pick a short-term allocation policy (rather than uniform distribution on the policy space), the winning strategy has lower levels of allocation fraction, $f$.

The market dynamics also show a gradual shift in the highest-performing policy through time. Five periods into competition the highest sales goes to the most myopic firm. However, in these early periods all policies in the neighborhood of $f$=0.08 yield growing sales as they take away market share from many inefficient competitors with higher $f$. Among these growth-enabling policies there are those that with modest investments grow their dynamic capabilities and gradually dominate the most myopic. This pattern of shift in dominant policy continues and in about 40 periods the long-term optimum policy ($f$=0.08) rises to dominance. Firms competing in this market therefore face a modest learning trap, as the dominant long-term policy does not create the highest initial sales or growth. Nevertheless, again we do not observe much value in the worse-before-better policies. Most declines in the short-term sales yield lower effort availability and a decline in the capabilities, benefiting the competitors and hurting the focal firm.

*2-3-2- Strategic competition*

Competition favors short-term policies further when firms choose their allocation policy strategically. Rational firms consider how other firms in the market act and they select their own allocation fraction accordingly. The half of the firms with the highest investment in dynamic capabilities have the slowest *initial* growth potential and therefore are often defeated by the more aggressive half. Knowing this, the firms entering the market want to strategically choose allocation policies that are on, or below, the median firm's allocation fraction. Intuitively the Nash equilibrium for this game is for everybody to select the minimum value on the range (here $f$=0), because being above half of the rest loses, and the only way for everybody to be below median, is for everybody to select the minimum. Simulation experiments show that indeed $f$=0 is a game theoretic optimum for competition among ten firms in this market (See e-companion, S4, for finding the equilibrium). Therefore under these assumptions, strategic selection of allocation policy leads the firms to allocate all their effort to the short-term, operational capabilities and to ignore dynamic capabilities all together.

## 3- Implications for capability development across different markets and organizations

Preceding analyses established three fundamental processes that change the relative value of long-term capabilities and resources. First, delays in building a capability increases the opportunity costs associated with slow expansion of the firm's effort base. More myopic policies are therefore favored further when fast growth opportunities are available to a firm. Second, under zero-sum competition surviving firms need to grow or sustain their market share. Short-term growth however requires a shift in policy towards more myopic effort allocation, than what would have been optimal in the absence of competition. Finally, rational firms foresee their competitors taking on more myopic policies. In order to survive, they want to be more myopic than the average competitor. Thus they all converge to spending little or no effort on dynamic capabilities. In this section we explore the implications of these mechanisms for different market conditions and firm structures. We explore how, as a result of these dynamics, efficient organizational effort allocation changes across different organizational and market settings.

**3-1- Firm structure and different economies of scale**

Section 2 discussed how reinforcing feedback processes resulting from "performance➔ effort availability➔ capability level➔ performance" are central to the tradeoffs between short-term and long-term investments. These feedback processes are also directly related to a firm's return on scale of different types of capabilities. Therefore one can expect a connection between (dis)economies of scale and the relative value of short-term and long-term capabilities. The base case firm structure includes strong incentives for growth due to economies of scale: doubling resources not only doubles the investment in operational capability, but also increases (through *g(.)* see Table S1, e-companion) the efficiency of those investments. As a result the overall output increases over twice. Such increasing return to scale benefits larger firms and provides incentive for growth, thus tipping the balance in favor of short-term capabilities. Therefore one can hypothesize that markets with increasing return to scale would favor short-term focus more than those with decreasing returns.

We explore this hypothesis through computational experiments. The return on scales can be changed through changing the returns on both dynamic and operational capabilities. First, consider firms in which the value of dynamic capabilities saturates at some level. This will create constant return on scales once we reach that saturation level. For example regardless of the strength of product development capability, the implementation and roll-out of new product lines may be limited by other physical constraints, thus limiting the maximum efficiency of investment in operational capabilities (See e-companion S5 for formulation details).

Under these assumptions the relative value of two capabilities under fixed effort does not change (unless return on dynamic capabilities saturates at low levels of this capability). Compared to the base case, a stronger bias against dynamic capabilities is observed when we consider endogenous effort. This may appear contrary to the hypothesis above. However, note that the saturation effect reduces the value of investment in dynamic capabilities. Therefore over longer time horizons, more myopic policies tend to become more attractive. They allow a higher portion of organizational effort to be devoted to operational capabilities, and as long as a small fraction is spent on building dynamic capabilities, their maximum value is to be reached. Consequently the winning firm after 35 months also spends less (*f*=0.03 vs *f*=0.07 in the base case) on dynamic capabilities. The strategic competition again leads to no investment in dynamic capabilities (*f*=0). See e-companion S5 for detailed simulation results. Overall, considering saturation of efficiency of dynamic capabilities increases the value of short-term focus, even though it also reduces firms' growth opportunities.

A second experiment investigates returns on operational capabilities. In the base case operational capability linearly increases output. Many markets, however, are represented by decreasing returns once the firm goes beyond an optimum size. We represent such markets by changing the equation 8 as follows:

$$PO[j] = (C_O[j]/C_{ON})^{\omega}.C_{ON}.p \quad (12)$$

Here the normal operational capability, $C_{ON}$, is a normalizing constant to keep the new firm comparable with the previous one, and $\omega$ captures the return to scale for operational capabilities. Simulations reported here use $\omega$=0.5, thus assuming a strong decreasing return to scale. The decreasing returns to scale reduce the viability of bigger firms and thus create limits to growth. These limits reduce the relative value of short-term focus: maximum endogenous growth is achieved at *f*=0.13 (compared with *f*=0.08 in the base case; in this case the optimum allocation is *f*=0.22 when effort is fixed). Similarly under uniform competition with 101 firms, the winning firm invests *f=0.15* of its efforts in capability building, somewhat higher than the base case. Despite the lower value of growth opportunities, the strategic equilibrium remains at *f*=0 despite the strong decreasing returns we have used. See e-companion, S5, for details.

The sensitivity of results to two alternative production functions is also tested. One production function assumes potential performance is a Cobb-Douglas, constant-return to scale function of available capability and the effort directly invested in creating output. A second formulation assumes that dynamic capabilities directly impact (potential) performance (rather than impacting efficiency of investments in operational ones) by determining the productivity of operational capabilities. Both formulations lead to qualitatively similar results as the base case therefore details are reported only in e-companion, S6.

In summary, the basic results hold under several different assumptions for firm's production function and economies of scale. Moreover, a firm's economies of scale with respect to both operational and dynamic capabilities mildly impact the capability development tradeoffs. Whereas reducing the return on each type of capability lowers its value against other types of capabilities, reducing the firm's incentives for growth increases the relative value of long-term investments. Low economies of scale therefore reduce the strength of mechanisms that depend on growth opportunities. This reduces the difference between efficient allocation policy in fixed vs. endogenous effort cases. However, foreseeing other firms' actions, competitors may still be pushed to abandon long-term capabilities even where strong decreasing returns dominate the market. This result is due to the fact that firms' survival is most threatened early in the competition when strong decreasing returns have not yet kicked in given the smaller size of all competitors. Therefore initially all firms still face a strong incentive to focus solely on short-term in order to survive.

### 3-2- Nature of capability development and effort investment processes

Alternative effort investment and capability development processes may impact the results. For example fast investment in many capabilities may be inefficient. The faster a firm invests, the greater may be the unit costs of resource and capability development. The increasing costs can result from the complexity of building the capabilities and the interactions between different components that constitute a capability. Such time compression diseconomies are empirically demonstrated (Mansfield 1968) and can complicate capability development (Dierickx and Cool 1989). We analyze time compression diseconomies by changing equations 4 to:

$$I_O = R_N.(R_O / R_N)^{\upsilon}.e_O; \quad I_D = R_N.(R_D / R_N)^{\upsilon}.e_D \qquad (13)$$

$\upsilon$, a parameter between zero and one, specifies the extent of the time compression diseconomies. $\upsilon$=0.5 is used in simulations to analyze a strong impact. $R_N$ is a normalizing parameter set to keep firm's behavior in a similar region as in the base case. See e-companion, S7 for details.

Time compression diseconomies reduce the value of extreme effort allocation policies because high investment levels waste more effort. Moreover, the firm slows and ceases to grow in endogenous case as the available efforts for allocation grows large, reducing the efficiency of investment (similar to decreasing return to scale case). At some point marginal cost of investment equals the marginal return on capability growth, and the organization ceases to grow even in an unlimited market. Therefore while with fixed effort a policy rather close to the base case ($f$=0.21) is optimal (See Figure 5), endogenous effort and uniform competition cases favor allocation policies at $f$=0.15 and $f$=0.17, significantly higher than the base case. The strategic competition equilibrium now shifts to $f$=0.10, much closer to the uniform competition. Focusing solely on operational capability becomes costly compared to more balanced allocation policies. Moreover, the strong growth opportunities that rewarded myopic firms in the base case are much weaker. Both factors lead to the viability of investment in dynamic capabilities in strategic competition.

<Figure 5>

Impact of organizational slack on effort availability is another important issue to consider. It can be argued that effort investment in different capabilities is often buffered from immediate organizational performance by organizational slack. We therefore test the impact of organizational slack in our model: slack is represented as a stock variable that integrates net revenue, and from which investments are made after some time (See e-companion, S7). The average time between earning and investing effort informs the size and the impact of slack. We use a 30 month slack average life ($T_B$) in the simulations reported.

Slack introduces a delay in the reinforcing feedback, between performance and investment, and thus reduces potential for growth: endogenous growth is significantly slower than the base case. As a result the advantage assigned to short-term investments by growth opportunity diminishes and endogenous growth and uniform competition favor firms with higher investment in long-term capabilities ($f$=0.13 and $f$=0.15 respectively). Interestingly, the strategic competition's equilibrium largely depends on slack size. For shorter slack lives/sizes (e.g. $T_B$=20), $f$=0 remains the dominant strategy. Larger slack (e.g. $T_B$=30), however, provides essential buffer during initial competition for the development of dynamic capabilities. This buffer allows for absorbing the performance value of those capabilities in time to avoid significant loss of market share (and thus available effort) to more myopic competitors. In fact the extreme case with $T_B \rightarrow \infty$ is equivalent to constant effort case we discussed in section 2.2.

Overall the nature of investment processes may have a significant impact on the long vs. short term tradeoffs in the presence of growth opportunities and competition. In tradeoffs among capabilities that include significant time compression diseconomies, such as internationalization (Vermeulen and Barkema 2002), alliance formation, and employee skills, growth opportunities and competitive pressures have a mild impact. Moreover, buffering investment in capability from firm performance, e.g. through subsidizing the new venture from other lines of work, providing a large initial pool of slack resources, or where efficient capital markets are available, can make the long-term capabilities viable even in the face of strong competition.

**3-3- Heterogeneous capability endowment**

Firms often enter competition with heterogeneous capability endowments. How does the introduction of heterogeneous initial capabilities impact the viability of long-term capabilities in the presence of competition? For example, firms with strong initial capability positions may be able to afford focusing on long-term capabilities beyond what is warranted when all the firms have the same initial capability levels. We analyze this question by a Monte-Carlo simulation of 101 competing firms with different initial capability levels. Equilibrium initial capabilities for firm j are multiplied by random factors, $U_O[j]$ and $U_D[j]$ (both follow Uniform(0,2)), that lead to significant heterogeneity in initial capability levels. All the other equations remain intact.

Figure 6 shows the frequency of different firms with different allocation policies being ahead of all of the players in the market. Results are reported for 10000 simulated markets, each with 101 competing firms under uniform competition conditions, and at three different points in time. The overall patterns are similar to the base case results: initially short-term policies are more likely to win, but as competition progresses, more investment in long-term capabilities start to pay off. As in the base case, the maximum success rate is achieved at $f$=0.08.

On the other hand, as the tails of the distribution show, initial resource endowment can allow a firm with non-efficient allocation strategy to win. For example in a few instances a firm wins despite spending as much as 30% of its resources on dynamic capabilities. Inspection shows such firms are starting, by chance, from a uniquely rich capability position in comparison with other firms in that market, and therefore have strong growth potential at the beginning. They then lock-into market dominance as they grow and increasing return dynamics compensate for their otherwise inefficient allocation fraction. The growth potential allows these firms to invest in the long-term capabilities while also strengthening their market position. In other words initial resources can act as a buffer that sustains a firm’s competitive position while it invests in dynamic capabilities and other resources that payoff over the long-term. While in the absence of resource endowment symmetry it is harder to solve the strategic competition problem, the same argument suggests that high initial endowments can strengthen otherwise losing strategies of investment in long-term capabilities. However, firms starting from a poor capability position probably have no option but to focus on fast-growth, short-term policies. E-companion provides additional details (S8).

**3-4- Growth opportunities in the market**

The market maturity may also impact the results. If the market is not growing, a firm can not afford to act less aggressively than the competition, or the short-term loss leads to reduction of available effort and long-term failure. However, many firms initially develop their capabilities in growing markets and transition to a mature market happens only later. We may expect that such growth opportunities in the market can provide another avenue through which investments in dynamic capabilities can be justified. We therefore analyze firms competing in a market two times bigger than the initial production capacity of all of the firms combined.

Under these assumptions all the firms in uniform competition enjoy an initial period in which they can grow, followed by the maturation of the market and the transition to a zero-sum game. As in the base case, the firm with the maximum growth potential (*f*=0.08) wins in this market. However, the results under strategic competition change. The unsaturated market enables a firm to invest in dynamic capabilities while benefiting from initial growth. By the time the market saturates, the firm has started to rip the benefits of investment in dynamic capabilities and therefore dominating the more myopic competitors. The strategic allocation policy shifts to a new equilibrium that includes investments in long-term capabilities and resources (*f*=0.06). Larger markets provide more time for unlimited growth and can shift the strategic allocation fraction up to the value that provides maximum growth potential (*f*=0.08 in this setting).

**4-Discussion**

Critics and proponents of resource based view (RBV) (Barney 2001; Priem and Butler 2001) agree that RBV will benefit from integrating analysis of internal resources and capabilities with the external competitive dynamics. Moreover, formalizing definitions and concepts and incorporating temporal dimension into resource based studies are important steps to strengthen RBV (Pacheco-de-Almeida and Zemsky 2007). These are exactly aligned with the focus of this study: through formal models we studied how growth opportunities and competition dynamically impact the evolution of different organizational capabilities and resources.

We build a model of a firm using the basic insight that different levels of organizational capabilities impact performance differently (Winter 2003). While the operational (zero level) capabilities directly impact performance, dynamic (first level) capabilities produce results with longer delays due to their indirect impact on performance. Our analysis of firms in growing and competitive markets shows that the delays involved between investment in long-term, e.g. dynamic, capabilities and performance can reduce the value of these capabilities through multiple mechanisms. First, when performance impacts the effort available for investment in capabilities, short-term focus gains additional advantage because it enables faster growth of the effort available. Moreover, competition puts more pressure on firms to focus on short-term or lose market share. In fact under strategic competition in saturated markets, firms that invest in long-term capabilities are likely to lose. Their competitors take away their market share and leave them with a depleted effort pool that can not be sustained until the benefits of long-term investments are materialized. Therefore firms will face a strong competitive pressure towards abandoning long-term capabilities all together. Figure 7 summarizes the impact of multiple firm and market factors on efficient allocation policies.

<Figure 7>

By explicitly modeling capability evolution at the firm level and how that interacts with competitive pressures at the market level, we provide additional insights into other important questions. Many have observed that firms under-invest in capabilities and resources that pay-off with long delays (e.g. Allen 1993; Hendricks and Singhal 2001; Repenning and Sterman 2002; Homer and Hirsch 2006). Heavy discounting due to executive incentives (Levinthal and March 1993), individual and organizational learning biases (Sterman 1989; Rahmandad 2008), and exploration-exploitation tradeoffs (Levinthal and March 1981; Herriott, Levinthal and March 1985; Levitt and March 1988) have been proposed to account for this observation. Our analysis suggests that what is considered under-investment in long-term initiatives for an isolated firm with fixed effort to allocate, may well be the best that can be done when opportunities for growth or competitive pressures are considered. This analysis therefore complements the literature that attributes low investment in long-term initiatives to incentive, learning, and organizational biases.

This study also adds another dimension to understanding why competition may not always favor the organization with highest potential performance. Previous research has shown that multiplicity of possible performance dimensions allow social and institutional factors to be as important a dimension in organizational survival as the technical performance of a firm is (Anderson and Tushman 1990). Moreover, organizations are buffered by their slack from temporary performance shortfall that their poor policies may cause (Levinthal 1991; Barnett, Greve et al. 1994). Furthermore, path dependencies resulting from reinforcing dynamics in organizations (Arthur 1989) may randomly favor inefficient configurations (Barnett and

Burgelman 1996). Finally, competition favors learning strategies that provide more stable patterns of behavior, even at the expense of expected performance (Levinthal and Posen 2007). We show how competitive pressures may force organizations to refrain from investment in long-term capabilities which are otherwise beneficial for the firm, leading to the domination of myopic policies in the market.

Extension of results to alternative firm and market structures reveals avenues through which firms can invest in long-term capabilities without losing in the competition. While the basic results are robust to several assumptions about firm structure, we show that time compression diseconomies in capability development favor long-term policies by reducing the efficiency of policies that focus on quick growth through one-sided investment. Similarly, availability of slack can reduce the impact of the dynamics discussed and promote some investment in long-term capabilities even in the presence of strong competition. This fact favors diversifying incumbent firms in competition with new firms in a market. It also adds to the advantages of firms in countries with well-established capital markets in competition with firms in countries without such markets. The latter should finance their growth directly from their own performance, thus strengthening the link between performance and effort availability. Moreover, growing markets provide firms with an opportunity to invest in long-term capabilities without being penalized by the loss of sales to more myopic competitors. Therefore the growth phase of a market provides an opportunity for building dynamic capabilities. This window of opportunity closes once the market is saturated and the competition becomes a zero-sum game. Interestingly, small players active in the competition in the initial growth phase of the market often lack the resource slack and thus are likely to invest very little in dynamic capabilities. Therefore a delicate balance exists between ignoring dynamic capabilities to foster initial growth and slack accumulation, and losing the window of opportunity to develop such capabilities while the market is growing.

Initial resource endowment interacts with these dynamics. In competitive markets strong initial resource endowments can provide a firm with a buffer from competitive pressures until the firm starts to benefit from its long-term investments (Section 3-3). This mechanism introduces interesting path-dependence dynamics: spending in long-term capabilities increases their level and thus the viability of strategies that favor further investment in these capabilities. On the other hand, once a firm is in a poor capability position, market forces leave the firm with few options other than further ignoring the long-term capabilities: e.g. today probably Ford can not try to step in Toyota's footsteps. In fact, if a firm has accumulated sufficient capabilities and resources during the growth phase of the market, it would then be in a position to benefit from further investments in long-term capabilities when the market matures. Therefore during the growth phase of a market, firms may face a critical dilemma: they can benefit from faster short-term growth by investing mainly in operational capabilities and production. However, this decision may rub them from the option of gaining superior performance through high investment in dynamic capabilities once the market matures. Small early differences in decisions regarding long-term capabilities can lead to large differences in the repertoire of feasible strategies the firm later faces.

Finally, the analysis here raises new questions regarding the viability of dynamic capabilities. Assuming that a firm plays rationally and faces a mature market dominated by reinforcing feedback, ad-hoc problem solving may prove more valuable than acquisition of dynamic capabilities. Empirical analysis can test the hypothesis that firms in markets dominated by reinforcing feedback are less amenable to investment in dynamic capabilities. Future studies can also analyze the conditions under which a firm can benefit from developing dynamic capabilities in these markets. Several other limitations of this study provide opportunities for future research. Our formulations of firm's performance were all simple and deterministic. We excluded the complexities arising from multi-dimensional capability spaces (Levinthal 2000) and stochastic performance that can lead to convergence to alternative peaks on rugged payoff landscapes (Levinthal 1997) and introduce capability traps (Levitt and March 1988). We assumed dynamic capabilities are independent of ad-hoc problem solving. However, sometimes ad-hoc problem solving leads to the creation of dynamic capabilities (Szulanski 2000). Our market aggregation mechanism assumed a homogenous demand base for a commodity product where demand is distributed between players based on their potential output levels. Niche markets and product differentiation based on heterogeneous customer tastes may impact the results. Firms may use the growth opportunities in one niche market to develop capabilities that are applicable in another market segment, therefore pacing their capability development strategy according to the opportunities available in multiple markets. Furthermore, we considered firms that are active in a single market. Larger firms are often active in multiple markets. This allows them to use the gains from one market to buffer from the competition the capability development activities in another market. Despite these limitations, we hope this analysis contributes to a more nuanced understanding of organizational capability development processes. All the simulation models are provided (See e-companion (S9)) for replication and expansion of the results.

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**Figures and Tables**

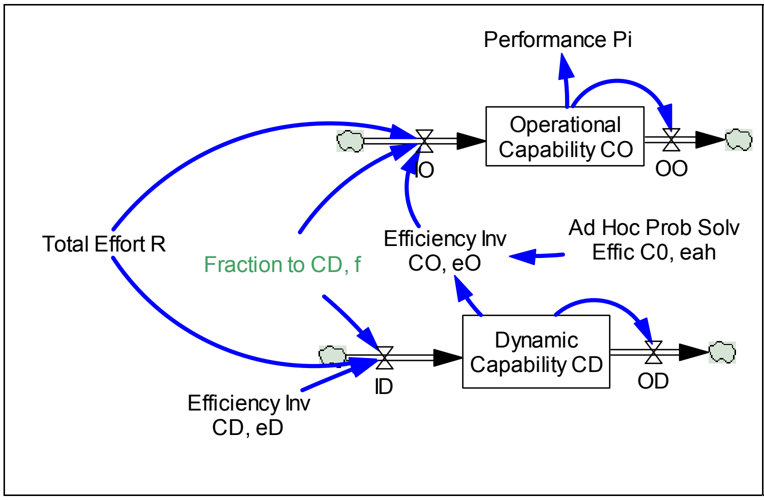


Figure 1- Overview of single firm model. The rectangles represent the stock variables (the two capabilities). The flow rates that control these capabilities are represented as valves. For simplicity only the main variables are shown. Complete equations are reported in the text.

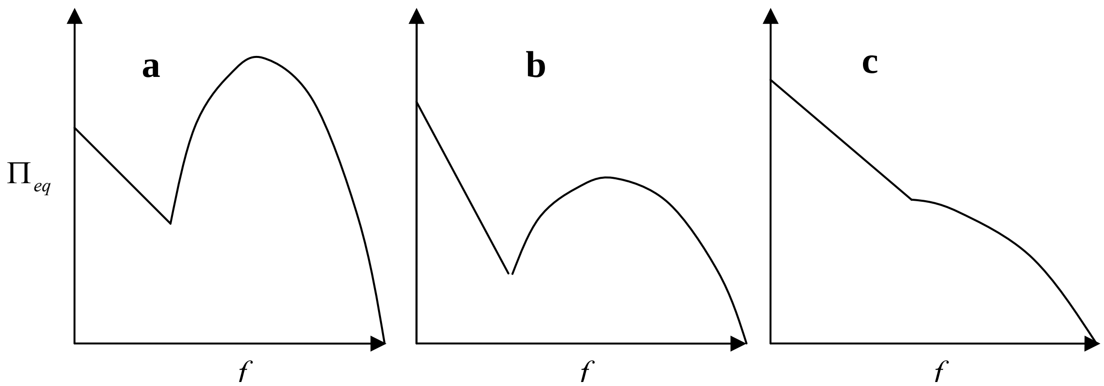


Figure 2- The three general conditions for equilibrium performance of a firm in light of the tradeoff between investment in operational and dynamic capabilities. Horizontal axis represents fraction of effort invested in development of dynamic capabilities (*f*) and changes between 0 and 1. Vertical axis denotes organizational performance in equilibrium. **a)** The maximum performance is attained by investing in both types of capabilities. A local peak exists where no investment in dynamic capability is required. **b)** Maximum performance is attained through the use of ad-hoc problem solving in order to generate operational capabilities. However, there is a local peak of performance where modest investment in dynamic capabilities partially pays off. **c)** The single peak in performance is achieved without investment in dynamic capabilities.

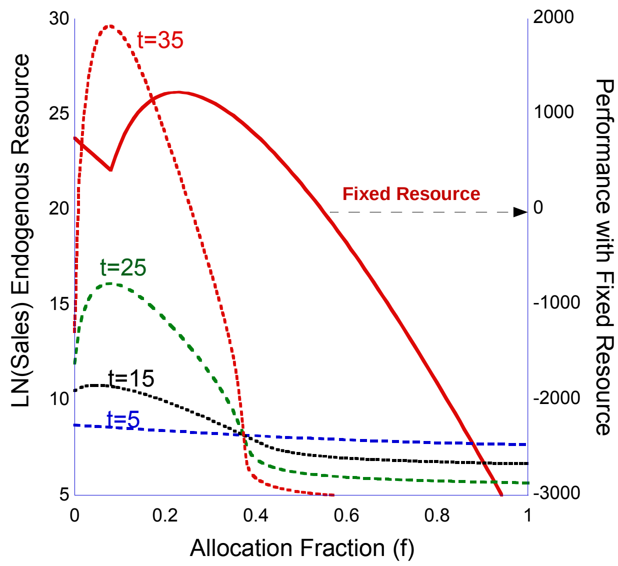


Figure 3- Natural logarithm of sales (left scale) for different allocation policies when efforts allocated are a function of performance and market is unlimited, reported at different times. Each point reports LN(Sales) for a firm using the allocation fraction from X axes at the reported time. Over the long-run peak sales is achieved by allocating no more than 8% of effort to dynamic capabilities. The performance for different allocation policies with fixed effort (solid line, right scale, in K$/Month) is also reported for comparison. Here peak performance is obtained at $f$=0.23.

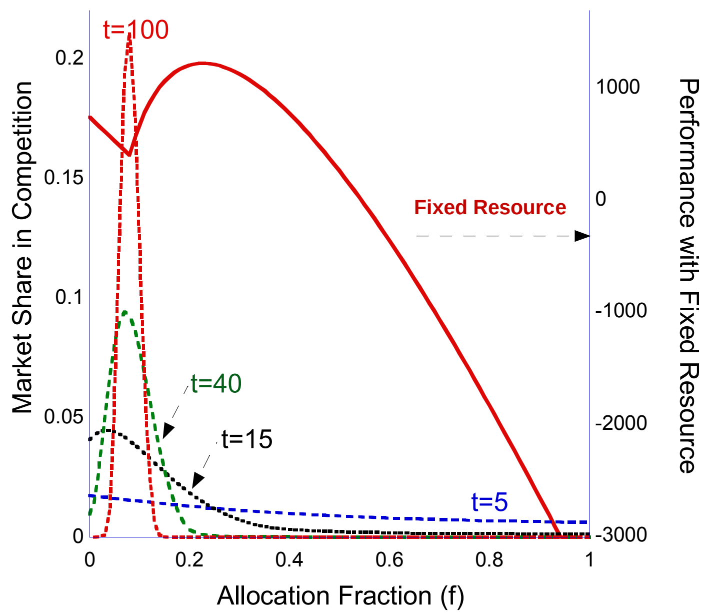


Figure 4-Market share for different firms in uniform competition, as a function of their effort allocation policy (left). Results based on $N$=101 competing firms at four different points in time are shown to highlight the gradual change in the dominant policy. Long-term dominant policy is achieved at $f$=0.08 and strategic equilibrium is at $f$=0. The performance for different allocation policies with fixed effort (solid line, right scale) is also reported for comparison (peak: $f$=0.24).

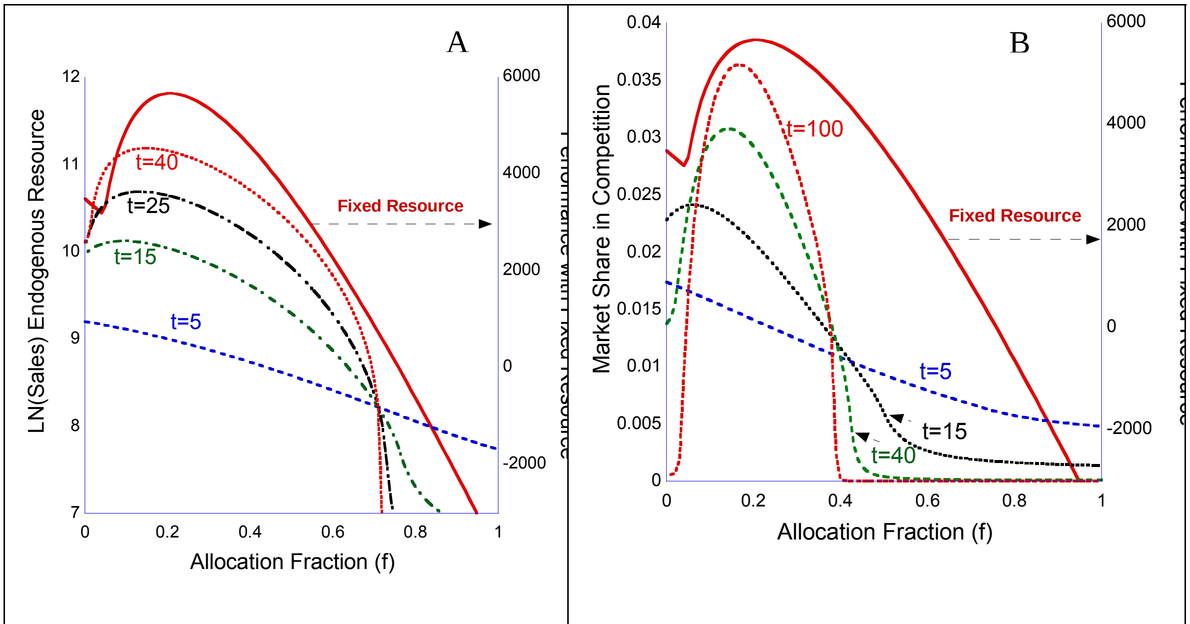


Figure 5– The result of analysis under time compression diseconomies where faster investment in resources and capabilities lead to additional unit development cost. A) Results for the case with endogenous effort (left axis) is compared to existence of fixed effort levels to invest (right axis). Peak performance is at *f*=0.15 for endogenous effort, compared to 0.21 for fixed effort. B) The results for the case with 101 firms competing with different levels of allocation fraction, *f*, is compared to the fixed effort case. The firm with *f*=0.17 wins the uniform competition. The game theoretic policy of *f*=0.10 dominates other policies in strategic competition.

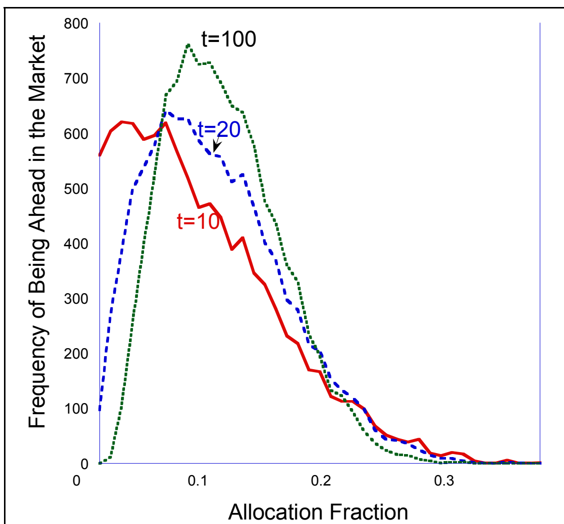


Figure 6- The frequency of firms with different initial capability endowments and allocation policies having the largest market share in uniform competitions among 101 firms. Results are reported from 10000 simulated markets with different random initial capability distributions. Frequency of leading firm's allocation fraction is reported at three different times in the progression of the markets to illustrate temporal dynamics.

| | | | |
|---|---|---|---|
| | +/N | + | Economies of scale |
| | - | - | Time compression diseconomies in both capabilities |
| | - | - | Resource slack |
| | - | N | Initial resources and capabilities |
| | - | N | Market growth opportunity |

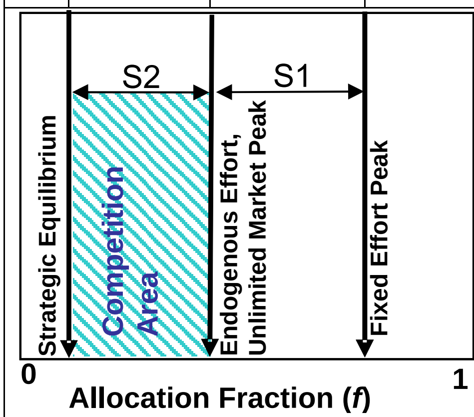


Figure 7- Shifts in best allocation policy due to growth opportunities and competition. Three performance peaks are identified for fixed effort, endogenous effort with unlimited market, and strategic competition's equilibrium. S1 and S2 represent the shifts in best allocation policy due to endogeneity and strategic competition. Competition without rationality assumption (e.g. uniform competition) can lead to winners in the striped area, depending on assumptions above market entrants. Impact of different firm and market variables on S1 and S2 are specified above, where +/-suggests increase/decrease in shift when we increase the variable on the right, and N suggests little or no effect.