STRATEGIC INFORMATION TECHNOLOGY ENTRENCHMENT

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ABSTRACT

Many economic and informational problems associated with organizational IT spending can be attributed to managerial rent-seeking. Because of the unavoidable incompleteness of labor contracts, managers with misaligned incentives and budgetary discretion often entrench themselves through their non-value-maximizing adoption decisions. In order to boost their bargaining power in future contract renegotiation, they invest excessively in IT projects they manage more effectively than their potential rivals. In addition, they tend to adopt technologies that can create large information asymmetries giving them significant knowledge advantage over their potential rivals \textit{ex post}. We study the implications and impacts of their rent-seeking behavior within the context of organizational IT adoption and management. The efficacies and the limitations of formal incentive contracting are discussed to underscore the need for additional governance mechanisms in combating entrenchment. Knowledge management is suggested as one of the available tools that may mitigate some of the agency problems associated with entrenchment. However, we caution our readers of the managerial self-policing issue that might emerge as companies deploy information systems to facilitate effective knowledge management. We further point out that the incentive provision potential of relational labor contracts merits systematic exploration in dynamic settings with repeated investments and bargaining.

\textbf{Keywords:} Agency Problems, Bargaining, Contract Renegotiation, Entrenchment, Information Technology Adoption, Knowledge Management, Organizational Decision-Making, Rent-Seeking.
“Managers of firms attempt to entrench themselves, increasing their bargaining power, e.g. vis-à-vis alternative management teams, and one of the ways that they do this is to take actions which increase information asymmetries. Doing so effectively reduces competition in the market for management.”


I. INTRODUCTION

In today’s digital economy where Information Technology (IT) is evidently becoming the backbone, it is not uncommon for managers to emphasize the strategic importance of IT investments. However, they may never tell you that they can secure their jobs and reap significant personal benefits by strategically influencing their organizations’ IT spending. Absent effective monitoring and incentive alignment, they can entrench themselves and obtain managerial rents\(^1\) by making opportunistic IT adoption decisions that erode corporate profitability and shareholder value.

Recent empirical evidence has demonstrated that undisciplined IT spending frequently destroys firms’ value and sometimes even leads to catastrophes in implementation (Carr, 2003; McAfee, 2003). For example, Carr (2003, p.49) writes:

Some managers may worry that being stingy with IT dollars will damage their competitive positions. But studies of corporate IT spending consistently show that greater expenditures rarely translate into superior financial results. In fact, the opposite is usually true.

These observations are actually consistent with the major findings given by many prior empirical studies using firm-level data on IT spending. For example, Hitt and Brynjolfsson (1996) find little evidence of positive effects of IT on firms’ market valuation. Their data analysis even suggests the possibility of an overall negative impact of IT on firms’ profitability. Using a resource-based perspective, Bharadwaj (2000) suggests that merely spending in IT will not lead to competitively significant IT capabilities that enhance firm performance in a sustainable manner. The fact that IT spending on average does not generate sustainable higher profits should not surprise those researchers who are familiar with the

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\(^{1}\) The term “rent” is widely used by economists as the financial payment that can not be justified by competitive market mechanisms. It has become almost axiomatic in the related literature that rent-seeking, as a market distortional behavior, usually leads to significant welfare losses.
competitive market equilibrium or the theories of competitive strategy. It is generally understandable that IT, once commoditized as a resource, will no longer confer a competitive advantage or be a source of competitive advantage (Clemons, 1991; Varian, 2003). Even if a firm’s strategic IT investments lead to a competitive advantage, its financial performance will not be significantly enhanced when, as suggested in Coff (1999), internal stakeholders instead of shareholders appropriate most rents from this competitive advantage.

In a seminal paper, Simon (1991a) calls on neoclassical economists to take a more serious look at the economic behavior that “takes place inside the skins of firms.” Gibbons (1999, 2004) further points out the inevitability of the convergence between the new organizational economics literature and the non-economic literature on organizational decision-making. Deviating from the traditional economics models where organizations are simplified as unified value-maximizing nodes in a social network, our study analyzes the internal inefficiencies associated with organizational IT investment decision-making. More specifically, in an incomplete contract setting where contract renegotiation is considered, our analysis shows why managerial entrenchment within organizations can bring a value-destroying reputation to undisciplined organizational IT spending.

**Managerial Empire-Building**

Generations of researchers have been trying to better understand the conflict of interest problem (frequently referred to as the agency problem) behind corporate veils ever since Berle and Means (1932) publish their influential book, *The Modern Corporation and Private Property*. One of the best known manifestations of corporate agency problems is managerial empire-building. With discretionary cash flow in hand, managers tend to invest excessively to build larger companies from which they can gain more private benefits and perquisites (e.g., see Williamson, 1964; Jensen, 1986). Although this empire-building theory can be used as one explanation for the inefficiencies in corporate IT spending, it does not
necessarily lead to IT overinvestment. Furthermore, the empirically observed technology overinvestment or underinvestment could be at least partially explained by many other theories, including risk preference incongruity (Holmström, 1979; Stiglitz, 1974; Grossman and Hart, 1983), managerial career concerns (Holmström and Costa 1986; Holmström, 1999), herding (Kauffman and Li, 2004; Li, 2004; Scharfstein and Stein, 1990), managerial myopia (Bebchuk and Stole, 1993), overconfidence (Rool, 1986) and so on.

Although these theories allow us to examine IT investment decision-making from multiple perspectives, they make it challenging for researchers to select the most appropriate theory under different scenarios. As business researchers, we are more interested in the business and technological implications of these theories than in theory comparison and evaluation. We also believe that it will be far more productive for researchers to investigate how agency problems affect IT managers’ investment strategies than to argue whether firm or market level IT overinvestment is empirically observed in different industries. Therefore, our study does not focus on the controversy surrounding IT overspending. In order to provide more concrete and specific business insights, we follow Simon’s call to take a closer look at the role played by IT managers in corporate investment decision-making.

**Beyond Empire-Building**

Until recently most corporate governance studies (not including the theoretical literature on firms’ internal hierarchies) have concentrated on the relationship between corporate top executives and outside shareholders. Some recent studies have suggested that many agency problems can be better understood if the relationship between corporate CEO and divisional or departmental managers is also considered (Bernardo, Cai and Luo, 2004; Bolton and Scharfstein, 1998; Scharfstein and Stein, 2000). Most IT managers participate in corporate IT investment decision-making processes at the divisional or departmental level, and they generally have to get top executives’ approval for significant IT spending (CIOs might be an exception, but they usually also need to report to CEOs for final investment

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2 Some theoretical studies dynamically model the disciplinary role of corporate debt, and their results generally suggest that managers’ empire-building preference will not necessarily result in *ex post* overinvestment (Hart and Moore, 1995; Stulz, 1990; Zwiebel, 1996).
authorization). Because of their expertise and experience, IT managers are often key advisors who help top executives shape corporate IT spending strategies. However, they have less discretion and flexibility in IT spending than CEOs. For example, they usually have to make investment decisions with inflexible IT budgets or under capital rationing, which makes it more difficult for them to engage in conspicuous IT overinvestment (e.g., empire-building).

Nevertheless, it would be mistaken to assume that the agency problem of IT spending is much less severe at the departmental or divisional level than it is at the top executive level. One reason is that, unlike top corporate executives whose compensation packages usually include powerful incentives (e.g., significant amount of stock options), most mid-level IT managers do not own a lot of stocks or stock options. Even if they do, there is still a free-riding problem because usually their performance does not meaningfully influence their companies’ stock performance (Hall and Murphy, 2003). More importantly, IT managers have much more discretion and flexibility in influencing the form of investment than they have in influencing the level of investment, which in many cases could exacerbate the managerial incentive problem in investment decision-making. Given the strategic importance of technology selection\(^3\) and IT spending prioritization, we believe that a thorough investigation of IT managers’ potentially opportunistic behavior is well warranted. If appropriately conducted, such a study should not only contribute to the rich and ever-growing corporate governance literature that follows Jensen and Meckling (1976), but also yield new insights into organizational IT adoption and management.

We study the incentive for IT managers to entrench themselves by strategically allocating the IT budget under their control. It is well known that IT professionals’ bargaining power vis-à-vis their employers significantly affects their compensation packages (Ang, Slaughter and Ng; 2002). The essential objective for managerial entrenchment is to make the incumbent manager more difficult to be replaced, which will offer the incumbent more leverage and bargaining power in future compensation contract renegotiation. When information and knowledge, as described in our model, are strategically

\(^3\) Using a real options model, Kauffman and Li (2005) analyze the strategic options embedded in technology selection under scenarios where incompatible technologies compete and uncertainties abound. Li (2005) studies how cheap talk affects emerging technologies’ diffusion in technology markets subject to network externalities.
manipulated *ex ante* for exploitation *ex post*, managerial entrenchment becomes an excellent example of the knowledge formation hazards conceptualized in Nickerson and Zenger (2004). Recent studies have recognized and emphasized the strategic role of IT human capital in enhancing organizational effectiveness (Mata, Fuerst and Barney, 1995; Roepke, Agarwal, and Ferratt, 2000). We believe that one major challenge in IT human resource management is what Holmström (1999) describes as the “fundamental incongruity” between IT employees’ concern for their human capital returns and companies’ concern for their financial returns. Our analysis suggests that IT managers, instead of allocating more money to the IT projects with higher expected financial returns, have incentives to spend excessively in those projects that they manage more effectively than their potential rivals. It further explains why IT managers can entrench themselves and extract significant rents by creating *ex post* knowledge superiority through their “strategic” budget allocation.

**Potential Remedies of Information Technology Entrenchment**

Although our paper does more to highlight managerial incentive problems in IT spending than to solve them, it does emphasize knowledge management and relational contracts as two potential tools in overcoming inefficient entrenchment. Undoubtedly, the optimal incentive contracting literature has greatly enhanced our understanding of the successes and limitations of contractual incentive provision in firms (Prendergast, 1999). An interesting question is: what can knowledge management, as an alternative to incentive contracting, help to mitigate managers’ propensity to entrenchment? So far few economic studies have explicitly examined the role of knowledge management in overcoming agency problems. Given the tremendous success enjoyed by the knowledge management research in both organization and information systems literature (Argote, McEvily and Reagans, 2003; Alavi and Leidner, 2001), it is unfortunate that we have not seen any meaningful convergence and interplay between the economics literature and the non-economic literature in this promising area.

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4 Some economists have long ago suggested the incentive justification for organizational information gathering and storage (e.g. Holmström and Tirole, 1989). In the organizational literature on the theories of the firm, we have recently seen some interesting discussions of the relationship between knowledge and opportunism (Coff, 2003; Conner and Prahalad, 1996; Foss, 1996; Nickerson and Zenger, 2004).
By exogenously incorporating the impacts of effective knowledge management into our analysis, we show that it becomes more difficult for incumbent managers to maintain significant information or knowledge superiority over their potential rivals. As a result, IT managers’ incentives for engaging in inefficient IT investment entrenchment will diminish considerably. Of course, the efficacy of knowledge management in overcoming entrenchment depends on how well knowledge management systems are designed to discourage knowledge hoarding and to induce truth-telling in knowledge valuation. These important incentive issues associated with organizational knowledge management and governance are well elaborated in some recent studies (Ba, Stallaert and Whinston, 2001a, b).

We believe that there is another fundamental incentive issue that could significantly lower the efficacy of knowledge management in disciplining managerial opportunism and rent-seeking. If those managers, who are the primary beneficiaries of existing information asymmetries and knowledge superiority, are delegated the decision-making authority in knowledge management, how can they behave benevolently and weaken their lucrative entrenchment voluntarily? This managerial self-policing issue and other difficulties with knowledge management underscore the need for other incentive provision mechanisms. Based upon the recent development in the relational contract literature, we argue that self-enforcing relational contracts can play an interesting role in supplementing both formal contracts and knowledge management to combat entrenchment.

The remainder of this paper is organized as follows: Section II investigates the impacts of two managerial entrenchment strategies on corporate IT investment efficiency. In Section III, we examine, in the context of IT adoption and management, the potential of knowledge management in overcoming managerial entrenchment and in improving shareholder value. The last section provides further discussion and concludes the paper.

II. STRATEGIC ENTRENCHMENT AND CONTRACT RENEGOTIATION

Strategic IT investment, to which managerial expertise and information availability are essential, is more susceptible to managerial entrenchment, and that is why we believe that examining IT investment
decision-making may yield important new insights. In fact, the importance of managerial incentive alignment in strategic investment has been repeatedly emphasized in prior economics literature. For example, (Holmström and Costa 1986, p. 857) reminds us:

The need to harmonize preferences between superiors should be strongest in areas where ability plays a significant role. … Strategic investment decisions, which are likely to involve sizeable human capital risks and opportunities for the manager, need incentive alignment and control.

In addition to managerial ability, information plays a significant role in strategic IT adoption. Modern literature in decision-making under uncertainty has provided us with a good understanding of the relationship between information availability and decision quality. However, the information structure in our model affects managerial decision-making through another avenue. We show that information asymmetries, in many cases of strategic IT investments, are intentionally created and maintained by managers whose objective is to maximize their own human capital returns. We argue that this managerial incentive problem is especially serious in IT adoption decision-making. The reason is because that the causally ambiguous nature of strategic IT investments often makes it hard to confirm or disconfirm, at least in the short run, any link between adoption decision quality and organizational performance.

The Model

We present a three-stage model with four dates \((t = 0, 1, 2, 3)\). At time 0, an IT manager is given a budget \(C\) for a firm’s long-term strategic IT investment. The manager is supervised by the top executives acting in the interest of the firm’s shareholders. The top executives know that the manager has an empire-building preference (he always invests all the money under his control), and thus impose a binding IT spending budget. At time 1, the manager splits \(C\) between two types of IT projects. He spends \(C_1\) on the first type of projects, those he manages better than his potential rival does, and he spends \(C_2 = C - C_1\) on the second type of projects, those his potential rival manages as well as he does.\(^5\) After time 1, the

\(^5\) A more general assumption is that the potential rival manages the second type of projects \(at\ \text{least}\) as well as the incumbent does. Such a scenario would not change the insights of our paper. It actually strengthens our core argument, because such a manager would have stronger incentives to prioritize type-1 projects over type-2 ones. The presence of a symbolic management rival in the labor market (or an emblematic corporate raider in the capital market) has been extensively discussed in the corporate governance literature as a managerial disciplinary mechanism (Shleifer and Vishny, 1989; Walsh and Kosnik, 1993; Walsh and Seward, 1990; Edlin and Stiglitz,
manager starts to manage the invested IT projects that are assumed prohibitively expensive to be reversed. He has an opportunity to renegotiate his compensation contract with the top executives at time 2. The expectations that contracts will be renegotiated in the future, an essential feature of most incomplete contract models (e.g., Hart and Moore, 1999; 2004; Wernerfelt, 2004), are the driving force behind strategic entrenchment in our model. After the contract renegotiation, the manager continues to manage the invested IT projects until time 3 when the terminal long-term investment payoffs are calculated. The sequence of events described above is depicted in Figure 1.

The firm’s long-term IT investment payoffs under the incumbent manager and the potential rival are given as

\[ R_i = q(E_i, I_i)B_1(C_1) + qB_2(C_2) \]

and

\[ R_r = q(E_r, I_r)B_1(C_1) + qB_2(C_2) \]

where \( B_1(C_1) \) and \( B_2(C_2) \) are the two types of IT projects’ investment payoff per unit of managerial effectiveness, and \( q(E,I) \) is managerial effectiveness as a function of a manager’s expertise \( E \) and information quality \( I \). We assume that \( B_1'(C_1) > 0, B_2'(C_2) > 0 \) and \( B_1''(C_1) < 0, B_2''(C_2) < 0 \), which simply implies that, holding managerial effectiveness constant, the investment payoffs increase as more money is invested, but they increase at a decreasing rate. It is also reasonable to assume that managerial effectiveness increases in both \( E \) and \( I \).

As described above, for the second type of IT projects there is no difference between the incumbent and the rival in terms of their managerial effectiveness. So we use a constant \( q \) to express both managers’ effectiveness in managing this type of projects.

1995; Chemmanur and Yan 2004). The potential rival described in our model is some individual who might step into the incumbent manager’s job either through internal promotion or external hiring. The different implications of the two types of replacements will be discussed later.
The incumbent’s initial salary is normalized to 0. He renegotiates his salary with the top executives at time 2, and his new salary at that time depends on how well he can manage the invested IT projects vis-à-vis the potential rival in the long run. We assume that his new salary is 

\[ S = \lambda(R_2 - R_1), \]

where \( R_2 - R_1 \) measures the extra investment payoff the firm can get under the incumbent, and \( \lambda \in (0,1) \) is the incumbent’s share of the extra payoff (it obviously depends on his bargaining power at time 2). The incumbent’s objective in the budget allocation is to maximize his long-term human capital return, given as 

\[ \lambda(R_2 - R_1) + \theta(R_1 - C - \lambda(R_2 - R_1)), \]

where \( 0 \leq \theta << 1 \) is the incumbent’s very small share of firm ownership. So the first part of his return comes from his managerial rents and the second part comes from his stock ownership.

The sequence of events described in our model is similar to that in Shleifer and Vishny (1989). They analyze the investment strategy of a top executive (e.g., a CEO) who has much more discretion over the magnitude of capital investment than the IT manager has in our model. Consequently, their paper’s major insight is that managers’ entrenchment incentives tend to result in corporate overinvestment and excessive business expansion, and that corporate and division-level capital rationing can help to counter managerial entrenchment. Our analysis, however, shows that IT managers with capital allocation discretion can engage in inefficient entrenchment even if they have a binding investment budget. Our paper’s concentration on the form of investment rather than the level of investment is particularly pertinent in the context of corporate IT adoption and management. Instead of joining the argument about whether consistent evidence of corporate-level IT overinvestment exists, our paper attempts to help practitioners and researchers to take a more serious look at the following questions: Are we observing overinvestment in some types of IT and underinvestment in some other types of IT? If yes, where does this investment distortion come from, and how can we deal with it?

**Make Your Expertise Pay: Buy More Manager-Specific IT**

We first consider the impact of the incumbent manager’s expertise on his IT investment strategy. The manager has the discretion to allocate \( C \) between two types of IT projects. The first type of projects
is manager-specific, which means that the incumbent has more project-specific expertise in managing them than the potential rival has. We assume that the incumbent and his rival have access to the same information and their expertise does not change over time (this assumption will be relaxed later). So we can write their effectiveness in managing the first type of IT projects as two constants with $q_i > q_r$.

To demonstrate the incumbent’s preference for manager-specific projects and the resultant investment inefficiencies, we first derive the firm’s optimal IT budget allocation $(C_1^*, C_2^*)$ that maximizes the firm’s long-term investment returns. To make things interesting, we assume that $(C_1^*, C_2^*)$ is an interior solution, which simply implies that $C_1^* \in (0, C)$. We then compare this efficient capital allocation to the incumbent’s personal optimal budget allocation $(C_1^{**}, C_2^{**})$ that maximizes his long-term human capital returns.

□ **PROPOSITION 1 (IT INVESTMENT ENTRENCHMENT: MANAGER-SPECIFIC RENTS).** The incumbent IT manager likes to invest excessively in those IT projects that better utilize his specific managerial expertise. Consequently, his IT budget allocation in those projects is always greater than the efficient allocation that maximizes the firm’s long-term investment returns (All Proofs are in Appendix A).

Proposition 1 suggests that the manager has the incentive to overspend money in those IT projects that he manages better than others, and consequently he spends less in other projects that do not give him an edge over his potential competitors. As a result of his discriminatory budget allocation, he fails to maximize the firm’s long-term investment returns. This result may seem counter-intuitive. How could it be less efficient for the manager to invest more money in projects that better utilize his personal expertise? The answer to this question is that the efficiency loss actually comes from the manager’s opportunistic overinvestment beyond the firm’s optimal budget allocation that has already taken managerial expertise into consideration. The logic behind this type of IT investment distortion is very clear: the incumbent manager can effectively entrench himself and bargain for more compensation than justified by the management labor market (his rents) in future contract renegotiation.
It is well known in the transaction cost and the asset ownership literature that, because of opportunism and contract incompleteness, there is usually underinvestment in relationship-specific assets.\(^6\) The reason our analysis suggests overinvestment rather than underinvestment in manager-specific IT projects is simply that the manager is not spending his own money (Shleifer and Vishny, 1989). In one extreme case where the IT manager’s ownership of the firm is zero \((\theta = 0)\), he will invest all the money under his control in manager-specific IT projects \((C^{IT}_1 = C, C^{IT}_2 = 0)\). In another extreme case where the manager is also the firm’s sole owner \((\theta = 1)\), he has no incentive to deviate from the firm’s optimal budget allocation \((C^{IT}_1, C^{IT}_2)\). As discussed before, compared to top executives like a CEO, most division or department-level IT managers have negligible firm ownerships, which unfortunately implies that they may be more prone to entrench themselves.

Excessively investing in manager-specific IT projects is only one strategy used by managers to fortify their trenches and to extract rents. Many IT managers who have successfully entrenched themselves do not have any distinctive expertise that can give them an edge over their potential rivals. Their alternative entrenchment strategy, which will be demonstrated in a more general version of our model, is arguably more harmful to firm-level IT adoption and management.

**Make Your Knowledge Pay: Create Informational Superiority**

We now drop the assumption that the manager and his rival have access to the same information and their expertise does not change over time. Recall that the manager’s future salary depends on \(R_i - R_r\), the extra IT investment payoff he can bring to the firm. So the incumbent, who wants to maximize his human capital return, will strategically allocate his IT investment budget to increase \(R_i - R_r\).

Because managerial effectiveness is a function of a manager’s expertise \(E\) and information quality \(I\), \(R_i - R_r\) can be expressed as \((q(E_i, I_i) - q(E_r, I_r))B_i(C_i)\). This expression implies that there are two reasons why the incumbent manages the first type of IT projects better than his potential rival does. First,

\(^6\) Early influential studies in this area include Williamson (1979) and Klein, Crawford and Alchian (1978). Grossman and Hart (1986) present a more formal treatment of contract incompleteness and asset ownership. For a recent literature survey, see Tirole (1999).
his personal expertise is more appropriate for this type of projects \((E_i > E_r)\). Second, the quality of his project-related information is better than that of his rival’s \((I_i > I_r)\). It is easy to see that Proposition 1’s results are still applicable to this setting.

□ **PROPOSITION 2 (IT INVESTMENT ENTRENCHMENT: INFORMATIONAL RENTS).** The incumbent IT manager will invest excessively in those IT projects that offer him informational advantages over his potential rival. Consequently, his IT budget allocation in those projects is always greater than the efficient allocation that maximizes the firm’s long-term investment returns.

This proposition immediately leads to several important implications to IT investment decision-making. *Ceteris paribus*, the incumbent manager favors IT investment projects with uncertainty that can be more quickly resolved for him than for his potential rivals. These projects offer the incumbent significant informational advantages that materialize in future contract renegotiation. Interestingly, most long-term strategic IT projects create substantial uncertainty and noise that can sustain the incumbent’s informational superiority over a significant time period. Moreover, the payoffs of most strategic IT investments are notoriously difficult to quantify in the short run, which provides managers with more flexibility in justifying their investment decisions *ex ante*. Therefore, it is understandable that IT managers with misaligned incentives prefer to spend excessively in long-term strategic IT projects even if they know that many of those projects are of lower quality than other available IT projects.

It is worth noting that our model does not explicitly describe how the quality of project-related information affects managerial effectiveness. In an insightful paper, Edlin and Stiglitz (1995) analyze several mechanisms through which the incumbent manager can extract significant informational rents. In their model, risk-averse rivals, because of their informational disadvantage, make fewer efforts than the incumbent does in managing invested projects. Consequently, their managerial effectiveness is reduced. In addition, they tend to ask for higher salaries to compensate for their perceived risks. Sometimes the problem of the winner’s curse under information asymmetry further makes potential rivals more reluctant to compete for the incumbent manager’s job.
There are two reasons why we do not directly model these mechanisms. First, deriving the incumbent manager’s optimal budget allocation requires some stringent assumptions about these mechanisms, which unnecessarily limits the generalizing ability of our analytical results. Second, explicitly modeling these mechanisms excludes other interesting scenarios where the incumbent IT manager can create or worsen informational problems to extract rents. The analysis in Edlin and Stiglitz (1995) focuses on the incumbent and his rivals’ asymmetric information about the invested projects’ prospects. This type of information asymmetry is not the only source from which the incumbent manager can extract rents in investment decision-making. As discussed in Stiglitz (2000), information asymmetries are a subset of the broader problem of knowledge imperfections. Nickerson and Zenger (2004) explicitly point out that agents, with the intention to enhance their bargaining power in the future, possess incentives to strategically influence organizational knowledge development and accumulation. In the context of IT adoption decision-making, we show that there are incentives for managers to invest excessively in any IT projects that make them more knowledgeable than their potential rivals in the future. Clearly, knowledge plays a critical role here in our study of the strategic entrenchment in IT adoption. So it is important for us to connect our analysis to knowledge management whose primary function is to deal with organizational knowledge-related problems.

III. CAN KNOWLEDGE MANAGEMENT OVERCOME ENTRENCHMENT?

There are at least two reasons why we argue that researchers should pay more attention to the interplay between the literature on corporate governance and the literature on organizational knowledge management. First, the problems of managerial entrenchment and rent-seeking, as Stiglitz (1999) points out, “may be particularly acute” in knowledge-based enterprises and the knowledge-driven economy in general. This judgment is also consistent with the major empirical insight given by Coff (2003). Second, there are interesting interactive dynamics between corporate governance and knowledge management. For example, as our analysis suggests, many managerial incentive problems arise because of knowledge-related issues which are frequently addressed in knowledge management studies. At the same time, there
are various kinds of incentive alignment issues in acquiring and in managing organizational knowledge and knowledge management systems (Ba, Stallaert and Whinston, 2001a, b). Before we examine the interactive dynamics between knowledge management and corporate governance, we discuss the role of some traditional methods in combating managers’ IT investment entrenchment.

**Active Monitoring and Contractual Remedies**

One major condition under which the IT manager in our model can engage in inefficient entrenchment is that the firm’s top management cannot differentiate his normal investment behavior from rent-seeking entrenchment. There are many reasons why this condition exists for long-term strategic IT investment. For example, the long-term payoffs of strategic IT investments are extremely difficult to quantify in the short run. In addition, many IT projects that can strongly entrench the incumbent manager are also profitable, at least in terms of the pre-compensation investment returns (Edlin and Stiglitz, 1995; Shleifer and Vishny, 1989). Undoubtedly, the firm’s top management can be more proactive in monitoring the IT manager’s investment behavior, which may help to stop some blatant cases of entrenchment. Top management may further reduce the manager’s budgetary discretion to avoid the extreme situation where certain types of IT investment are not funded at all because of managerial biases (Ross and Beath, 2002). However, active monitoring and supervision are usually costly and in some cases may result in efficiency loss because of budgetary inflexibility. They remain, at best, a partial solution to managerial entrenchment as long as the fundamental knowledge-related problems exist in an organization.

The traditional wisdom from the optimal incentive contracting literature suggests that, if a frontal attack on the inherent organizational informational problems is infeasible or too costly, providing managers with incentives not to behave opportunistically might be a reasonably good solution. In the context of managerial entrenchment, Edlin and Stiglitz (1995) argue that contractual restriction of salary bargaining or incentive provision through stock ownership could mitigate managers’ propensity to entrenchment. We formalize their argument in the next two propositions.
□ **Proposition 3 (Incentive Provision Through Stock Ownership).** Providing the IT manager with initial higher stock ownership moves his personal optimal IT budget allocation closer to the firm’s efficient budget allocation.

□ **Proposition 4 (Contractual Restriction of Salary Bargaining).** Contractual restriction of the manager’s salary bargaining power reduces his rents associated with IT investment entrenchment, which moves his personal optimal IT budget allocation closer to the firm’s efficient budget allocation.

Although the two approaches seem to have potential in combating managerial entrenchment, their efficacy in the real business organization is considerably attenuated by several factors. First of all, as we have discussed before, it is very uncommon and often impractical for a mid-level IT manager to own a significant share of the firm in which he works. Even if the decision-maker is a top executive, the efficiency loss resulting from granting him significant stock ownership may significantly outweigh the benefits of curbing managerial entrenchment (Bebchuk and Fried, 2003; Hall and Murphy, 2003).

Furthermore, contractual restriction of salary bargaining, like the prevention of contract renegotiation or rent-sharing, has serious problems in its implementation. In a dynamic setting, the firm’s commitment not to engage in future contract renegotiation or rent-sharing will not impact managers’ entrenchment incentives unless it is deemed credible (in the terms of game theory, any credible strategy in a dynamic game must be subgame perfect). Even if the firm finds some mechanisms to make a binding commitment at a reasonable cost, restricting contract renegotiation in a competitive management labor market often has some undesirable consequences on efficiency. For example, without contract renegotiation and rent-sharing, a firm may continue to lose the ablest managers to the job market because of its compensation rigidity.

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7 For example, some companies specify detailed executive compensation schemes in their corporate bylaws to leave very limited room for contract renegotiation. Some organizations have a “no counteroffer” policy to discourage salary bargaining. See section 3 of Hart and Moore (1999) for an in-depth discussion of the difficulties associated with committing not to renegotiate a contract.
All the methods discussed so far attempt to remedy the problem of managerial entrenchment without directly attacking its inherent cause. By aiming to tackle organizational information and knowledge related problems, knowledge management could open a new front in the fight against managerial rent-seeking behavior such as IT investment entrenchment.

**Knowledge Management vs. Managerial Entrenchment**

To search for fresh insights into how to overcome entrenchment, we need to go beyond the traditional economics literature that often views a firm as a nexus of contracts. By viewing a firm as an institute of knowledge integration, the knowledge management literature, in our opinion, could shed new light on IT investment entrenchment caused by various knowledge-related problems. Our previous discussion argues that targeting information asymmetries and knowledge imperfections could have direct impacts on managerial incentives for entrenchment. We formalize this argument in the next two propositions.

- **PROPOSITION 5 (THE EFFECT OF EXPERTISE DISPARITY ON ENTRENCHMENT).** *Other things being equal, the smaller the incumbent IT manager’s expertise advantage over his potential rival at the time of contract renegotiation, the closer the incumbent’s personal optimal IT budget allocation is to the firm’s efficient budget allocation.*

- **PROPOSITION 6 (THE EFFECT OF INFORMATION DISPARITY ON ENTRENCHMENT).** *Other things being equal, the smaller the incumbent IT manager’s informational advantage over his potential rival at the time of contract renegotiation, the closer the incumbent’s personal optimal IT budget allocation is to the firm’s efficient budget allocation.*

It is obvious that companies should not reduce the incumbent manager’s expertise or lower the quality of his project-related information. They instead should concentrate on making the rival more knowledgeable after he is hired to replace the incumbent. Why do we consider the disparity in managerial expertise as a knowledge related problem? In the knowledge management literature, there are clear distinctions between tacit knowledge (knowing how) and explicit knowledge (knowing about). Intuitively, a manager’s personal expertise significantly depends on his specific tacit knowledge that can
only be gradually revealed through its application (Simon, 1981, 1991b; Grant, 1996; Kogut and Zander, 1992). As a result, observed disparity in managerial expertise usually reflects the difference in tacit knowledge which is much more difficult to observe. Compared to expertise disparity, the information quality disparity (information asymmetry) in our model measures the incumbent manager’s advantage of having more explicit knowledge of the invested IT projects. It is worth noting that, as emphasized in Nonaka (1994), tacit knowledge and explicit knowledge are often mutually convertible. For example, an IT manager who can access explicit knowledge of a project in the short run may be able to develop manager-specific tacit knowledge (e.g., through learning by doing) over time.

To effectively combat managerial entrenchment in IT spending, Propositions 5 and 6 suggest that the firm should try to reduce the knowledge gap between the incumbent manager and his potential replacement. The key to implementation lies in the firm’s learning of its employees like the incumbent manager, which, as argued by Simon (1991b), is one of the two ways in which organization learning can be achieved. In the real business world, there are many examples where firms retain its key employees’ knowledge through different methods of learning. For example, firms sometimes assign assistants to work with key employees who are expected to leave in the near future. By doing that, they try to retain knowledge and minimize the disruption that might be caused by key employees’ departure. By facilitating organizational learning and knowledge retention, knowledge management understandably has some potential in overcoming entrenchment. This assertion also applies to knowledge management systems which are, in most cases, IT-based systems.

Firms need to focus on different aspects of knowledge management when they deal with the two types of knowledge disparity described in our analysis. To reduce the information asymmetry between the incumbent and his potential rivals, firms need to spend more resources on information retention and knowledge storage. Organizational amnesia may negatively affect decision-making quality in many ways (e.g., see Hirshleifer and Welch 2002). In our model, poor retention of explicit knowledge about IT

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8 We thank Gordon Davis for offering us this example based on his own experience. Gordon worked as a consultant before he joined academia, and an assistant was assigned to work with him shortly after his firm learned his intention to leave.
projects creates noise and reduces the managerial effectiveness of potential rival managers, which offers the incumbent incentives to engage in inefficient entrenchment. Reducing tacit knowledge disparity is more challenging. This is because tacit knowledge generally can not be easily codified or revealed. Therefore, firms should make more efforts to encourage meaningful knowledge sharing, to reduce internal knowledge transferring costs, and to facilitate the integration of managerial tacit knowledge into organizational knowledge bases. By doing that, even if a new manager who replaces the incumbent lacks certain expertise to manage some type of IT projects, he can quickly develop the required expertise with the help of the relevant knowledge retained by the firm. Consequently, it becomes more difficult for the incumbent to engage in entrenchment facilitated by organizational knowledge imperfections.

**Managerial Self-Policing and Relational Governance**

When we emphasize the potential of knowledge management in overcoming managerial entrenchment in IT investment, we implicitly assume that effective knowledge management systems can be implemented by the firm to deliver the desirable impacts on its organizational memory. In fact, one motive for capturing employee expertise in automated systems, as pointed out by Simon (1991b, p.129), is that “it makes organizational memory less vulnerable to personnel turnover.” Some recent studies investigate how knowledge management systems can be implemented to enhance an organization’s memory capacity and retention capability of its employee’s knowledge and information (Stein and Zwass, 1995; Alavi and Leidner 2001). Nevertheless, it is our belief that, even in today’s economy where advanced knowledge management systems abound, this assumption should be subject to scrutiny and debate.

The key issue here is not whether a firm has the resources to acquire various knowledge management systems, but whether it can, through sound decision-making processes, implement those systems to achieve the desirable objectives. This issue is absolutely not trivial given the fact that most companies in today’s knowledge-driven economy still exhibit some features of the “organized anarchy” described in Cohen, March and Olsen’s (1972) garbage can model. If many companies, as argued in Feldman and March (1981), invest heavily in information gathering and knowledge acquisition primarily
for signaling or other symbolic purposes, we should not expect to see any significant improvement in their capabilities of fighting managerial entrenchment. For example, Gilmour (2003) points out that there is no solid evidence of the payoffs of billions of dollars spent in knowledge management technologies, and he attributes it to corporate culture problems: “People guard their information and selectively release it. This tendency to hoard knowledge is a core problem of corporate culture.”

It is easy to see that this corporate culture problem usually arises because of incentive misalignment in knowledge management. Pinpointing potentially acute incentive problems in knowledge acquisition and sharing, Ba, Stallaert and Whinston (2001a) advocate the view that incentive alignment should be included as a third dimension in knowledge management system design. In the context of our model, we agree with them that, to realize the full potential of knowledge management systems in overcoming entrenchment, system designers must appropriately address incentive issues like free-riding or knowledge hoarding.

We further argue that, even if system designers can take care of those issues, there is still one fundamental incentive problem associated with knowledge management system adoption and implementation. It is imperative to point out that it is corporate managers (in many cases IT managers) who make decisions on what knowledge management systems to adopt and on how to implement the adopted systems. Unfortunately, those managers happen to be the major beneficiaries of managerial entrenchment created and sustained by various knowledge-related problems that knowledge management intends to solve. Because of this inherent incentive conflict, managers are very likely to take advantage of their authorities by minimizing the impacts of knowledge management systems on their personal lucrative entrenchment. Consequently, it is a myth that, without successful incentive alignment, corporate managers will behave benevolently and play a self-policing role in knowledge management decision-making.

In addition to this self-policing issue, there are other strategic issues that may significantly limit the potential of knowledge management in weakening managerial incentives for entrenchment. For example, many firms may not want to codify their managers’ knowledge and expertise into systems, because they
fear that their knowledge resource may become more imitable and transferable so rival firms can apply it (Mata, Fuerst and Barney, 1995; Coff, Coff and Eastvold, 2006). Therefore, we believe that knowledge management, like formal contracting and monitoring, has its inherent limitations in overcoming entrenchment. Effectively mitigating entrenchment problems in today’s knowledge-driven economy, in our opinion, entails the employment of other channels of incentive provision, and relational incentive provision is certainly among these channels. Recent development in the organizational economics literature demonstrates the potential of relational contracts in overcoming opportunism both between and within firms (e.g., Gibbons, 2005; Levine, 2003). The essential tradeoff emphasized in this literature is between the short term gains from opportunistic behavior and the long term losses from damaged relationships. In our model, the incumbent manager’s incentive for entrenchment will be significantly weakened if his decision quality is somewhat linked to his long term humane capital returns. Because of the causally ambiguous nature of IT investments, firms often assess the quality of managers’ IT adoption decisions subjectively, which underscores the importance of relational governance. Baker, Gibbons, and Murphy (1994) demonstrate why efficiency can be improved by simultaneously using formal contracts based on objective performance and relational contracts based on subjective assessments. Poppo and Zenger (2002) provide empirical evidence substantiating the argument that there are valuable complementarities between formal contracting and relational incentive provision. So it would be interesting to investigate the interactive dynamics between the two mechanisms in the context of organizational IT adoption, and to study how organizations can take advantage of these complementarities to fight inefficient entrenchment more effectively.

IV. DISCUSSIONS AND CONCLUSION

Could managerial opportunism weaken strategic IT investment’s contribution to corporate profitability? How can an IT manager with a binding IT budget, by strategically overspending in certain types of IT projects, establish information and knowledge advantages over his potential rivals in the future? What is the role of compensation contract renegotiation in facilitating managerial rent-seeking?
What are the impacts of managerial entrenchment on corporate IT adoption and management? Our study attempts to provide researchers with a theoretical perspective from which these questions can be formally studied. By looking through the corporate veil behind which most IT investment decisions are made, our analysis sheds fresh light on the inefficiency of organizational strategic IT spending. Specifically, it shows that forward-looking IT managers, in order to gain leverage in future contract renegotiations, have incentives to entrench themselves in investment decision-making. With managerial discretions in IT budget allocation, they tend to invest excessively in those projects that they can more effectively manage in the long run vis-à-vis their potential rivals.

Unlike most agency-theoretic models that assume exogenous information asymmetries, our model recognizes the incumbent IT manager’s ability to create informational problems that he can exploit ex post. This recognition is particularly important in the context of strategic IT investment where opportunities for informational rent-seeking abound. Its significance is even more noticeable when we analyze the IT manager’s incentive for creating knowledge superiority over his potential rivals.

Our study concentrates on the entrenchment problem associated with investments in manager-specific projects. Following the seminal work in Becker (1964), there is a great deal of theory around firm-specific human capital. Before we discuss the IT investment scenarios involving firm specificity, we like to emphasize the difference between project-specific human capital and firm-specific human capital. Shleifer and Vishny (1989) use “manager-specific investment” to stress the fact that a manager may possess specific human capital that can be better utilized in some invested projects. Gibbons and Waldman (2004) propose the term “task-specific human capital” to conceptualize the similar idea that some of the human capital is “specific to the tasks being performed, as opposed to being specific to the firm.” They demonstrate how the concept of task-specificity can be applied to better explain the well documented cohort effects studied in Baker, Gibbs and Holmström (1994). In addition, they argue that this new human capital concept can be used in some business strategy studies where the issue of firm specificity has been well understood.
Despite the difference between firm-specificity and manager-specificity, most results of our study can be extended to address the potential entrenchment problem caused by firm-specificity. It is commonly observed that firms often invest in customization when there are more cost-effective off-the-shelf products that better serve their needs. Here the customized products may not be manager-specific, but they are generally firm-specific, which, because of learning by doing, offers incumbents an edge over their external rivals in the long run. Of course, in terms of entrenchment, firm-specific investments may not be as effective as manager-specific investments. The reason is that firm-specific investments do not protect incumbent managers from the competition of internal rivals. Moreover, managers’ firm-specific human capital tends to depreciate upon their leaving the firm, which not only limits their labor mobility, but also reduces their bargaining powers in contract renegotiation. On the other hand, human capital specific to tasks or projects, as argued in Gibbons and Waldman (2004), is more likely to be reasonably valued in the labor market.

Although managers may have stronger incentives to accumulate human capital specific to their expertise than that specific to their companies, they often face a lower hurdle in justifying firm-specific investments than manager-specific investments. Because most insiders can somewhat benefit from firm-specific investments, the link between entrenchment and firm-specificity is presumably stronger in situations where a group of insiders make investment decisions. It is often argued from the resource-based perspective that managerial expertise is the only attribute of IT that can generate sustainable competitive advantage (Mata, Fuerst and Barney, 1995). By relating our study to both project-specific and firm-specific human capital, organizational strategy researchers could further investigate the core rigidity associated with IT human capital (Leonard-Barton, 1992). In our opinion, incorporating firm-specificity in the study of entrenchment in organizational IT adoption could also shed fresh light on the relationship between IT and firm boundaries. It is well understood that IT, if properly deployed, can improve incentive structure and consequently facilitate more efficient organizational design (Nault, 1997; Zenger and Hesterly, 1997). However, there is still an ongoing debate between researchers about the joint impacts of technological advance and asset specificity on firm boundary choices (e.g., Poppo and Zenger...
1998). By highlighting the entrenchment problem in organizational IT adoption, our study suggests that, because of both IT capabilities and rigidities, the complicated role played by IT in the theory of firm warrants more theoretical and empirical investigations.

Another major goal of our study, as encouraged by Simon (1991a) and Gibbons (1999, 2004), is to explore a new avenue for the interplay between the economic and non-economic insights on organizational knowledge management and managerial decision-making. Some economists and organizational theorists share the viewpoint that the continuously increasing knowledge intensity in the knowledge-driven economy could severely exacerbate the problem of managerial opportunism (Coff, 1997, 2003; Stiglitz, 1999). Our study of a dynamic managerial entrenchment model further reinforces and substantiates this viewpoint. In our model, the IT manager strategically entrenches himself by creating information asymmetries for future exploitation. Our analysis suggests that effective knowledge management, by limiting the incumbent manager’s information and knowledge superiority over his potential rival, has the potential to overcome managerial entrenchment in IT spending. Consequently, we argue that this may be a reasonable corporate governance justification for allocating more resources to information retention and knowledge storage.

To justify knowledge management as a new front against managerial rent-seeking, we discuss the limitations of active monitoring and contractual incentive provision in fighting IT investment entrenchment. However, we never advocate denying their role as viable governance mechanisms. Instead we believe, if properly used, they could greatly enhance the efficacy of knowledge management in overcoming entrenchment. For economists who are interested in corporate governance, they should recognize the unique role of knowledge management in reducing agency costs, and integrate it into their optimal incentive contracting approach. For management and strategy researchers who are interested in the knowledge-based view of the firm, they should understand the various incentive problems associated

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9 Coff (2003) explicitly asks “how else might managers use informational asymmetries for personal gains”, and suggests that future research should “look for specific information asymmetries and explore how employees exploit them”.
with knowledge management, and explore the possibility of adopting economic tools like contractual remedies (especially relational contracts) to deal with those issues.

Among those incentive issues in knowledge management, the difficulty of managerial self-policing is emphasized as a major impediment to the successful adoption and implementation of knowledge management systems. We question the plausibility of assuming that entrenched managers will voluntarily destroy their lucrative entrenchment by effectively implementing organizational knowledge management initiatives. Therefore, one interesting extension of our study is to endogenize the delegation of knowledge management authority in a more general model. In such a model, we will be able to better study the economic impacts and organizational implications of different knowledge management governance structures. For example, we may analyze the efficiency improvement of giving the knowledge management authority to a top executive (e.g. a Chief Knowledge Officer directly supervised by the board) who is less entrenched or more easily controlled through incentive contracting. This extension may also provide an alternative interpretation of the results given by recent event studies of various IT-related initiatives (e.g., Chatterjee, Richardson and Zmud, 2000; Sabherwal and Sabherwal, 2003). For instance, we may ask whether the observed impacts on market valuation are also driven by more efficient information and knowledge governance enabled by those IT-related initiatives.

We examine the dark side of organizational IT investment decision-making in a managerial entrenchment study where “discipline-based property rights” (Williamson 1996, p. 25) are nowhere to be found. It is our belief that many exciting research opportunities in this area are awaiting researchers who can think beyond disciplinary boundaries.
APPENDIX A:

Proof of Proposition 1: The firm’s optimal IT budget allocation \((C_1^*, C_2^*)\) that maximizes its long-term investment returns is determined by solving:

\[
\max_{c_1, c_2} q_1 B_1(c_1) + q_2 B_2(c_2) - C \quad \text{s.t.} \quad C_1 + C_2 = C
\]

Because this objective function’s second derivative is always negative, its interior maximum \((C_1^*, C_2^*)\) is given by \(q_1 B_1'(C_1^*) - q_2 B_2'(C_2^*) = 0\). However, the incumbent manager’s objective in IT investment is to maximize his long-term human capital returns by solving:

\[
\max_{c_1, c_2} \lambda(R_q - R_r) + \theta(R_q - C - \lambda(R_q - R_r)) \quad \text{s.t.} \quad C_1 + C_2 = C
\]

This objective function can be simplified as \((1 - \theta)\lambda(R_q - R_r) + \theta(R_q - C), and its second derivative is \((1 - \theta)\lambda(q_1 - q_2)B_1'(C_1^*) + \theta(q_1 B_1'(C_1^*) - q_2 B_2'(C_2^*)) = 0\). Rearranging the equation, we have \(q_1 B_1'(C_1^*) - q_2 B_2'(C_2^*) = (1 - 1/\theta)\lambda(q_1 - q_2)B_1'(C_1^*) < 0\). Because \(q_1 B_1'(C_1^*) - q_2 B_2'(C_2^*) \) monotonically decreases with \(C_1\), it is easy to see that \(C_1^* > C_1^*\) and \(C_2^* < C_2^*\). If we also consider the possibility that \(C_1^* > C\), the manager’s personal optimal IT budget allocation is \(\min(C_1^*, C) > C_1^*\). Q.E.D.

Proof of Proposition 2: The proof is very similar to that of Proposition 1, and it is omitted here.

Proof of Propositions 3 & 4: In our model, any non-boundary maximum \((C_1^{**}, C_2^{**})\) should satisfy \((1 - \theta)\lambda(q(E_r, I_r) - q(E_r, I_r))B_1'(C_1^{**}) + \theta(q(E_r, I_r)B_1'(C_1^{**}) - q_2 B_2'(C_2^{**})) = 0\). Rearranging the equation, we have \([1/(\theta - 1)\lambda(q(E_r, I_r) - q(E_r, I_r)) + q(E_r, I_r)]B_1'(C_1^{**}) = q_2 B_2'(C_2^{**})\). It is easy to see that \(C_1^{**} = C_1^*\) when either \(\theta = 1\) or \(\lambda = 0\).

Defining \(f(\theta, \lambda) = (1/\theta - 1)\lambda[q(E_r, I_r) - q(E_r, I_r)] + q(E_r, I_r)\), we have \(\partial f(\theta, \lambda)/\partial \theta < 0\) and \(\partial f(\theta, \lambda)/\partial \lambda > 0\). It is also easy to see that \(\partial B_1'(C_1)/\partial C_1 < 0\) and \(\partial B_2'(C_2)/\partial C_1 > 0\). Hence we have
\[ \partial C_i^{**} / \partial \theta < 0 \text{ and } \partial C_i^{**} / \partial \lambda > 0. \] Of course, in the case of the boundary solution, small changes in \( \theta \) or \( \lambda \) do not affect the IT manager’s personal optimal budget allocation.

\textit{Q.E.D.}

\textbf{Proof of Propositions 5 & 6:} In our model, any non-boundary maximum \((C_i^{**}, C_j^{**})\) should satisfy\((1 - \theta)\lambda(q(E_i, I_i) - q(E_r, I_r))B_i'(C_i^{**}) + \theta(q(E_i, I_i)B_i'(C_i^{**}) - qB_2'(C_2^{**})) = 0.\) Differentiating the equation totally with respect to \(E_r\), we get

\[
[(1 - \theta)\lambda(q(E_i, I_i) - q(E_r, I_r))B_i'(C_i^{**}) + \theta(qE_i, I_i)B_i'(C_i^{**}) + \theta q B_2'(C_2^{**})]\frac{\partial C_i^{**}}{\partial E_r} = (1 - \theta)\lambda B_i'(C_i^{**}) \frac{\partial q}{\partial E_r}.
\]

Since \(B_i'(C_1) > 0\), \(B_2'(C_2) > 0\), \(B_i'(C_1) < 0\), \(B_2'(C_2) < 0\) and \(\frac{\partial q}{\partial E_r} > 0\), we know \(\frac{\partial C_i^{**}}{\partial E_r} < 0.\) Because of the symmetry between \(E_r\) and \(I_r\), we immediately have \(\frac{\partial C_i^{**}}{\partial I_r} < 0.\)

We know from Proposition 1 that \(C_i^{**} > C_i^*\), which completes the proof of Proposition 5 & 6 for all non-boundary maximum \((C_i^{**}, C_j^{**})\). Of course, in the case of the boundary solution, small changes in \(E_r\) or \(I_r\) do not affect the IT manager’s personal optimal budget allocation.

\textit{Q.E.D.}
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