Determinants of Mode of Innovation in IT Firms

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Abstract

In the research, we investigate the role of diversification in the type of innovation strategy followed by incumbent firms in the IT industry. We setup a two-stage game theoretic model where, in the first stage, the incumbent decides whether to invest in R&D or acquire a preemptive stake in the entrant. In the second stage, the incumbent decides whether or not to acquire a successful entrant. Our main result is that a more diversified incumbent is more likely to invest in acquisition than engage in R&D. We also collect data on financial indicators for firms in the IT industry using the Compustat database to empirically test our main result. Our empirical model confirms our proposition that firms with a degree of diversification are more likely to innovate through acquisition than through R&D.
1. Introduction

How to respond appropriately to the threat of new entry is a perennial dilemma facing incumbent IT firms. The fast pace of technological change, which leads to rapid introduction of new products, presents unique challenges to incumbent firms in the IT industry. For example, the cost of entry in IT industries is usually low and startups with intellectual capital can emerge as industry leaders in a short time (for example, Cisco and Google). Scholars have examined this issue primarily in the context of two strategies – innovation through research and development (R&D), and innovation through acquisition ([6]). One of the common paradigms to study firms’ innovation strategy is diversification. However, very little work exists on how diversification relates to the mode of innovation followed by firms. In other words, are diversified firms more likely to innovate through acquisition, or are they more likely to innovate through R&D?

Both R&D and acquisition strategies are common in the IT industry. Firms can pursue innovations internally, i.e., they can invest in (R&D) and launch new products in the market. For example, Intel’s line of microprocessors has been the staple of the PC industry for over two decades. Recently, Intel launched the Atom processor which is immensely successful in the Netbook market (one of the fastest growing segments in the PC industry). Firms such as Cogent (which provides fingerprint and biometric solutions) and Maxim (which designs and manufactures linear and mixed signal integrated systems) innovate primarily through investments in R&D. An alternate strategy that firms can follow is to strategically acquire other companies. Firms such as Cisco have been highly successful in leveraging acquisitions as a competitive strategy. For example in the early 1990s, when Cisco realized the customers started preferring switches to routers, it acquired switch-maker Crescendo. Since then, Cisco has completed dozens on acquisitions to enter new markets or to complement its existing products.
Similarly, Google acquired a small startup named Writely which enabled it to launch its online office suite GoogleDocs.

While this dilemma about which innovation strategy to follow exists in many industries, it is especially important in the IT industry due to the preponderance of emerging technologies, and a plethora of startups which try to build business models around these technologies and disrupt the industry status quo. The IT industry is fast paced and the industry status quo can change every few years. For example, in the mid 1990s, a new startup company named Yahoo emerged as the leading search engine provider on the Internet, only to have its dominance usurped by a newer startup named Google in the early 2000s. Incumbent firms need to be cognizant of the emerging technology landscape as well as of the shifting consumer preferences in the IT industry. One of the common strategies that new entrants follow is targeting the ‘blind spot’ of the market leaders. Blind spot is defined as the flaws that can result from a company’s mistaken or incomplete view of the industry and competition ([25]). It is conceivable that a firm which operates in many different markets has a bigger ‘blind spot’ than firms which operate in a single market. Acs and Audretsch [1] suggest that innovations are likely to come from smaller firms in industry sectors with a low concentration and fast changing technology. For example, the threat of new entrants can come to Cisco in any of the 16 product markets that it operates in. In such scenarios, incumbent players are often blindsided by entrants who introduce products to occupy the incumbents’ blind spot because the former fail to anticipate all possible threats. Once new entrants are successful in launching a new product ahead of the incumbent, the latter can respond by licensing the new technology or acquiring the new entrant ([11]).

Therefore, the number of markets that a firm operates in (or diversification) is likely to be a key factor in determining its innovation strategy. This seems to be supported by anecdotal
evidence. Less diversified companies, which focus on a narrow product line, mainly invest in R&D, whereas more diversified companies, which offer a broad product range, mainly follow a strategy of investing in acquisitions. For example, firms such as Intel and Lexmark are based around a core product and most of their revenues are tied to that product. Both firms innovate mainly through investments in R&D. Intel invests heavily in research and development primarily aimed at its microprocessor line of products. This enables Intel to be in a better position to predict technological changes and adapt its products accordingly. Baysinger and Hoskisson [5] suggest that R&D intensity is higher for dominant-business firms than diversified firms. On the other hand, Oracle has a broad product portfolio based around several technologies such as database systems, middleware, and enterprise systems, and primarily follows an acquisition strategy. Verisign, which mainly provides internet infrastructure services but also has a diverse product portfolio ranging from SSL certificates, Domain Name Services, and Enterprise Security, spends around 3 times on acquisitions than on R&D.

Therefore, while anecdotal evidence and past literature points to a link between diversification and mode of innovation followed by the firm, there has been little research in this area. With this motivation, we propose our main question as follows: how does the extent of diversification impact the innovation strategy of a firm?

To answer this question, we propose an analytical framework where an incumbent decides between acquiring a startup or investing in its own R&D in a two stage game theoretic model. Our main result is that the extent of diversification is positively related to the probability of a firm choosing acquisition over R&D as a mode of innovation. We also show that the incumbent is more likely to invest in R&D when consumers prefer the new technology over existing products in the market. We collect data on the relevant financial indicators for IT firms in the US
from the Compustat database and provide empirical support for our main result that the degree of
diversification is positively associated with the probability of a firm choosing acquisition over
R&D.

1.1. Literature Review

One of the main reasons for diversification by firms is the availability of slack resources
([20]). If the slack resources become available all of a sudden, then a firm is likely to go the
acquisition route ([22]). The impact of R&D on firm performance is a well researched topic
([13]). The learning literature suggests that an important benefit of R&D is that it helps firms to
develop absorptive capacity, which enables them to generate new knowledge ([8]). A firm’s
absorptive capacity for learning, however, depends on its endowment of relevant technology-
based capabilities ([19]). R&D investment is the necessary condition for the creation of
absorptive capacity ([23]). The knowledge management literature suggests that innovation
occurs when a firm identifies the potential opportunities to fill the gaps in the industry
positioning map, such as new customer segments, new customer needs, or new production
methods ([17]). Therefore, efficient knowledge exchange among functions internal and external
to the firm is critically important to success ([18]). Roussel et al. [21] suggest that R&D is the
key to develop new knowledge within a firm.

Acquisitions become possible when non-owners of an asset value it more than the owners
([12]), and usually involve an “acquirer with a high asset valuation purchasing a target with a
low asset valuation”. Blonigen and Taylor [6] study whether acquisition and R&D are positively
or negatively related in hi tech industries in the US. Xue [24] find a positive relation between
CEO compensation and probability of investing in acquisitions over R&D. While the decision to pursue innovation through acquisition versus R&D seems like an ‘either or’ decision, in reality the two may be complementary ([2]). For example, the theory of absorptive capacity ([8]) predicts that firms which have an internal knowledge base will be in a better position to absorb external knowledge generated through acquisitions. Such firms are also in a better position to adapt external knowledge gained through acquisitions to local conditions ([9]). Cassiman and Veugelers [7] provide empirical evidence of complementarities between R&D and external acquisitions by measuring the impact of different innovation strategies on new product sales.

2. Analytical Model

2.1 Basic Model – No Innovation

Suppose there are \( n \) products in the market, the demand for which stems from a representative consumer. Let \( Q_{i,n} \) denote the consumer’s demand for product \( i \) and \( P_{i,n} \) the product price, for \( i=1,..,n \). The consumer has constant elasticity of substitution (CES) preferences

\[
U_n = \left( \sum_{i=1}^{n} Q_{i,n}^\theta \right)^{1/\theta}, \quad \text{where } \theta \in (0,1).
\]

With these preferences, the elasticity of substitution across any pair of products is \( \sigma = 1/(1 - \theta) \), which lies in the range \( \sigma \in (1, \infty) \). The consumer allocates the income \( Y_n \) towards consumption. In the spirit of Benassy [4], consumers have a taste for variety. The greater is the number of products available to purchase, the more utility is derived by the consumer from consumption. In our framework, this effect is manifested by an increase in the allotment by the consumer towards expenditures in response to an increase in the number
of products; thus, \( Y_n \) is increasing in the span \( n \) of the market: \( Y_n = n^\nu Y \), where \( \nu > 0 \) represents the extent to which consumers value variety. The consumer solves the problem

\[
\max_{\{Q_j, \theta\}_{i=1}^n} \left( \sum_{i=1}^n Q_i \right)^{1/\theta} \quad \text{subject to} \quad \sum_{i=1}^n p_{i,a} Q_{i,a} \leq Y_n.
\]

In accord with Dixit and Stiglitz [10], the inverse demand function of product \( i \) is

\[
p_{i,a} = \left( \frac{Y_n}{Q_{i,a} \theta} \right)^{1-\theta} \quad \text{for} \quad i = 1, \ldots, n,
\]

where \( \theta \) represents the extent to which consumers value variety. The consumer solves the problem

\[
\frac{\sum_{i=1}^n p_{i,a} Q_{i,a}}{\theta} \leq Y_n.
\]

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\]

where \( \theta \) represents the extent to which consumers value variety. The consumer solves the problem

\[
\frac{\sum_{i=1}^n p_{i,a} Q_{i,a}}{\theta} \leq Y_n.
\]

We infer that \( \varepsilon = 1/(1-\theta) \) is the price elasticity of demand under the standard Dixit-Stiglitz assumption that the price index \( \bar{P}_n \) is taken as given by the producers of each product line.

In each of the \( n \) product markets, the incumbent is competing in Cournot fashion against a competitive fringe of \( m \) identical firms. The marginal cost of producing any of the existing products is \( c_I \) for the incumbent and \( c_F \) for a fringe firm. Being larger and more established, the incumbent has a cost advantage: \( c_I < c_F \). Because each product enters the utility function of the representative consumer symmetrically, and costs of production are identical across product lines, each market is identical.

**Proposition 1:** Consider the market prior to the innovation. The equilibrium price of the typical product is

\[
p_a = \frac{mc_F + c_I}{m}.
\]

The profits of the typical fringe firm and the incumbent are

\[
\Pi_{f,a} = \left( \frac{c_I - \theta c_F}{m} \right) \left( \frac{1 - \theta \varepsilon}{mc_F + c_I} \right) \quad \text{and} \quad \Pi_{i,a} = \left( \frac{Y_n}{1 - \theta} \right) \left( \frac{mc_F + c_I}{mc_F + c_I} \right)^2.
\]

A fringe firm is inactive if \( c_F \geq c_I / \theta \), i.e., if the marginal cost of production is sufficiently large relative to that of the incumbent. If the competitive fringe is inactive \( (m=0) \), then the aggregate profits of the incumbent is \( \Pi_{i,n} = Y_n / \varepsilon \), and the price becomes the usual monopoly markup over marginal cost,

\[
p_n = \frac{c_I}{\theta} = \frac{c_I}{1 - 1/\varepsilon}.
\]
2.2 New Product Introduction

Suppose a new product (labeled 0) is introduced in the market. Given the consumer expenditure function $Y_n = n^\nu Y$, we can infer that consumers’ expenditure increases as the new product is introduced. This assumption also follows from anecdotal evidence that new products introduced in the market have the potential to make consumers spend more. For example, new products such as the iPad and the Atom processor based Netbooks opened new markets for their respective manufacturers (Apple and Intel, respectively).

We assume that the incumbent competes in this new product market with a new entrant. Let $Q_{0,n+1}$ denote the representative consumer’s demand for the new good, and $P_{0,n+1}$ its price. The inverse demand function of an existing product $i$ is $p_{i,n+1} = \left(\frac{(1 - \alpha)Y_{n+1}}{Q_{i,n+1}P_{n+1}}\right)^{-\gamma}$ for $i = 1, \ldots, n$,

where $\bar{P}_{n+1} \equiv \sum_{j=1}^{n} P_{j,n+1}^{-\theta_i(1-\theta)}$ is a price index and where $\alpha \in (0,1)$ represents the extent to which the new product is a substitute for the collection of existing products. The inverse demand function of the new product is $p_{0,n+1} = \alpha Y_{n+1}Q_{0,n+1}^{-\gamma}$. We assume that existing products and the new product are linked only via the budget constraint of the consumer. This follows from the fact that the elasticity of substitution is one between the new product and the collection of existing products, which in turn follows from the Cobb-Douglas relationship between the new product and the collection of existing products. The consumer spends the share $1 - \alpha$ of his budget on existing products, $\sum_{i=1}^{n} p_{i,n+1} Q_{i,n+1} = (1 - \alpha)Y_{n+1}$; and the share $\alpha$ on the new product, $p_{0,n+1} Q_{0,n+1} = \alpha Y_{n+1}$. In this sense, the parameter $\alpha$ also represents the importance the consumer assigns to the new
product relative to the collection of existing products. On one hand, because the consumer has a
taste for variety, the total expenditures of the consumer increase in response to the innovation:
\(Y_{n+1} > Y_n\). On the other hand, the share \(\alpha\) of the consumer’s budget is now allocated towards the
new product.

The aggregate profits of the incumbent derived from all \(n\) markets of existing products are
\[
\Pi_{I,n+1} = \left(\frac{(1 - \alpha)Y_{n+1}}{1 - \theta}\right) \left(\frac{(1 - \theta)\theta_j + m(c_y - c_x)}{mc_y + c_x}\right)^2.
\]

If the incumbent is a monopoly in the new
product market, then the profits of the incumbent derived from the new product are
\(\pi_{I,0}^M = \alpha Y_{n+1}\).

### 2.3 The Innovation Game between the Incumbent and Entrant

In this subsection, we present the details of the game and derive conditions under which the
incumbent finds it optimal to invest in R&D versus acquisitions. The game has two stages. The
incumbent decides in the first stage of the game whether to perform R&D at cost \(R\) or obtain a
stake in the entrant at cost \(S\). If the R&D cost \(R\) exceeds the stake cost \(S\), then obtaining a stake
strictly dominates performing R&D since, all other things being equal, the incumbent is more
profitable with a stake in the entrant. Thus, to render the game non-trivial, we assume (A1)
\(S > R\). In the second stage of the game, the incumbent decides whether or not to acquire the
entrant at cost \(E\), which is the same regardless of having a stake or not. If the incumbent
performs R&D in the first stage, then an innovation race ensues between the incumbent and
entrant, which the incumbent wins with probability \(1 - p\) and the entrant wins with probability \(p\).

If the incumbent performs R&D and wins the race, then there is no need for the incumbent to
consider acquiring the entrant. However, if the incumbent performs R&D and loses the race, then
the incumbent does consider acquiring the entrant. If the incumbent obtains a stake in the entrant, then the entrant invents the new product for certain, after which point the incumbent considers acquiring the entrant. Figure 1 describes the stages of the game.---Insert Figure 1 here-------

We solve for the subgame perfect Nash equilibrium (SPNE) of the game. To implement backwards induction so as to derive the SPNE, we begin by solving Stage 2.

2.3.1 Stage 2: The Decision of the Incumbent to Acquire the Entrant

Suppose the incumbent performed R&D but the entrant was successful at inventing the new product. The incumbent decides whether to acquire the entrant or not. If the incumbent acquires the entrant, then the payoff is monopoly profits from the new product minus the cost of acquisition, $\Pi_{I,n+1} + \pi_{I,0}^M - E - R$. If the incumbent does not acquire the entrant, then it earns $\Pi_{I,n+1} - R$. Thus, the incumbent acquires the entrant if monopoly profits from the new product exceed the cost of acquisition, $\pi_{I,0}^M \geq E$. Applying the result $\pi_{I,0}^M = \alpha Y_{n+1}$ and consumer income $Y_{n+1} = (n+1)^{\nu} Y$, this condition becomes

$$n + 1 \geq \left( \frac{E}{\alpha Y} \right)^{1/\nu} \tag{1}$$

Suppose the incumbent obtained a stake in the entrant. Acquiring the entrant yields $\hat{\Pi}_{I,n+1} + \hat{\pi}_{I,0}^M - E - S$, while not acquiring the entrant yields $\hat{\Pi}_{I,n+1} - S$. Thus, the incumbent acquires the entrant if

$$n + 1 \geq \left( \frac{E}{\alpha Y} \right)^{1/\nu} \tag{2}$$
It is common for incumbent technology firms to acquire a strategic stake in startup firms, and steer the technology development in a way which enhances the value of their own products. For example, Intel acquired a strategic stake in graphics technology firm Imagination in an attempt to influence its future technology development to match better with Intel’s products. It is reasonable to assume that Imagination’s products developed under influence from Intel would enhance the value of Intel’s products which use Imagination’s technology.\(^1\) Because of the synergies enjoyed by the incumbent and entrant, we have that \( \hat{Y} > Y \), implying that \( \left( \frac{E}{\alpha \hat{Y}} \right)^{\frac{1}{\nu}} < \left( \frac{E}{\alpha Y} \right)^{\frac{1}{\nu}} \). Note that this comparison presumes that the cost of acquiring the entrant is the same irrespective of whether the incumbent has a stake in the entrant.

The following proposition summarizes the decision of the incumbent to acquire the entrant, which gives rise to two cases.

**Proposition 2:** Suppose the new product is invented. The subgame perfect Nash equilibrium (SPNE) exhibits the following outcomes in Stage 2 of the game.

- **Case 1:** Suppose the incumbent is focused: \( n + 1 < \left( \frac{E}{\alpha \hat{Y}} \right)^{\frac{1}{\nu}} \). Then the incumbent does not acquire the entrant.

- **Case 2:** Suppose the incumbent is average: \( \left( \frac{E}{\alpha \hat{Y}} \right)^{\frac{1}{\nu}} < n + 1 \leq \left( \frac{E}{\alpha Y} \right)^{\frac{1}{\nu}} \). Then the incumbent acquires the entrant only if it has a stake.

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• **Case 3:** Suppose the incumbent is diversified: \( \left( \frac{E}{\alpha Y} \right)^{1/v} \leq n + 1 \). Then the incumbent acquires the entrant.

Suppose the incumbent is *focused*, having few products in its portfolio with narrow scope. Then the monopoly profits it would attain upon acquiring the entrant are not sufficiently great to outweigh the cost of acquisition. Suppose the incumbent is *diversified*, having a large product portfolio with broad scope. Then the span of the market is large enough to warrant acquiring a successful entrant, irrespective of whether or not the incumbent performed R&D or obtained a stake.

Because \( \left( \frac{E}{\alpha Y} \right)^{1/v} < \left( \frac{E}{\alpha Y} \right)^{1/v} \), if the incumbent has obtained a stake in the entrant, then it does not need to be as diversified to acquire a successful entrant. In other words, the incumbent is more likely to acquire the entrant if it has a stake.

### 2.3.2 Stage 1: The Decision of the Incumbent to Obtain a Stake or Perform R&D

Consider Stage 1 of the game. The incumbent must decide whether to perform R&D, incurring the cost \( R \), or obtain a stake at cost \( S \). We divide our analysis into the three cases. Within each case, we obtain two sub-cases (labeled A and B). As with the three cases, the two sub-cases are presented in order of increasing degree of diversification.

**Case 1: Incumbent is Focused**
The expected payoff of performing R&D is $\Pi_{I,n+1} + (1-p)\pi_{I,0}^M - R$ because the incumbent does not acquire the entrant if the incumbent loses the race. The payoff of obtaining a stake is $\hat{\Pi}_{I,n+1} - S$ because the incumbent does not acquire the entrant in this case. Define the term

$$\Pi = \left( \frac{1 - \alpha}{1 - \theta} \right) \left( \frac{(1 - \theta) c_j + m (c_F - c_j)}{mc_F + c_j} \right)^2.$$  It follows that the incumbent performs R&D instead of obtaining a stake if and only if

$$n + 1 \leq \left( \frac{S - R}{\Pi (\hat{Y} - Y) - (1 - p)\alpha Y} \right)^{1/r} \quad (3)$$

Under assumption (A1), this condition presumes that the synergies associated with having a stake in the entrant are sufficiently great to satisfy

$$(A3) \; \Pi(\hat{Y} - Y) - (1 - p)\alpha Y > 0.$$  Otherwise, the incumbent would strictly prefer performing R&D, rendering the model unrealistic.

The following proposition derives the SPNE.

**Proposition 3:** If the incumbent is focused (i.e., Case 1 holds), the subgame perfect Nash equilibrium (SPNE) of the game is the following.

- **Case 1A:**
  $$n + 1 \leq \min \left\{ \left( \frac{S - R}{\Pi (\hat{Y} - Y) - (1 - p)\alpha Y} \right)^{1/r}, \left( \frac{E}{\alpha Y} \right)^{1/r} \right\}.$$  The incumbent performs R&D in the first stage and does not acquire the entrant in the second stage (if the incumbent loses the innovation race).

- **Case 1B:**
  $$\left( \frac{S - R}{\Pi (\hat{Y} - Y) - (1 - p)\alpha Y} \right)^{1/r} < n + 1 < \left( \frac{E}{\alpha Y} \right)^{1/r}.$$  The incumbent obtains a stake in the first stage and does not acquire the entrant in the second stage.
Case 2: Incumbent is Average

The expected payoff of performing R&D is $\Pi_{I,n+1} + (1 - p)\pi_{I,0}^M - R$ because the incumbent acquires the entrant only if it has a stake. The payoff of obtaining a stake is $\hat{\Pi}_{I,n+1} + \hat{\pi}_{I,0}^M - E - S$ because the incumbent acquires the entrant in this case. It follows that the incumbent performs R&D instead of obtaining a stake if and only if

$$n + 1 \leq \left( \frac{S + E - R}{\Pi(Y - Y) + \alpha(Y - (1 - p)Y)} \right)^{\frac{1}{\alpha}} \quad (4)$$

The following proposition derives the SPNE.

**Proposition 4:** If the incumbent is average (i.e., Case 2 holds), the subgame perfect Nash equilibrium (SPNE) of the game is the following.

- **Case 2A:**

$$\max \left( \frac{S + E - R}{\Pi(Y - Y) + \alpha(Y - (1 - p)Y)} \right)^{\frac{1}{\alpha}} + \left( \frac{E}{\alpha Y} \right)^{\frac{1}{\alpha}} < n + 1 \leq \left( \frac{E}{\alpha Y} \right)^{\frac{1}{\alpha}}.$$ The incumbent obtains a stake in the first stage and acquires the entrant in the second stage.

- **Case 2B:**

$$\left( \frac{E}{\alpha Y} \right)^{\frac{1}{\alpha}} < n + 1 \leq \min \left( \frac{S + E - R}{\Pi(Y - Y) + \alpha(Y - (1 - p)Y)} \right)^{\frac{1}{\alpha}} + \left( \frac{E}{\alpha Y} \right)^{\frac{1}{\alpha}}.$$ The incumbent performs R&D in the first stage and does not acquire the entrant in the second stage (if the incumbent loses the innovation race).

The expected payoff of performing R&D is $\Pi_{I,n+1} + \pi_{I,0}^M - R - pE$ because the incumbent acquires the entrant only if the incumbent loses the innovation race. The payoff of obtaining a
The stake is \( \hat{\Pi}_{t,n+1} + \hat{\Pi}_{t,0}^M - E - S \) because the incumbent acquires the entrant in this case. It follows that the incumbent performs R&D instead of obtaining a stake if and only if

\[
\left( \frac{S - R + (1 - p)E}{\hat{Y} - Y} \right)^{1/\gamma} \geq n + 1
\]

(5)

The following proposition derives the SPNE.

**Proposition 5:** If the incumbent is diversified (i.e., Case 3 holds), the subgame perfect Nash equilibrium (SPNE) of the game is the following.

- **Case 3A:**
  \[
  \left( \frac{E}{\alpha Y} \right)^{1/\gamma} \leq n + 1 \leq \left( \frac{S - R + (1 - p)E}{(\hat{Y} - Y)(\Pi + \alpha)} \right)^{1/\gamma} \]
  The incumbent performs R&D in the first stage and acquires the entrant in the second stage (if the incumbent loses the innovation race).

- **Case 3B:**
  \[
  \max \left\{ \left( \frac{S - R + (1 - p)E}{\hat{Y} - Y} \right)^{1/\gamma}, \left( \frac{E}{\alpha Y} \right)^{1/\gamma} \right\} < n + 1 \]
  The incumbent obtains a stake in the first stage and acquires the entrant in the second stage.

Overall, we find that the more diversified is the incumbent, the more likely it is to obtain a stake and acquire the entrant, and the less likely it is to perform R&D. For example, in Case 1A, which is the region in which the incumbent is the most heavily focused, the incumbent performs R&D in the first stage and does not acquire the entrant in the second stage; and in Case 3B, which is the region in which the incumbent is the most heavily diversified, the incumbent obtains a stake in the entrant in the first stage (instead of performing R&D) and acquires the entrant in the second stage.
We can combine the results from propositions 3, 4, and 5 to calculate the sub-game perfect Nash equilibrium. The results, expressed as a function of the degree of diversification ‘n’ and the relative importance consumers place on the new product ‘α’ can be summarized as follows:

**Proposition 6:** The tendency of an incumbent to choose acquisitions over R&D increases with increase in diversification, and decreases if consumers attach more importance to the new product over existing products.

This result can be summarized in Figure 2 in the Appendix. We can see that the probability to invest in acquisitions increases on the lower right side of the graph. On the other hand, tendency to do acquisitions decreases on the top left side of the graph. The dominant strategy space consists of i. taking stake in stage 1 and acquisition in stage 2 (Region R IV), and ii. doing R&D in stage 1 and no acquisition in stage 2 (Region R I). However, we also find that investing in both R&D & acquisition in stage 1 and stage 2 respectively (Region R III), and taking a stake in stage 1 and not investing in acquisition in stage 2 (Region R II) are also feasible strategies.

3. Empirical Support

To test the results of proposition 6, we collect data on relevant financial indicators from Compustat for IT firms in the US. The variables that we measure include: **RND:** denotes the R&D investments by a firm as a fraction of its total sales; **ACQUISITIONS:** denotes the investments made by a firm in acquiring other firms as a fraction of its total sales; **DIVERSIFICATION:** we measure diversification using the Herfindahl index. If a firm operates in m segments and $s_i (i = 1, ..., m)$ is the proportion of sales in segment $i$ as a fraction of total firm
sales, the Herfindahl Index is given as \( 1 - \sum_{i=1}^{n} s_i^2 \) – [15]. We also include the relevant control variables based on prior studies ([6]) for our analysis, as follows: **PROFITABILITY:** measured as the return on assets of the firm; **SIZE:** natural logarithm of its total assets; and **DEBT:** denotes the long term debt of a firm as a fraction of its total assets. Prior studies show a positive relation between R&D spending and internal financing ([14]). Our dependent variables for this study is \( Y = \frac{ACQUISITIONS}{RND + ACQUISITIONS} \), which is the fraction of a firm’s investment in new innovations \( (RND + ACQUISITIONS) \) that it devotes to acquisitions. The model that we estimate is as follows:

\[
Y = \alpha + \beta_1 \cdot SIZE + \beta_2 \cdot PROFITABILITY + \beta_3 \cdot DIVERSIFICATION + \beta_4 \cdot DEBT
\]

All our variables are measured as an average over three years (2004 – 2006). We use firms with the following SIC codes to shortlist IT companies for our sample: Programming (SIC Codes 7371 – 7379), Computers (SIC Codes 3570 -3577), Electronics (SIC Codes 3600 -3674) – [3]. Our sample size is 1222 firms. We control for industry level fixed effects in our model. The results of the regression are as follows: ------------Insert Table 1 here----------The \( R^2 \) of the regression is 8.1% and an F-test shows that our model is significant at the 0.01 level. All variance inflation factors (VIF) are less than 2 suggesting that correlation among independent variables is not a problem in our data. The regression provides support for our proposition that diversification is positively related to a firm choosing to invest more in acquisitions than R&D as an innovation strategy. We also show that firm size is positively associated with a higher probability of investing in acquisition than R&D. The other variables do not have a significant impact on the innovation strategy of a firm.
4. Conclusions and Future Research

The main contribution of this study is that we extend prior literature to investigate the impact of diversification on IT firms’ incentives to invest in research and development versus acquisitions. We propose a two stage game theoretic model to study the competition between an incumbent firm and a new entrant in a market where the entrant performs R&D to launch a product around a new technology. The incumbent can respond by either investing in its own R&D, or acquiring the entrant if the latter is successful, or both. We find that diversified incumbents are more likely to invest in acquisitions. We find that firms prefer R&D over acquisitions if consumers have a stronger preference for the new product. Our results also highlight the conditions under which incumbent firms invest in both R&D and acquisitions, and where incumbent firms acquire a stake, but do not acquire the entrant completely. We also validate our main result by empirically testing the relation between diversification and type of innovation strategy.

References


Appendix

Figure 1. Stages of the game

Note: SI and SE denote that incumbent and entrant are successful respectively. A and nA denote acquisition and no-acquisition respectively
Figure 2: Overall equilibrium in terms of diversification, n (X-axis) and preference for new technology α (Y-axis).

The values of the cutoff points as specified in the diagram are as follows:

\[ C_1 = \left( \frac{S - R}{\Pi(\hat{Y} - Y) - (1 - p)\alpha Y} \right)^{1/v} \]

\[ C_2 = \left( \frac{S + E - R}{\Pi(\hat{Y} - Y) + \alpha(\hat{Y} - (1 - p)Y)} \right)^{1/v} \]

\[ C_3 = \left( \frac{S - R + (1 - p)E}{\hat{Y} - Y)(\Pi + \alpha)} \right)^{1/v} \]

\[ L_1 = \left( \frac{E}{\alpha \hat{Y}} \right)^{1/v} \]

\[ L_2 = \left( \frac{E}{\alpha Y} \right)^{1/v} \]
\[ \alpha_1 = \frac{V}{W+V} \]
\[ \alpha_2 = \frac{X}{W+X} \]

where

\[ V = \frac{E \cdot (\hat{Y} - Y)}{(S - R) \cdot Y + E \cdot (2 - p) \cdot Y - E \cdot \hat{Y}} \]
\[ X = \frac{E \cdot (\hat{Y} - Y)}{(S - R + E) \cdot Y + E \cdot (\hat{Y} - Y)} \]
\[ W = \left( \frac{1}{1 - \theta} \right) \left( \frac{(1 - \theta)c_i + m(c_F - c_i)}{mc_F + c_i} \right)^2 \]

### Table 1: Results of Fixed Effects Regression

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std Err</th>
<th>t-value</th>
<th>p-value</th>
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<tbody>
<tr>
<td>SIZE</td>
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<td>0.013</td>
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<td>0.43</td>
</tr>
</tbody>
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