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# Target Capability, not Target Sector, Matters

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## ABSTRACT

When a firm grows, should it grow where it has capability or where it has sector opportunities? We find that what capability to focus matters more than what sector to focus in determining firm performance. We resolve the two important puzzles in firm theory (the focus and the boundary of firm) from the perspective of administrating investment opportunities. Focus denotes how related a firm's projects are; boundary denotes how many distinct projects a firm manages concurrently. We analyze the tradeoff between informational efficiency and option value that a firm's relatedness in its investment opportunities generates. Our solutions imply, first, a firm's focus and boundary are substitutes. Second, the value of a multi-project firm is a convex function of its focus. Thus, the intermediate focus is the "stuck-in-the-middle situation" of corporate strategy. Third, the optimal hurdle rate for investment is a function of focus, but not firm boundary. The higher the focus of a firm is, the more serious the errors in valuation become. Our results suggest that the decision to choose between focus and diversification is not as important as the decision to choose between capabilities such as flexibility and information system. The focus in a capability, not the focus in the type of target sector, determines the value of the firm with investment opportunities. Thus, our results correspond to dynamic capabilities (Teece et al. 1997, Helfat et al. 2007) and management innovation (Hamel, 2006), but contrasts with Porter (1985) and 'conventional wisdom' (Khanna and Yafeh, 2007). Further, we provide a novel explanation for the Bowman Paradox - without relying on the sample-selection bias argument. Methodologically, combined with the mechanism design approach in modeling, the results suggest the integration of organizational economics and capability literature. We also show that real option and resource allocation perspectives are useful to resolve the puzzles in firm theory.

Keywords: focus, diversification, boundary, flexibility option, information system, resource allocation process

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## INTRODUCTION

With the firm objective to grow, a firm faces two choices. One is business strategy to grow its existing businesses through competitive advantage. The second is corporate strategy for administering new projects either related or unrelated. Therefore, it determines the boundary of a firm whether to use a business strategy by advancing existing projects or a corporate strategy by adding new projects. It determines the focus of a firm whether to use related or unrelated corporate strategy. Hence, we can call the former as the problem of firm boundary and the latter as the problem of firm focus. To rephrase, firm-boundary decision asks whether to explore a different project or to exploit existing ones, while firm-focus decision asks whether to explore related or unrelated project. Similarly, a corporate strategy can be related or unrelated. A firm conducts related (focused) corporate strategy by investing in new projects related with its existing lines. Unrelated (unfocused) corporate strategy invests in unrelated projects.

Both decisions are major issues for the firm theory. Firm theory is to investigate the behavior and organization of firms (Archibald 1987: The New Palgrave: A Dictionary of Economics). Thus, firm theory issues partly overlap organizational design problems that deal with firm's configuration, structure, or architecture (Burton & Obel 2004). The behavior and organization of firms have remained poorly understood (Holmstrom & Tirole 1989) although they are the critical decisions of the executives (Burton & Obel 2004). In particular, prior research has largely ignored how the firm makes the firm-focus and firm-boundary decisions jointly or how organizations jointly design the amount and type of investment opportunities.

Given the lacuna in firm and investment theories, our research question is how firms jointly manage their boundary and focus, or how firms jointly manage its boundary and focus, or what the optimal joint decision is. Since this is a too large research topic to cover satisfactorily in one paper, we decide to approach the problems from the perspective of internal resource allocation. Similarly, we operationalize the decision about strategy into the decision about investment strategy (Bower 1970, Bower & Gilbert 2005).

How a firm allocates its resources is an important determinant of how a diversified firm performs (Bower 1970, Scharfstein & Stein 2000, Bower & Gilbert 2005, Khanna & Yafeh 2007). The analysis on internal resource allocation also leads us to apply real option and agency theories. Real option is a useful framework to consider generating innovations from investment opportunities (Grenadier & Weissb 1997).

The process of internal resource allocation is subject to agency problems (Scharfstein & Stein 2000, Bower & Gilbert 2005).

First, we view a firm as a set of investment opportunities or a portfolio of real options (Myers 1984; Dixit & Pyndick 1992). We embed the real options in the process of internal resource allocation that transforms potential investment opportunities into realized projects dispersed across divisions. The internal resource allocation process includes the procedure of information sharing, the rule to relate the valuation of a project with investment and managerial compensation. The headquarters (HQ) exercises the property right to design the structural context (Bower 1970) and to allocate internal resources. We model these properties of internal resource allocation process. We find that the relatedness among real options is an important variable to derive the optimal process of the allocation.

Second, we model agency issues. Internal resource allocation incorporates agency problems (Bower 1970, Scharfstein & Stein 2000, Bower & Gilbert 2005). The challenges HQ faces are that: (1) the project managers have different incentives from that of HQ, and (2) they may have different information about projects than HQ does. If the agency problems are severe, resource allocation and firm collapse. We incorporate into our model the governance mechanism of resource allocation process about addressing agency problems and maintaining the boundary of firms.

We will show that the above setting allows us to specify the optimal configuration of firm and management of investment opportunities expressed in terms of real options. The desired focus and the boundary of the firms follow from how we configure the optimal resource-allocation process about managing investment opportunities. Importantly, we derive what matters in firm value and competitive advantage is neither about which target sector to focus nor about whether to use unrelated diversification vs. focus. What matters is *what target capability to choose*. This is the central finding of this paper.

This paper has several other contributions to existing research. First, we provide new insights about the benefits of focus. We show that focus enhances the efficiency of information system. Second, we investigate the tradeoffs between unrelated and related diversification in order to derive optimal diversification. The source of tradeoff is the information efficiency and option values existing in focus and unrelated diversification respectively. Third, we examine the cost-of-capital in multidivisional firms. One

interesting question is how HQ applies cost-of-capital to evaluate the projects of multiple divisions. In particular, we can answer how such cost-of-capital changes as the boundary and focus of firms vary. These are interesting questions, but prior research has not investigated them well. Fourth, we rigorously derive the optimal process and organization of internal resource allocation in multidivisional firms. This framework can guide multidivisional firms to efficiently allocate internal resource as well as maximize innovations in their internal resource management. Fifth, we establish real options framework as the theory of firm to explain the two major issues of firm theory, i.e. how the boundary and focus of firms emerge.

Finally, we provide a novel explanation to Bowman Paradox (Bowman 1980). Bowman Paradox questions the inverse relationship between risk and performance, seemingly unintuitive phenomenon. One popular answer is to argue that the paradox arises from statistical misspecification such as the sample-selection bias (Andersen, Denrell & Bettis 2007). We can show that the paradox can emerge even without the sample-selection bias. Instead, we link between organization design and the Bowman Paradox or between firm theory and the paradox.

## RELATED LITERATURE

We propose the two significant issues in firm theory, firm boundary and firm focus, are inseparable from each other. We frame the problem as administering real options in the process of internal resource allocation (Bower 1970, Bower & Gilbert 2005) such as how many investment opportunities to administer and what types of investment opportunities to manage. In our approach, two countervailing forces work to generate optimal number and type of real options. One force determines the efficiency of information system, and the other the value of investment option portfolios. We draw intuitions from the literature about firm boundary, firm diversification, real option, flexibility, and information system based on correlated mechanism. Thus, we integrate the intuitions from both organizational economics and capability literature.

First, in the theory of the firm, why does a firm exist or how does its boundary occur? Since Coase (1937) posed the question, various theories have appeared. Transaction cost economics (Williamson 1975) argues that the efficiency of internal transaction with respect to market transactions determines firm boundary. Asset specificity, which results in hold-up problem, is one of important underlying variables to determine the transaction cost. Resource-based view (RBV) suggests that firm boundary changes through the

deployment of resource to other projects in order to generate superior performance (Barney et al. 2001). Knowledge-based view (Kogut & Zander 1992) proposes that firms arise because they are better than markets to handle tacit knowledge. Neoinstitutional theory (Scott 2007: 3rd edition) views the boundary change as the diffusion of organizational forms. Firms attempt to build legitimacy by adopting organizational forms. Contractual and property-right views argue that firms are contractual arrangement to fill the incompleteness of standard market contracts (Grossman & Hart 1986; Hart & Moore 1990).

Second, one of the primary issues in firm theory is whether diversification creates value or not. It has been argued that unrelated diversification destroys firm values (diversification discount, Rumelt 1974). More recently, the results are mixed. After controlling the sample selection biases in the choice of corporate strategies, some researchers suggest that diversification can generate value (diversification premium). Villalonga (2004ab) and Martin & Sayrak, (2003) provide nice reviews for this issue.

We note the tradeoff between related and unrelated diversification. One benefit of unrelated diversification comes from flexibility option. Trigeorgis (1996) analyzes the flexibility option inherent in the decision about internal resource allocation. Stein (1997) models the option as winner picking in internal capital market. The lower the relatedness is, the more evident the best project becomes. This increases the value of flexibility option. In contrast, one benefit of focus occurs from the superior design of information system. This insight is from Vickrey-Clarke-Groves (Vickrey 1961; Clarke 1971; Groves 1973; Cremer & Mclean 1985, 1988). Vickrey-Clarke-Groves (VCG) mechanism induces the players of a game to reveal their types and private information. Hence, VCG mechanism ensures ex-post efficiency. For instance, under a VCG auction, the winner of the auction always values the prize most. Cremer and Mclean (1985, 1988) investigate the mechanism design problems in detail when the types of agents are related. In this situation, they show that the principal can implement the same allocation as if one has full information about the types. Such mechanism is well investigated also in McAfee, McMillan and Reny (1989), McAfee and Reny (1992).

We understand the value of firms as the aggregate value of real options that a firm owns (Myers 1984). The structure of a firm, i.e. focus and boundary, results from how the firm designs the portfolio structure of underlying real options. Kumar (2005) finds that real option approach well explains the boundary decision of joint ventures such as acquisition and divestiture. Tong and Reuer (2006) find that the

heterogeneity in the practices of firms to administer latent real options generates the heterogeneity in firm values. Scherpereel (2008) proposes option-creating institution (OCI) view of firm in order to incorporate the manner that firms explore growth opportunities and handle qualitative uncertainties. Grenadier and Weissb (1997) show how to apply real option in assessing investment opportunities and innovations.

The intuition of our results is consistent with the significance of dynamic capabilities (Teece et al. 1997, Helfat et al. 2007) and management (Hamel 2006), but partially contrasts Porter's (1985) sector targeting. Teece et al (1997) propose that competitive advantages arise from how a firm copes with rapidly changing surroundings through administering internal and external competencies. Hamel (2006) proposes that the innovation in management has determined the competitive advantages of various organizations and institutions. In addition, we extend the Porter's notion of 'stuck in the middle' in business strategies (cost leadership vs. differentiation) into corporate strategies. However, in contrast to Porter's recommendation about sectoral targeting, we emphasize the importance of capability targeting. We also disagree with 'conventional wisdom' that argues the significance of sectoral focus (Khanna and Yafeh, 2007).

## SETTING

Table 1 lists important concepts and behavioral assumptions used in our model. The nominal definitions of focus and unrelated diversification are high and low relatedness among projects in a firm. Their operational definitions use average correlation -- the ratio between common and idiosyncratic shocks to projects in a firm. The operational definition of firm boundary is the number of projects in a firm. We presume that the events in a multidivisional firm occur in the sequence described in Table 2. In the first period, process design, signaling, initial investment and initial cash flow occur. In the second period, reinvestment and firm value realization occur. At reinvestment stage, HQ puts all money in the best project. Table 2 describes only one cycle - without loss of generality. Any organization of going concern has series of such cycles that can overlap each other.

Burgelman (1983, 1991) provides detailed description and mechanism about signaling in the first period and reinvestment in second period. Burgelman calls such processes as internal variation, selection and retention mechanisms using the terminology of cultural evolutionary theory. We argue that Burgelman mechanism implies important tradeoff between the potential of variation and the benefit of retention,

which existing literature has not emphasized. We clarify the tradeoff by relating the characteristics in variation and retention with the benefits of focus and unrelated diversification. Similarly, Burgelman (1983) calls for the balance between order and diversity that corporate management needs to control, which we capture with the balance between focus and unrelated diversification. As Burgelman (1983, 1991) shows the importance of this strategic process, we demonstrate how the organization of internal resource allocation determines firm value.

******* Insert Table 1 and Table 2 *******

The settings in Table 1 and Table 2 and some additional technical assumptions yields the optimal configuration of internal resource-allocation process in terms of information system and allocation process described in Table 3. The optimal process becomes the basis of our computational model. We explain the proof and computational process in APPENDIX 1.

******* Insert Table 3 *******

## SIMULATION AND RESULTS

In Table 4, we relate propositions based on our computational results. The propositions summarize our results and guide empirical tests for future research. We will discuss the results and propositions sequentially in this section.

******* Insert Table 4 *******

We perform Monte Carlo simulation 10^5 times to compute firm values. Figure 1 presents the relation between the expected return and the diversification, measured with both the number of divisions and the correlation.

******* Insert Figure 1 and Figure 2 *******

In Figure 1, the X-axis denotes t, the fraction of the common factor in the type of a division. It essentially represents the correlation among divisions, i.e. the extent of focus. The Y-axis is the number of divisions that the HQ considers investing in, i.e. the boundaries of a firm. The Z-axis is the expected return computed with the ratio between expected firm value and the initial internal resources. It also signifies average Tobin's q because it is post-investment market-to-book ratio. It is clear that the number of divisions and the correlation affect the expected return in very different ways. This shows the importance of

distinguishing conventional diversification in terms of correlation from the number of divisions. That is why we call the first focus/ diversification and the latter boundary.

Figure 2 depicts the relationship between firm value and focus measured with correlation. The graphs at low place are the returns when the number of divisions is smaller; upper graphs are the opposite case. As the number of divisions (k) increases, the graph changes from balanced smiles to smirks. Such patterns arise because the number of divisions affects firm value more when correlation is small than when it is large. Thus, the correlation and the number of divisions are substitutes ($\partial^2 V/(\partial t \partial k)<0$) of each other. In other words, small firms tend to show focus, while large firms tend to exhibit unrelated diversification. Therefore, when a firm has many divisions, it is better for the firm to reduce the correlation among them. It is an intuitive recommendation. As the projects are less inter-independent, the flexibility option that HQ owns becomes more valuable. In particular, the value of the best project increases with the increase in the number of options. In contrast, when the correlation is high, adding another correlated division does not create much value because the new project is much alike the other ones.

The expected return is a convex function of correlation, implying that we are likely to observe firms demonstrating either much focus or much unrelated diversification. To rephrase, in equilibrium, we will observe diversified firms clustered at high and low relatedness among divisions. This is an example of how corporate strategy can create value by appropriately choosing the extent of relatedness among divisions. Porter (1985) argues that:

> Interrelationships among business units are the principal means by which a diversified firm creates value, and thus provide the underpinnings for corporate strategy (p. 3)

One can argue that high-focus firm would produce larger marginal benefit from adding an unrelated project instead of adding a highly related project. However, it is important to note that ours is an equilibrium argument, meaning that firms already optimize their organization structure. Adding either correlated or independent task does not help marginally. What this paper proposes is that in equilibrium we will observe the clusters of highly related and highly unrelated diversified firms (U-shape clustering).

In fact, U-shape clustering is partially in line with the intuition of Porter (1985). Porter defines ‘stuck in the middle’ as the situation in which a firm engages in each generic strategy, but fails to achieve any of them. U-shape clustering occurs when firms avoid being stuck in the middle of narrow or broad targets through corporate strategies. While Porter stresses ‘stuck in the middle’ in product market (cost leadership vs. differentiation), we show that the similar phenomenon can happen in corporate strategy.

In addition, the U-shape result corresponds to the broader literature about corporate diversification. The portfolio view about corporate diversification implies that unrelated diversification lowers the total risk of a firm, so that it can eventually increase its performance (Amit & Livnat 1988, Chang & Thomas 1989). In comparison, to overturn the portfolio view, diversification can be inefficient since shareholders can conduct portfolio diversification more easily, or agent problems arise (Brealey, Myers, & Allen 2005, Ross, Westerfield, & Jaffe 2002). Our results show that the two views are *valid in the polar cases, but may miss the bigger picture*. Ambiguous empirical results strengthen this conjecture (Campa & Kedia 2002, Graham, Lemmon & Wolf 2002; Villalonga 2004ab) in which neither diversification premium nor discount prevails. In addition, Khanna and Yafeh (2007) list several papers that report U-shape relationship between diversification and performance.

Our findings recommend a firm to concentrate either in option value or in information system to become the organization of either *unrelated* or *related* diversification respectively. Thus, *what matters in corporate strategies is not about whether to specialize in a sector, but about whether to specialize in a capability* such as maximizing option values and informational efficiency. Whether to seek in related or unrelated sector is less relevant than what capability to build. Our finding is consistent with the intuition of dynamic capabilities (Teece et al. 1997) and management innovation (Hamel, 2006). However, ours contrasts Porter (1985), which recommends firms to focus on a few selected target sectors, 'conventional wisdom’, which advocates the benefits of corporate focus (Khanna and Yafeh, 2007).

Furthermore, our U-shape can explain Bowman Paradox (Bowman 1980) without relying on the sample-selection bias story (Andersen, Denrell & Bettis 2007). The literature tends to measure the risk of a firm with how its performance fluctuates. The variance of performance is a natural measurement (e.g. variance of accounting performance in Bowman’s original paper). In our model, focus increases the variance,

but unrelated diversification decreases it. For example, in the limiting case of very large number of projects, the variance converges to the variance of common factor multiplied by the squared fraction of the common factor. This is one in perfect focus, but zero in perfectly unrelated diversification in our normalized setting. The law of large numbers is the relevant intuition. Since the performance is the U-shape function of focus, risk-performance relationship is negative at the left hand of the U-shape. This pattern corresponds to Bowman Paradox.

******* Insert Figure 3 *******

Figure 3 expresses expected return as a function of the number of divisions. The flat graphs describe the relationship under focus. The peaked ones occur when the type of divisions are independent. The firm value is an increasing function of the number of divisions. Thus, the HQ wants to consider as many projects as possible for potential investment decisions. However, if it is costly to acquire a real option (e.g. a fixed cost of maintaining a division or a project), a unique solution for the optimal number of divisions will arise. Since the marginal benefit of adding divisions decreases, the increasing or the constant marginal cost of adding real options will produce the optimal solution. This is clearly a realistic case. The labor costs of hiring project managers, which we have been disregarded, can be material fixed cost. Administrative costs are also important. Besides such straightforward costs, the cost of multiple divisions can arise due to monitoring (Stein 1997), coordination (Fluck & Lynch 1999), and market's discount on free cash-flow due to the flexibility in cash deployment (Matsusaka & Nanda 2002, Inderst & Mueller 2003).

The change in the marginal value of adding a division comes from the change of the marginal value of flexibility option, and is the representation of the law of large numbers. The marginal value of the flexibility option is positive because the expected value of the best projects increases with the increase of firm boundary. The best project is the first-order statistic of the sample. The marginal value of enhanced precision is also positive, because adding one more project is analogous to adding one more signal upon which HQ can estimate the value of a project. Our simulation results demonstrate that the sum of those marginal values diminishes with firm boundary. The result comes from the statistical properties of first-order statistics and of the accuracy of sample mean (the law of large numbers).

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Our results address the issue of Coase (1937). In his critique of Joan Robinson and other economists, he argues that the upward-sloping cost curve of a firm is not enough to determine the size of the firm because the firm can broaden its boundary. Coase (1937) writes,

> But it is clear that a firm may produce more than one product and, therefore, there appears to be no prima facie reason why this upward slope of the cost curve in the case of perfect competition or the fact that marginal cost will not always be below marginal revenue in the case of imperfect competition should limit the size of the firm. (Coase 1937)

Coase proposes that firm boundary arises from the tradeoff between the cost of using price mechanisms (marketing costs) and the cost of organizing different projects in the firm. Nevertheless, such a transaction cost story is silent as to why the marginal benefit of internalization decreases or marginal cost increases in order to produce the solution for firm boundary. This paper answers those questions based on the statistical properties of the flexibility option and information system on related signals. Thus, we can conjecture that if it is costly to attain an investment opportunity, our model provides the interior solution for the optimal number of divisions. This conjecture is in line with Coase's argument to determine the benefit and the limit of integration via firm instead of market transaction.

> … factor of production (or the owner thereof) does not have to make a series of contracts with the factors with whom he is co-operating within the firm, as would be necessary, of course, if this co-operation were as a direct result of the working of the price mechanism. For this series of contracts is substituted one (Coase 1937: 336)

> … a firm will tend to expand until the costs of carrying out the same transaction by means of an exchange on the open market or the costs of organizing in another firm (Coase 1937: 341)

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Figure 4 presents the relationship between the optimal hurdle rate and the corporate strategies in terms of focus and boundary. To remind, a firm invest in a project only when the expected return from the project exceeds a hurdle rate. We find that, while correlation affects optimal hurdle rate, firm boundary does not.

******* Insert Figure 4 *******

Although we conduct Monte Carlo simulation 10^6 times, we could not achieve a smooth shape when relatedness between divisions is close to nonexistent. This implies that the sensitivity of firm value to the change of hurdle rate is high when a multidivisional firm exhibits focus. Therefore, the focused firms with related diversification should pay close attention to hurdle rates. The Figure 5 and Figure 6 show these patterns more clearly.

******* Insert Figure 5 and Figure 6 *******

In Figure 5, the X-axis denotes correlation, and the Y-axis displays optimal cost of capital, creating a U-shaped curve similar to the relation between firm value and focus, but more skewed. In Figure 6 in which no clear relationship is visible, the X-axis indicates number of divisions, and the Y-axis denotes optimal cost of capital. In conclusion, optimal hurdle rate is subject to the focus, but less to the boundary of firms.

Figure 7 integrate our propositions in line with Table 4. Valuation accuracy influences the performance of focus much. Hurdle rate is a function of focus, not of boundary. Focus and boundary are substitute such that the firms with related diversification tend to have narrow boundary. Focus decreases the value of flexibility option, but enhances information system. The expansion in firm boundary increases the benefits of both flexibility option and information system, but at decreasing rate. The expansion is costly because HQ should purchase and administer larger number of real options. A firm tends to specialize in exploiting either flexibility option or information system resulting in either focus or unrelated-diversification entity respectively. The specialization and cost of expansion determines the organizational design of an optimized firm.

******* Insert Figure 7 and Figure 8 *******

Figure 8 summarizes managerial implications. Managers jointly decide whether to maximize option value and whether to maximize the benefit of information system. The joint decision generates four possible

combinations of organization. We call {high information system, high option value} as bog, {high info, low option} as knowledge, {low info, high option} as portfolio, and {low info, low option} as inaction.

At bog, an organization attempts maximizing the values of both flexibility option and information system. This involves moderate diversification, while allowing flexible application of cost of capital. However, such effort leads to stuck-in-the-middle because it cannot achieve specializing in any capability. At knowledge, an organization chooses to specialize in the capability of managing information system. This involves focus and allows applying cost of capital flexibly. At portfolio, an organization opts to specialize in the capability of managing real-option portfolio. This involves unrelated diversification and requires applying cost of capital accurately. At inaction, an organization does not utilize either real-option portfolio or information system. This cannot accomplish any capability. This behavior implies ineffective management and moderate diversification. We believe both knowledge and portfolio fine, but neither bog nor inaction desirable.

## REMARKS

### Why we apply mechanism design approach to organization design

Mechanism design investigates how to elicit information and how social decisions can respond to information constraints. It is a special case of agency theory research (Mas-Colell et al, 1995). Agency theory has relation with information theories, has several links to mainstream organization perspectives and makes novel contributions to organization design (Eisenhardt 1989). Hence, mechanism design is valuable to design organizations considering information structure and conflicting interests as a subset of larger agency theory. This relation motivates us to utilize mechanism design approach in order to investigate the optimal organization design such as focus and boundary of firms. In addition, we follow the recommendation of Eisenhardt (1989), and Burton and Obel (2004) to examine information systems, uncertainties and risks.

To apply the standard approach of mechanism design (Myerson 1981, Fudenberg & Tirole 1996), we set the game between HQ and division such that, once the HQ announces the organization/ mechanism design, it should not change it during the game. The HQ's ability to commit to a mechanism arises in various situations. Intuitively, the optimal static allocation remains optimal in a dynamic context with commitment. Explanations that are more elaborate also exist.

First, our model may represent a repeated game between the HQ and its divisions. Then, by the Folk theorem (Fudenberg & Maskin 1986), we can achieve any feasible and individually rational payoffs, if both HQs and divisions are patient enough. In this case, deviating from the commitment is not optimal.

Second, if HQ and divisions have identical time preferences, non-cooperative bargaining produces Bayesian equilibrium in which a mechanism exists and produces the same allocation (Fudenberg & Tirole, 1996).

Third, if HQ commits to outside investors about the organization structure that specifies internal-resource allocation rule, the HQ can change the allocation rule only upon the approval of a board meeting. However, such change is undesirable to all participants of this game.

Fourth, the notion of mechanism design and the HQ's commitment to it correspond to the 'constitution writing' (Bower 1970, Bower & Gilbert 2005), which argues that the primary role of top management team is to define and manage the organization's structural context.

**The comparison with external financing**

One can argue why our model is more appropriate to explain internal capital market than external capital markets, such as bank lending and equity issuing. We can address the argument in several ways.

First, as for bank lending, since banks do not have ownership over the projects financed, they cannot increase investment in profitable projects freely. The banks can only relax their credit constraints. More seriously, if the project performs poorly, the bank can only sell assets in the project to recoup its investment. These banks may have to dispose of illiquid assets, such as firm specific capitals, at significantly discounted prices. Thus, banks have difficulty in exercising flexibility option. In contrast, the HQ can simply redeploy asset to other divisions.

Second, banks have less incentive to monitor projects than HQs, in order to identify winning and losing projects. The presence of property right determines such incentives. Gertner, Scharfstein and Stein (1994) provide detailed comparison between HQ and banks based monitoring.

Third, as for stock issuance, minor stockholders do not have controlling rights over assets. They have neither right to sell assets in an unprofitable project nor the authority to increase investment in a profitable project. Stockholders can trade stock, but such trading does not mean the rearrangement of assets such that it

increases investment in profitable projects and liquidates unprofitable projects. Shareholder activism is not much helpful either. The decentralized stockholders do not have much incentive to monitor projects due to the cost of activism.

Fourth, stocks normally represent the claims on the average assets in a firm, rather than those for specific projects. Indeed, project-specific stocks are infrequently traded.

## CONCLUSION

Our research question starts from how a firm makes joint decision about boundary and focus. In order to solve the problem, we combine the game theoretic approach in organizational economics and the strategic intuition of capability literature. We find capability targeting is more important than sectoral targeting to determine the value of a firm. This result corresponds to dynamic capability (Teece et al. 1997) and management innovation (Hamel 2006). We also extend Porter's intuition about stuck-in-the-middle in business strategy to corporate strategy while contrasts Porter's recommendation about targeting sectors (Porter 1985). In addition, we resolve two important puzzles in firm theory -- the boundary and focus of firm -- with the framework about real option and internal resource allocation.

Our propositions guide managers to implement corporate strategies and organization design jointly. First, when considering focus or unrelated diversification, firms need to think them in terms of target capability rather than target sectors. We recommend specialization in either maximizing the value of real option portfolio or designing superior information system. The unrelated diversification or focus in sectors follows depending on which capability a firm chooses. The failure to specialize in capability may result in costly stuck-in-the-middle status in corporate strategy.

Second, a multidivisional firm with a large number of divisions may seek further unrelated diversification in order to attain independence among its divisions. A related diversification in which the projects are highly correlated needs to have a small number of divisions. The marginal values of a firm's focus and boundary exhibit negative correlation. Thus, managers should consider the tradeoff between focus and boundary during decision-making.

Third, the optimal hurdle rate for investment is a function of focus, but not firm boundary. The optimal hurdle rate is highly skewed and convex function, in which either related or unrelated diversification

firms require higher rates than the moderately diversified ones. Errors in determining optimal hurdle rate are particularly costly to the focused firms with related diversification. This result suggests additional cost of focused firms since the optimality in hurdle rate influences the value of related diversification much. The managers in related diversification should be particularly careful about resource allocation. Their mistakes potentially have large ramification. In relation, we derive the optimal structure of internal resource-allocation process.

Fourth, a corporate strategy needs to balance the countervailing forces in option value and information system to determine focus and boundary. This tradeoff is novel in literature and suggests a solution to the puzzle about when related or unrelated diversification arises. The relatedness among the information of managers conceptualizes the extent of relatedness in a firm. High relatedness reduces the option value of the HQ's flexibility. On the other hand, it makes the internal resource-allocation process more efficient informationally. The value of a multidivisional firm is subject to such double aspects of correlation.

Fifth, the tendency of decreasing marginal values in firm boundary results from the real option approach of ours. This result informs managers about the limit of expanding firm boundary. Given the decreasing marginal benefit of boundary, if a fixed cost exists to obtain investment opportunities, an interior solution is present for the optimal number of divisions. This demonstrates how the theory of real option becomes a theory of firm.

Sixth, multidivisional firms may need to seek, in expectation, either much related or unrelated diversification at optimum. The value of a multidivisional firm is a convex function of its focus. The intermediate focus is the stuck-in-the-middle situation of corporate strategy.

Many next steps are possible. First, empirical models may test the predictions made in this paper. Second, we can reexamine diversification premium/discount with the theories developed in this paper. We propose that diversification literature should model the decision of focus and boundary *jointly* during empirical analysis in order to avoid misspecification. Third, while we derived the desired organizational configuration, we can include the cost of such configuration in order to generalize our results further.

## REFERENCES


Amit, R. & Livnat, J. (1988). Diversification and the risk-return trade-off. Academy of Management Journal, 31(1), 154 -- 166.

Andersen, T.J. , Denrell, J. & Bettis, R.A. (2007). Strategic responsiveness and Bowmans risk-return paradox. Strategic Management Journal, 28 (4): 407 -- 429.

Archibald, G. C. (1987). Firm, theory of the. The New Palgrave: A Dictionary of Economics.

Argyres, N., Felin, T., Foss, N., Zenger, T. (2009). Organizational economics and organizational capabilities: from opposition and complementarity to real integration. Organization Science, 20 (4): 832 -- 834.

Barney, J., Wright, M., & Ketchen Jr, D. J. (2001). The resource-based view of the firm: Ten years after 1991. Journal of Management, 27(6), 625 -- 641.

Bower, J. L. (1970). Managing the Resource Allocation Process: A Study of Corporate Planning and Investment. Harvard Business School Press.

Bower, J. L., & Gilbert, C. G. (2005). From Resource Allocation to Strategy. Oxford University Press.

Bowman, E.H. (1980). A risk/return paradox for strategic management. Sloan Management Review, 21: 17 -- 31.

Brealey, R.A. & Myers, S.C. & Allen, F. (2005). Principles of Corporate Finance. New York: McGraw-Hill/Irwin.

Burgelman, R. A. (1983). Entrepreneurship and strategic management: insights from a process study Management Science, 29(12): 1349 -- 1364.

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

Burton, R. M., & Obel, B. (2004). Strategic Organizational Diagnosis and Design: The Dynamics of Fit. Kluwer Academic Publishers.

Campa, J. M. & Kedia, S. (2002). Explaining the diversification discount. Journal of Finance, 57 (4). 1731 -- 1762.

Chang, Y. & Thomas, H. (1989). The impact of diversification strategy on risk-return performance. Strategic Management Journal, 10 (3), 271 -- 284.

Clarke, E. H. (1971). Multipart pricing of public goods. Public Choice, 11(1), 17-33.

Coase, R. H. (1937). The Nature of the Firm. Economica, 4(16), 386-405.

Cremer, J., & McLean, R. P. (1985). Optimal Selling Strategies under Uncertainty for a Discriminating Monopolist When Demands Are Interdependent. Econometrica, 53(2), 345-61.

Cremer, J., & McLean, R. P. (1988). Full Extraction of the Surplus in Bayesian and Dominant Strategy Auctions. Econometrica, 56(6), 1247-57.

Eisenhardt, K. (1989). Agency theory: an assessment and review. Academy of Management Review 14 (1) 57 -- 74.

Dixit, A. K., & Pindyck, R. S. (1994). Investment under uncertainty. Princeton University Press Princeton, NJ.

Fluck, Z., & Lynch, A. W. (1999). Why Do Firms Merge and Then Divest? A Theory of Financial Synergy*. The Journal of Business, 72(3), 319-346.

Fudenberg, D., & Maskin, E. (1986). The Folk Theorem in Repeated Games with Discounting or with Incomplete Information. Econometrica, 54(3), 533-554.

Fudenberg, D., & Tirole, J. (1991). Game Theory. Mit Press.

Gertner, R. H., Scharfstein, D. S., & Stein, J. C. (1994). Internal versus External Capital Markets. Quarterly Journal of Economics, 109(4), 1211-30.

Graham, J. R., Lemmon, M. L. & Wolf, J. G. (2002) Does corporate diversification destroy value? Journal of Finance, 57 (2). 695 -- 720.

Grenadier, S R & Weissb, A.M. (1997). Investment in technological innovations: an option pricing approach. Journal of Financial Economics 44 (3), 397-416.

Grossman, S. J., & Hart, O. D. (1986). The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration. The Journal of Political Economy, 94(4), 691.

Groves, T. (1973). Incentives in teams. Econometrica, 41(4), 617-631.

Hamel, G. (2006). The why, what, and how of management innovation, Harvard Business Review 84 (2), 72 -- 84

Hart, O., & Moore, J. (1990). Property rights and the nature of the firm. Journal of Political Economy, 98(6), 1119 -- 1158.

Helfat, C., Finkelstein, S., Mitchell, W., Peteraf, M.A., Singh, H., Teece, D.J., Winter, S.G. (2007). Dynamic Capabilities: Understanding Strategic Change in Organizations. Oxford, U.K.: Blackwell

Holmstrom, B., & Tirole, J. (1989). Theory of the firm. Handbook for Industrial Organization, Volume 1, Edited by Richard Schmalensee and Robert D. Willig. Elsevier Press.

Hoskisson, R. E. & Hitt, M. A. (1990). Antecedents and performance outcomes of diversification: a review and critique of theoretical perspectives. Journal of Management, 16 (2), 461 -- 509.

Inderst, R., & Muller, H. M. (2003). Internal versus External Financing: An Optimal Contracting Approach. The Journal of Finance, 58(3), 1033-1062.

Khanna, T.; Yafeh, Y. 2007. Business groups in emerging markets: paragons or parasites? Journal of Economic Literature, 45 (2): 331 -- 372.
Kogut, B., & Zander, U. (1992). Knowledge of the firm, combinative capabilities, and the replication of technology. Organization Science, 3(3), 383-397.
Kumar, M. V. S. (2005). The value from acquiring and divesting a joint venture: A real options approach. Strategic Management Journal, 26(4), 321-331.
Martin, J. D., & Sayrak, A. (2003). Corporate Diversification and Shareholder Value: A Survey of Recent Literature. Journal of Corporate Finance, 9(1), 37-57.
Mas-Colell, A., Whinston, M. D., Green, J. R. (1995). Microeconomic Theory. Oxford University Press, New York.
McAfee, R. P., McMillan, J., & Reny, P. J. (1989). Extracting the Surplus in the Common-Value Auction. Econometrica, 57(6), 1451-1459.
McAfee, R. P., & Reny, P. J. (1992). Correlated Information and Mechanism Design. Econometrica, 60(2), 395-421.
Myers, S. C. (1984). Finance Theory and Financial Strategy. Interfaces, 14(1), 126-137.
Myerson, R. B. (1981). Optimal Auction Design. Mathematics of Operations Research, 6(1), 58-73.
Porter, M. E. (1985). Competitive advantage: creating and sustaining superior performance. Free Press. New York.
Ross, S.A, Westerfield, R.W. & Jaffe, J. (2002). Corporate Finance. New York: McGraw-Hill.
Rumelt, R.P. (1974). Strategy, structure, and economic performance. Boston, MA: Harvard Business School Press.
Scharfstein, D. S., & Stein, J. C. (2000). The Dark Side of Internal Capital Markets: Divisional Rent-Seeking and Inefficient Investment. The Journal of Finance, 55(6), 2537-2564.
Scherpereel, C. M. (2008). The option-creating institution: a real options perspective on economic organization. Strategic Management Journal, 29(5), 455 - 470.
Scott, W. R. (2007). Institutions and Organizations: Ideas and Interests (Third Edition., p. 280). Sage Publications, Inc.
Stein, J. C. (1997). Internal Capital Markets and the Competition for Corporate Resources. Journal of Finance, 52(1), 111-33.
Teece, D.J., Pisano, G.P. & Shuen, A. (1997). Dynamic capabilities and strategic management. Strategic Management Journal, 18 (7): 509 -- 533.
Tong, T. W., & Reuer, J. J. (2006). Firm and industry influences on the value of growth options. Strategic Organization, 4(1), 71 - 95.
Trigeorgis, L. (1996). Managerial flexibility and strategy in resource allocation. The MIT Press. Boston, MA.
Vickrey, W. (1961). Counterspeculation, auctions, and competitive sealed tenders. Journal of Finance, 16(1), 8-37.
Villalonga, B. (2004a). Diversification Discount or Premium? New Evidence from the Business Information Tracking Series. The Journal of Finance, 59(2), 479-506.
Villalonga, B. (2004b). Does Diversification Cause the'Diversification Discount'? Financial Management, 33(2).
Williamson, O. E. (1975). Markets and Hierarchies. Free Press. New York

## APPENDIX 1: OPTIMAL PROCESS OF INTERNAL RESOURCE ALLOCATION

The HQ and its divisions play a typical signaling game in which the HQ designs a mechanism and the divisions send messages about their types. We regard the designed mechanism as the process for internal resource allocation.

Managers want to maximize their respective project budgets. Project managers derive private benefits that increase with the resources under their control (Stein, 1997). They make signaling (reporting) decisions in line with these objectives. There are infinite ways of signaling. However, we can restrict the message space to the true space, and impose truth-telling conditions, for the appropriate equilibrium concept of our model is Bayesian Nash equilibrium. An incentive-compatible direct mechanism can represent any Bayesian Nash equilibrium of any Bayesian game (Revelation Principle; Myerson 1981).

Suppose there are N projects (divisions). The type of a project, which the manager of the project identifies, is the return on investment. The return from a project 'i' is specified with factor model as follows:

$$r_i = 1 + t\varepsilon_f + (1\text{-}t)z_i. \quad (1)$$

$\varepsilon_f$ is the same to all projects, a common factor or systematic shock to a firm. $z_i$ is an idiosyncratic shock so that it is different across all projects. $\varepsilon$ and z are distributed independently and identically. t exists between zero and one in order to specify correlation among divisions. If t is one, the types of all projects are the same to define perfect focus. If t is zero, every project is independent to indicate perfectly unrelated diversification.

If we normalize the risk-free rate as one without loss of generality, $t\varepsilon_f + (1\text{-}t)z_i$ terms are excess returns. For simplicity, both systematic and idiosyncratic shocks are drawn from standard normal distribution. Thus, first, the unconditional expected return from a project is the same as the risk-free return. Second, the risk premium of all projects is set to zero.

Let us denote $s_i$ as the signal about the type $r_i$. In addition, $a_i$ indicates internal resource allocation to division i. The strategy of division i is plain: The manager reports $s_i$ about $r_i$ in order to maximize $a_i$.

### The HQ's allocation strategy

Once the HQ receives messages from the divisions, it allocates internal resources based upon the pre-specified capital-budgeting routine. Let us denote M as the total internal resource that the HQ owns. The optimal capital-budgeting process solves the following problem:

Maximize firm value (2)
with respect to capital-budgeting process,
Subject to:
Incentive compatibility (truth-telling condition):
$a_i(r_1, r_2,\ldots, r_i,\ldots ,r_N) \geq a_i(r_1, r_2,\ldots, s_i,\ldots r_N)$ for all i and $s_i$. (2.1)
Limited liability: $a_i(\bullet) \geq 0$ for all i. (2.2)
Resource constraints: $\sum a_i \leq M$. (2.3)

The objective of the HQ is firm-value maximization. The design of resource allocation process is a constraint optimization problem with three constraints. The first is an incentive compatibility condition to ensure truth telling by division managers upon Revelation Principle (Myerson 1981). The divisions aim to maximize budget. They will signal their types truthfully only when lying does not bring more internal resource. The incentive compatibility requires that the truth telling be Nash equilibrium in which unilateral deviation (lying) does not bring about higher budgets. It is important to remind that we can apply truth-telling condition without any loss of generality. In reality, of course, managers may lie. However, we can transform all such disclosure strategies into truth-telling game upon Revelation Principle.

The second condition stipulates that the HQ cannot borrow money from divisions. The HQ has property rights over all assets that the divisions own. Hence, the total internal resource M is the sum of all the

resources that either the HQ or its divisions own. Thus, by definition, the divisions do not have any resources to lend to HQ.

The third condition requires that the HQ cannot allocate more internal resources than what it possesses. The solution to the above problem defines the optimal resource-allocation process. The following theorem describes the optimal resource-allocation process.

*Theorem: The optimal process to allocate internal resources is as follows. (1) The HQ selects N projects out of N0 projects with the same probability to form a firm (define firm boundary). (2) The HQ estimates the expected return of a project conditional on the signal from the other N-1 divisions. (3) If the estimated expected return of a division is greater than a cost-of-capital $\tau$, the division receives M/N. Else it receives nothing. Fourth, the HQ stores the remaining internal resource at a risk-free rate.*

We describe the intuitive proof as follows:

*PROOF: The HQ should not use the information from a division to evaluate that division. If a division knows that its signal can affect its budget, it has incentive to manipulate the signal. Such an argument shares the same intuition with the VCG mechanism. Given risk neutrality, the best way to assess the investment opportunity of a division is to compute its expected return conditional on a signal from the other divisions. The HQ will invest in a division as far as the estimate is greater than a pre-specified cost of capital. Since we consider only symmetric equilibrium without loss of generality, the cost of capital should be the same for all projects. It is possible that the estimates of all projects are above the cost-of-capital. Thus, a division can receive at most M/N in expectation in which M is total internal resource and N is the number of projects in which the HQ considers investing. On the other hand, the allocation should not be less that M/N because the HQ is risk-neutral. Indeed, the risk-neutral HQ wants to increase investment as far as the expected return is higher than cost-of-capital. With a similar intuition, the HQ should select N out of $N_0$ projects in such a way that all divisions should have equal chance of selection. Upon Myerson's terminology (Myerson 1981), virtual valuation and incentive compatibility move in opposite directions in our model. Thus, the HQ should compensate every division equally in expectation of this result. Hence, the cost-of-capital and the selection probability should be fair.* ■

The proof is not complete because it does not specify the cost-of-capital and the firm boundary. This will be done in a later section. To combine the derived process of optimal internal resource allocation with the sequence of events, we can derive the detailed structure of resource-allocation process as Table 3, which the following sections explain in detail.

***Firm boundary and project managers***

We will relate the N selected projects with *firm boundary*. Once the HQ chooses N projects, it assigns one project manager per project. The task of the managers is to investigate the type of projects and to report them to the HQ. Later, the HQ uses the information to select K projects out of the N project to invest.

***Learning and information asymmetry***

The HQ and the project managers share common knowledge about the data generating process of $r_i$. The project manager of project i can identify $r_i$, but cannot identify $\varepsilon_f$ (systematic shock) and $z_i$ (idiosyncratic shock) separately. This means that managers have expertise only on their own projects. The HQ does not even know $r_i$.

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***Signaling***

The project manager reports $s_i$ about $r_i$. They are willing to lie to maximize resource allocation to their divisions.

***Indexing, project selection and the benefit of focus & many divisions***

The HQ performs valuation for projects based on reports. The valuation for project i is indexed with conditional expectation,

I $\quad id(i) = E(r_i|\{s_1, s_2, \ldots, s_{i-1}, s_{i+1}, s_N\})$. (3)

Given the truth-telling condition, $s_j$ equals to $r_j$. Let $\tau_i$ be predetermined cost of capital for project i. The HQ select projects i if id(i) is greater than $\tau_i$. Because all projects are same ex-ante in this setup, $\tau_i$ should be the same.

As the correlation t increases, the conditional expectation id(i) becomes a better estimate for $r_i$ that creates *the benefit of focus*. This benefit is in line with the efficiency of VCG mechanism. As the number of project increases, id(i) also becomes a more accurate estimate due to the law of large numbers. This generates *the benefit of having large number of divisions*.

***Investment***

If $id(i)>\tau_i$, then project i receives M/N in which N denotes firm boundary and M does total internal resource. If $id(i)<\tau_i$, then project i receives nothing.

If $id(i) > \tau_i$, then $a_i = M/N$; Else, $a_i = 0$. (4)

Therefore, to indicate $K = \#\{i| id(i)>\tau_i\}$, the HQ invests K*M/N in projects and stores (N-K)*M/N in safe assets. Our simulation normalizes both risk-free rate and M as one. This setting is close to exchange call-option. Hence, we frame the investment behavior of firm in the literature about real option theory of firms (e.g. Dixit & Pindyck 1994 for comprehensive review).

One can argue that it would be better to allocate M/K to the projects over the hurdle rate. However, such allocation would induce project managers to under-report their signals. If project managers under-report, it lowers id(i) and K. With lower K, the managers expect to receive more resources (M/K). Therefore, since the allocation should be independent of the signals, the allocation should be M/N.

***First cash flow, learning and the trade-off in cost of capital***

At the end of the first period, the HQ collects $(\Sigma r_j)(M/N)$ from projects in which j is in $\{i| id(i)>\tau_i\}$. It also recoups (N-K)M/N from risk-free storage. Thus, the first period cash flow is in total $(\Sigma r_j)(M/N) + (N-K)M/N$. If the first period cash flow is less than zero, the HQ declares bankruptcy.

The HQ learns the type of projects after it invests in projects. If the HQ had lowered the cost-of-capital, the HQ would have invested more and have learned more project types. For instance, if we exclude the possibility of project managers stealing cash, the HQ can learn the types of projects just by observing the output.

***Exercising the flexibility option at second period***

The HQ now knows which project is the best among those it has financed. It invests cash flow from the first period in the best project of the second period if the type of the best project is greater than the risk-free rate. If the best one is less than the risk-free rate, the HQ stores its internal resource in risk-free technology.

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Such practice demonstrates managerial flexibility. The option value of flexibility increases with focus and firm boundary. If HQ had lowered the cost-of-capital at the first stage, it could have expected higher value of the best type because the value of the best type increases with the size of population. In addition, if the correlation (t) had been lower, the expected value of the best type could have been higher because its value increases with the dispersion of the population. This presents the benefit of unrelated diversification and large firm boundary.

***Firm value realization and dividend payout***

At the end of the second period, the HQ obtains the second period cash flow -- max{1, $r_{max}$}*(first period cash flow). $r_{max}$ is max{$r_i$| id(i)>$\tau_i$}. In the model without iteration, the HQ pays out all the cash to investors, and the situation is over at this point.

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Table 1: Concept Table

| Concepts | Nominal definition/ assumptions | Operationalization |
|---|---|---|
| Benefit of focus | Cost of unrelated diversification; benefit of related diversification | The efficiency of VCG mechanism; mechanism design under correlated signal |
| Cost of focus | Benefit of unrelated diversification; the opportunity cost of related diversification | The presence of the flexibility option to reallocate resources to superior opportunities |
| Divisions | Unit to conduct a project -- an indivisible unit of investment opportunities (real options) | Real options: one real option per division |
| Divisions objective | Maximization of the benefit of divisions, not the benefit of firm | Behaviors in order to receive as much internal resource as possible |
| Firm boundary | The range of activities of a firm; the number of divisions | The number of divisions in a firm |
| Firm focus | The extent of relatedness of business units, projects or businesses in a firm; diversification; the extent of related diversification | The average correlation among projects in a firm: the ratio between common and idiosyncratic components of projects |
| Firm performance | The realized returns to the stakeholders of a firm; The object that a firm should maximize | Liquidation value at the end of business activity |
| Headquarters (HQ) | The decision maker and organizational designer of a firm | Design of structural contexts of internal resource market such as how to design information system, how to allocate internal resource, and how to compensate divisions |
| HQ objective | Firm value maximization; Shareholder value maximization | Maximization of the returns given investment, which we normalize as one |
| Hurdle rate | A capital budgeting rule; The required rate of return that a project should satisfy in order for a firm to undertake investment in the project | The required rate for a binary decision: A project receives investment if its expected return is greater than hurdle rate. Otherwise, the project is discarded |
| Project | Real option; Indivisible unit of investment opportunities; It transforms an input to valuable outputs under quantitative or qualitative uncertainties | A random variable that transform given inputs to random outputs; The return of project exhibit normal distribution |

This table summarizes the core concepts in this paper. We first describe nominal definition in line with our research subject and related literature. Second, we develop operational definitions in order to develop models to generate novel predictions. We shade particularly important two concepts -- firm boundary and focus.

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Table 2: Sequence of events

| Stages | Events |
|---|---|
| First Period | |
| Resource accumulation | Investors endow the HQ with the certain amount of internal resource |
| Information asymmetry | Nature endows PMs with investment opportunities, which are drawn from a known probability distribution. While PMs observe the values, the HQ does not observe them. HQ just knows the probability distributions. Thus, information asymmetry occurs. |
| Process design | HQ announces structural contexts, the rules and procedures of capital budgeting |
| Signaling | Project managers (PM) assess the types of their projects and report them to HQ. PMs compete for limited internal resources (Burgelman 1991, Stein 1997) |
| Initial investment | The HQ invests internal resource to projects based on the reports of PMs (Internal experimentation and selection process, Burgelman 1991) |
| Initial cash flow | The HQ observes the outcome of the first period investment and learns the types of projects it financed. |
| Second Period | |
| Reinvestment | The HQ reallocates the cash flow from the first period investment to make the second period investment (Internal variation, selection and retention mechanism, Burgelman 1991) |
| Firm value realization | Everyone observes the second period cash flow, which is terminal firm value |

HQ denotes headquarters, and PM does project managers. In the first period, process design, signaling, initial investment and initial cash flow occur. Reinvestment and firm value realization happen in the second period. Burgelman (1983, 1991) provides detailed description and mechanism about signaling in the first period and reinvestment in second period. Burgelman calls such processes as internal variation, selection and retention mechanism using the terminology of cultural evolutionary theory. We offer the implicit conflict in the Burgelman mechanism between the potential of variation and the benefit of retention by relating them with focus and diversification respectively. Burgelman (1983, 1991) shows the importance of this strategic process.

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Table 3: The Optimal Process of Internal Resource Allocation and operationalization

| Stages | Optimal Process (nominal description) | Optimal process (operationalization for modeling) |
|---|---|---|
| First period | | |
| Resource accumulation | Investors endow the HQ with the certain amount of internal resource | The amount of internal resource is normalized into one without loss of generality. |
| Information asymmetry | Nature endows PMs with investment opportunities, drawn from a known probability distribution. While PMs observe the values, the HQ does not observe them. HQ just knows the probability distributions. Thus, information asymmetry occurs. | PM observes project return, but HQ cannot. The return from a project 'i' is specified with factor model as follows: $r_i = r_f + t\varepsilon_f + (1\text{-}t)z_i$. $\varepsilon_f$ and $z_i$ are independently and identically distributed (standard normal). Without loss of generality, the riskless rate $r_f$ is set to one. |
| Organization design about information system and real option portfolio | (1) The HQ designs organization and makes announcement about the organization structure and the rules of internal resource allocation. (2) The HQ determines how many projects it will include in its boundary. The projects in the boundary have positive chance to receive internal resource. | HQ maximizes firm value with respect to capital-budgeting process subject to incentive compatibility condition, limited liability condition and resource constraints. |
| Reporting | PMs report the type of projects to the HQ. They are willing to lie in order to receive as much investment as possible. | The project manager reports $s_i$ about $r_i$. They are willing to lie to maximize resource allocation to their divisions. |
| Indexing | The HQ assigns indexes to the projects. The indexes are the estimates of the type of project. The estimate of a project is the unbiased estimator of its mean based on the report from the other projects. | To define conditional expectation as $id(i) = E(r_i\|\{s_1, s_2, \ldots, s_{i-1}, s_{i+1}, s_N\})$. id(i) becomes the valuation about investment opportunities. |
| Flexibility option (1) | The HQ selects the projects whose indexes are greater than the pre-announced hurdle rate. Then, the HQ allocates the pre-announced amount of investment to the projects over the hurdle rate. The HQ saves the remaining resource in a risk-free asset. | The initial investment is: If $id(i) > \tau_i$, then $a_i = M/N$; Else, $a_i = 0$ in which M and N are total internal resource and firm boundary respectively. |
| Second period | | |
| 1st cash flow | The HQ collects the cash flow from the first period investment. HQ declares bankruptcy if the first period cash flow is negative in aggregate. | HQ collects $(\Sigma r_j)(M/N)$ from projects in which j is in $\{i\| id(i)>\tau_i\}$. It also recoups (N-K)M/N from risk-free storage. If the total value is negative, HQ declares bankruptcy. |
| Learning and flexibility option (2) | The HQ identifies the type of projects, so that it knows the best project. The HQ reinvests the cash flow from the first period in the best project that it has identified. | HQ invests cash flow from the first period in the best project of the second period if the type of the best project is greater than the risk-free rate. Otherwise, it stores its internal resource in risk-free technology. |
| 2nd cash flow | The HQ collects the cash flow from the second period investment. This cash flow is the realized firm value. | $\max\{1, r_{max}\}$*(first period cash flow). $r_{max}$ is $\max\{r_i\| id(i)>\tau_i\}$. |
| Cash dividend | The HQ pays out the cash flow to investors. In case of repeated game, we return to the first stage. | END of one round of simulation. We conduct 10^5 simulation. |

HQ is the headquarters, and PM is project manager. This figure combines the sequence of events with the optimal internal resource allocation process designed by the HQ. We derive the optimal process as Appendix 1. Appendix 1 also provides detailed explanation about the computational operationalization in line with our derived optimal process of internal resource allocation.

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Table 4: Computational Results and Corresponding Propositions

| Results | Corresponding Propositions |
|---|---|
| Figure 2 | (1) The focus and the number of divisions in a multidivisional firm are substitutes of each other to determine the value of the firm. Equivalently, the firm boundary and diversification are complementary. (2) A multidivisional firm with many divisions tend to seek further diversification. (3) The focused firms with related diversification, in which divisions are highly correlated, tend to have small number of divisions. The less focused firms with unrelated diversification are likely to have more divisions. (4) In equilibrium, multidivisional firms show either high unrelated or related diversification. |
| Figure 3 | If it is costly to acquire an investment opportunity, our model provides the interior solution for the optimal number of divisions[1]. |
| Figure 4 | The deviation from optimal hurdle rate costs related diversification more than unrelated diversification. |
| Figure 5 | Multidivisional firms with either high related or unrelated diversification use higher hurdle rates to assess investment opportunities than those with moderate diversification. |
| Figure 6 | Firm boundary does not affect optimal hurdle rates but the correlation among projects does. |

We generate predictions from our computational analysis. For readers, we first summarize our results with appropriate figures and then describe our proposition in accordance to the figures. We drop Figure 1 because Figure 2 and Figure 3 jointly cover it.

[1] Intuitively, it is far from being costless to acquire new investment opportunities.

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Figure 1: Firm value, boundary and diversification

Total internal resource (M) is set to one. The X-axis denotes t, the fraction of common factor in the type of a division. It essentially represents the informational relatedness among divisions (focus). The Y-axis represents the number of divisions in which the HQ considers investing. The Z-axis displays the expected return such that it is the ratio between expected firm value and the initial internal resource. It also signifies average Tobin's q because it is a post-investment market-to-book ratio. We normalized all random variables to standard normal and performed Monte Carlo simulation 10^5 times to compute firm values. We divided firm value by initial internal resource to calculate expected return.

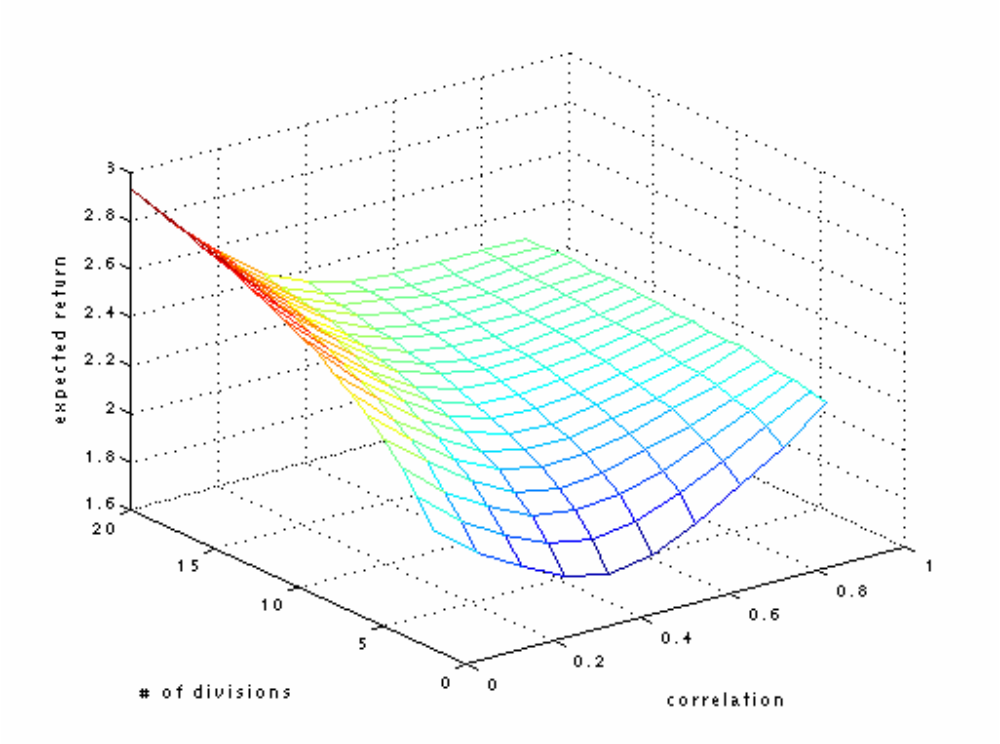

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Figure 2: Firm value and Focus
X-axis denotes correlation, and Y-axis does expected return. Total internal resource (M) is set to one. The correlation essentially represents the informational relatedness among divisions (focus). The Y-axis displays the expected return such that it is the ratio between expected firm value and the initial internal resource. It also signifies average Tobin's q because it is a post-investment market-to-book ratio. We normalized all random variables to standard normal and performed Monte Carlo simulation 10^5 times to compute firm values. We divided firm value by initial internal resource to calculate expected return.

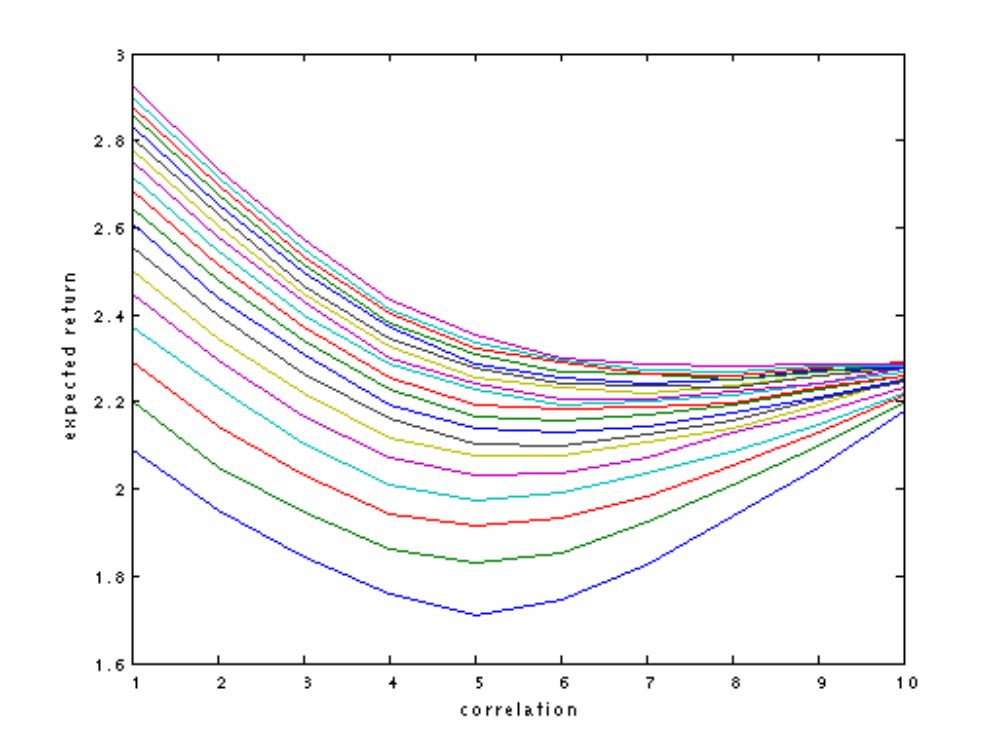

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Figure 3: Marginally decreasing firm value and the number of divisions (boundary)
The X-axis indicates the number of divisions and the Y-axis displays expected return. Total internal resource (M) is set to one. The number of divisions essentially represents the boundary of a firm. The Y-axis displays the expected return such that it is the ratio between expected firm value and the initial internal resource. It also signifies average Tobin's q because it is a post-investment market-to-book ratio. We normalized all random variables to standard normal and performed Monte Carlo simulation 10^5 times to compute firm values. We divided firm value by initial internal resource to calculate expected return.

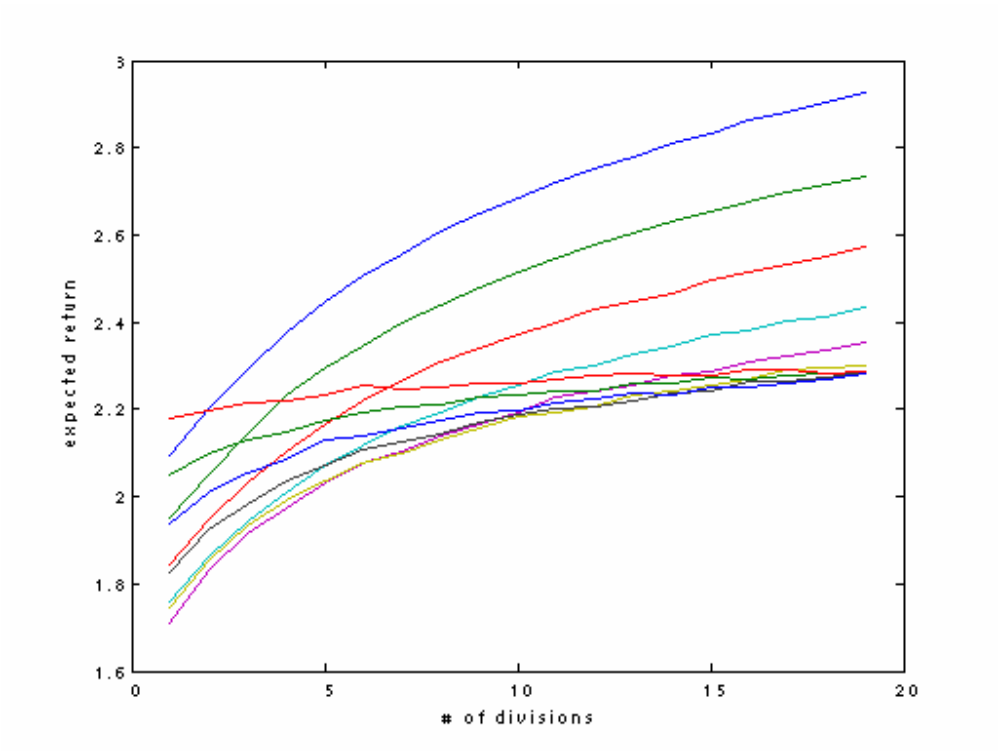

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Figure 4: Optimal Hurdle Rate and Corporate strategies
Total internal resource (M) is set to one. The Y-axis denotes correlation among divisions. The X-axis is the number of divisions. The Z-axis is the optimal cost of capital to maximize firm values. The correlation represents the informational relatedness among divisions (focus). The number of divisions stands for firm boundary. The optimal cost of capital ensures the maximum value of firm. We conduct 10^6 simulation to obtain the optimal cost of capital. HQ allocates internal resources to a division only when its expected return is greater than the predetermined cost of capital. Thus, the cost of capital is hurdle rate.

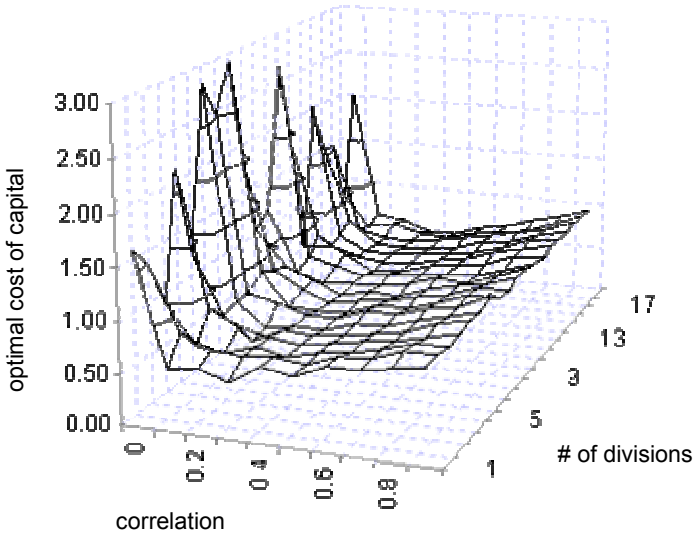

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Figure 5: Optimal Hurdle Rate and Focus
The X-axis denotes correlation, and the Y-axis displays optimal cost of capital. Total internal resource (M) is set to one. The X-axis denotes correlation among divisions. The Y-axis is the optimal cost of capital to maximize firm values. The correlation represents the informational relatedness among divisions (focus). The number of divisions stands for firm boundary. The optimal cost of capital ensures the maximum value of firm. We conduct 10^6 simulation to obtain the optimal cost of capital. HQ allocates internal resources to a division only when its expected return is greater than the predetermined cost of capital. Thus, the cost of capital is hurdle rate.

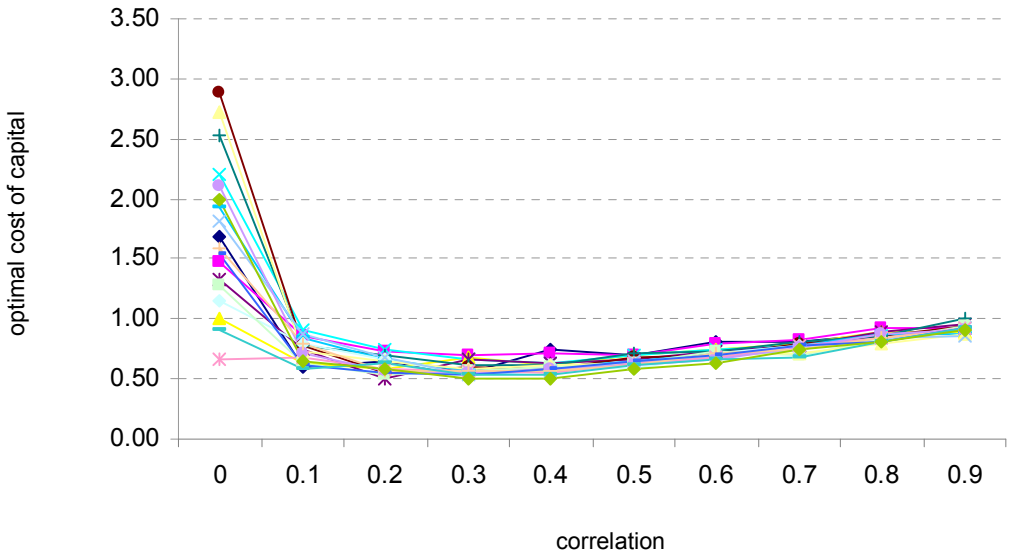

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Figure 6: Optimal Hurdle Rate and the Number of Divisions
The X-axis indicates the number of divisions and the Y-axis represents optimal cost of capital. Total internal resource (M) is set to one. The X-axis is the number of divisions. The Y-axis is the optimal cost of capital to maximize firm values. The correlation represents the informational relatedness among divisions (focus). The number of divisions stands for firm boundary. The optimal cost of capital ensures the maximum value of firm. We conduct 10^6 simulation to obtain the optimal cost of capital. HQ allocates internal resources to a division only when its expected return is greater than the predetermined cost of capital. Thus, the cost of capital is hurdle rate.

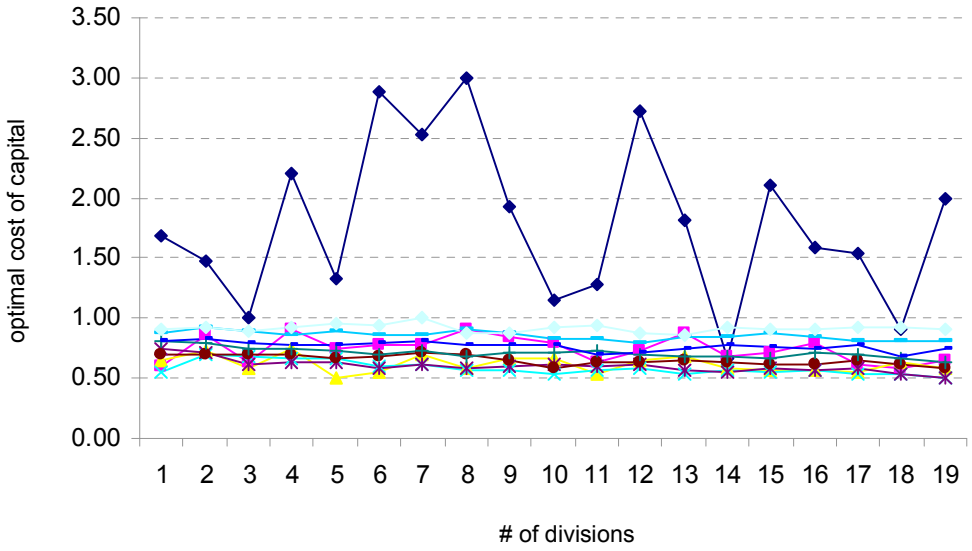

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Figure 7: Summary of Propositions
The figure describes the structure of our propositions. + and – denote positive and negative relationship respectively. Two variable x and y are substitute if they determine a value function as $\partial^2 V/\partial x \partial y > 0$.

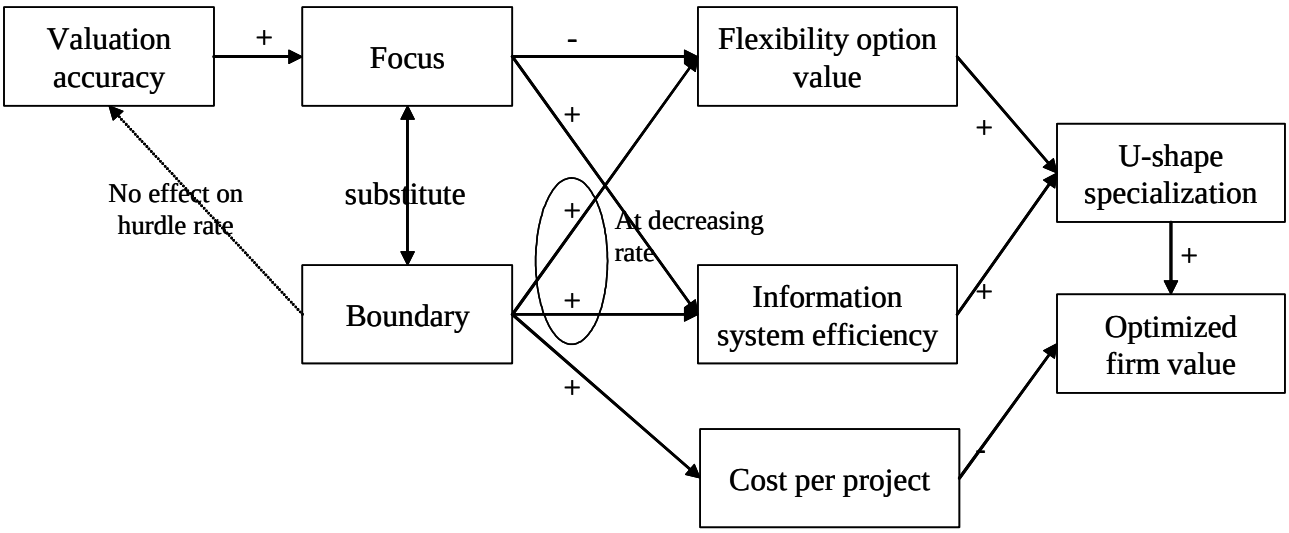


Figure 8: Summary of managerial implication
Figure 8 summarizes managerial implications. Managers jointly decide whether to maximize option value and whether to maximize the benefit of information system. The joint decision generates four possible combinations of organization. We call {high information system, high option value} as bog, {high info, low option} as knowledge, {low info, high option} as portfolio, and {low info, low option} as inaction.

| TO DO | HIGH OPTION VALUE | LOW OPTION VALUE |
|---|---|---|
| HIGH INFO SYSTEM | <u>BOG</u><br>stuck in the middle<br>Moderate diversification<br>Flexible cost of capital | <u>KNOWLEDGE</u><br>Focus<br>Specialization in information system<br>Flexible cost of capital |
| LOW INFO SYSTEM | <u>PORTFOLIO</u><br>Unrelated diversification<br>Specialization in flexibility<br>Accurate cost of capital | <u>INACTION</u><br>Ineffective management<br>Moderate diversification<br>Accurate cost of capital |