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COMPETITION AND ITS VIRTUE TO NEW STARTUPS UNDER THE POTENTIAL THREAT OF ENTRY

Abstract. *An innovation racing model simulates the strategic investment of rapidly growing but recently established U.S. startups, defined as rapid-growth startups, with differentiated original markets from pre-existing incumbent markets. For this, an entry signaling game is considered. Large incumbents send a signal either 'enter' or 'not enter' to the startups' original markets, which will affect the relative innovation qualities of the startups. If a 'not enter' signal reaches to the startups' original markets, the market perceived innovation of the startups would increase and vice versa. Combined with a high or a low value of market shock, I construct four business scenarios: {high market perceived innovation, high market luck}, {high market perceived innovation, low market luck}, {low market perceived innovation, high market luck}, and {low market perceived innovation, low market luck}. The simulation is designed to test a necessary and a sufficient condition. A necessary condition is that rapid-growth startups must be able to grow to be market leaders and a sufficient condition is that rapid-growth startups must overcome hostile M&A threats by the large incumbents. Differently from a general presumption that startup companies lacking initial endowments are less likely to grow rapidly under the potential threat of entry, the model predicts two conflicting outcomes. First, rapid-growth startups are more likely to maintain their market leaderships when their original markets are expected to become more competitive. Therefore, crisis would visit, surprisingly, when they enjoy strong market position rather than when they are exposed to tense competition. Second, when their original markets become competitive, rapid-growth startups are able to acquire their early competitors. These simulation results suggest an important message to policy makers: competition is desirable to raise rapidly growing startups. A panel fixed effect model supports the simulation predictions.*

Keywords: *Startup, innovation, entry signaling, market fluctuation, M&A.*

JEL Classification: C63, L25, and M13

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I. Introduction

1.1. Background

The effect of entry mode on firm growth path has not been considered yet even if entry type has a non-negligible impact on firm growth path, survival, and even exit. For instance, subsidiary or joint venture can start with their parent firm's supports. Firms created by M&A can begin with huge initial endowments, and thus they are more likely to survive and achieve fast growth (Cefis, E., O. Marsili, H. Schenk, 2009; Denning, Hulburt, and Ferris, 2006; Gong, Shenkar, Luo, and Nyaw, 2005; Luo, 2003; Luo, Y, 2002; Rugman and Verbeke, 2001). Concerning on this issue, an easy presumption is that startups lack initial endowments, such as labor and capital, are likely to fail quickly. Therefore, this paper addresses an important question: what if there are rapidly growing but recently established startups. Under competitive environment, how have they survived and achieved a rapid growth? Therefore, this paper presents recently established startups but have grown to become some of the largest firms in the United States. For this purpose, the Fortune 500 indexes for the years 1993 and 2003 are compared. To prevent double counting, new entrants are excluded if they had been listed *ex ante* in the 1993 Fortune index. In 2003, there are 358 new Fortune 500 entrants. The initial entry types of 358 new Fortune 500 entrants are tracked through *Standard & Poor's Corporate Descriptions plus News*, and 240 entrants are founded as startups.[2] This paper focuses on 44 new entrant startups, particularly those founded after 1975 defining them as 'rapid-growth' startups.[3]

Even when a startup owns a superior innovation, three types of risk exist. First, market may not respond to its innovation at all. Second, late entrants can leapfrog the startup. Third, the startup is exposed to hostile M&A threats during its incubating stage. Therefore, a necessary condition and a sufficient condition must be satisfied in order to incubate rapidly growing startups. A necessary condition is that startups need to invest strategically in order to compete against large conglomerates and a sufficient condition is that they must be able to overcome hostile M&A threats by conglomerates. The 44 rapid-growth startups are such firms that have overcome the three types of market risks and that were listed as Fortune 500 firms within 30 years or less since foundation.

1.2. Entry Signaling and Innovation

A common phenomenon among rapid-growth startups is that almost all of them have explored differentiated product (service) segments avoiding 'head-to-head' competition with large conglomerates in incumbent markets. For example, 16 rapid-

[2] Startup, subsidiary, M&A firm, spinoff, and joint venture are 240, 50, 43, 17, and 8 firms .

[3] The year 1975 has been chosen in particular because new business opportunities have emerged for incubating new startups such as IT boom and health and distribution industries.

growth startups are evaluated to be pioneers that have explored new products (services) in such major business journals as *Fortune*, *Business Week*, and *Forbes*.[4]

Another eye-catching feature prevalent among rapid-growth startups, although they have entirely different growth histories as well as different industry backgrounds, is that they have managed their investment strategically.[5] Therefore, I would like to define such investment behaviors as strategic investment.

According to Kerin, Varadarajan, and Peterson (1992), firm internal capability, formulated through strategic investment in capital goods, is indispensible to maintaining the market leadership of first mover. Nevertheless, their work does not focus on startup only, their result provides an important implication such that strategic investment on capital goods can play an important role in the expansion of startups competing with differentiated innovations. Actually, the strategic investment of rapid-growth startups has leveraged their rapid growth. The evidence is that the firm value evolution of rapid-growth startups coincides with their capital investment exactly (see Figure 1), which suggests that successful startup companies have leveraged investment capabilities, eventually producing sustainable innovations. Astonishingly, many innovations of rapid-growth startups have become standard business models now.[6]

[4] Specifically, they are United Auto Group (1990), EMC(1979), Microsoft(1975), Oracle(1977), Calpine(1982), Starbucks(1984), United Health Group (1977), Oxford Health Plans (1984), Health South(1984), Cisco Systems (1984), Qualcomm (1985), Amgen (1980), Solectron (1977), Staples (1985), Office Depot(1985), and Amazon.Com(1994). These firms are reported as niche marketers at least twice in the above journals since 1975 (Yim, 2010).

[5] For instance, Oxford Health Plans (founded in 1984) invested $30.7 million in 1994 and its investment had doubled in the next five years. During this period, Oxford Health Plans endeavored to establish freedom plan network. Cisco (founded in 1984) has adopted M&A driven growth strategy. It was not until 1991 that Cisco recorded a significant investment. In order to make its innovative router as a standard networking device, Cisco had completed a series of M&A's from 1992 to 1995 for removing competitors. As a result, its acquisition sales contribution reached $253.7 million in 1996. Since then, Cisco actively invested to establish foreign production networks for securing price competitiveness. Qualcomm (founded in 1985) initially licensed its CDMA technology to some Korean mobile manufacturers such as Samsung and LG. Afterwards, Qualcomm strategically attempted to preempt European standard GSM (*Global System for Mobile Telecommunication*) in global markets.

[6] Microsoft, Qualcomm, EMC, and Oracle introduced O/S, CDMA, RAID storage devices, and database management. UnitedHealth Group is the innovative private HMO model approved by Congress and the Administration in 1977. Starbucks created the "take-out-espresso-with-barista" coffee franchise market and Costco created an innovative one-stop membership retailing chain market. Staples and Office Depot specialized office-good retailing market while AutoZone did auto part chain. Cisco pioneered networking router and Encompass Services did automated payroll services. FedEx pioneered one-night-second-day ground shipping service, which became a standard business in air courier industry. The initial market of *Gateway* was to provide fully equipped breakthrough products with the lowest prices; as a result, *Gateway* was

Nonetheless, few previous works have put emphasis on this topic.[7] Therefore, I address two research themes. First, I simulate an innovation game with entry signaling between rapid-growth startups and their early competitors (i.e., public firms worked in the initial SIC's of the startups) in order to examine if the startups can grow to be market leaders surpassing large late followers. Second, I empirically test the predictions of the simulation model.

For constructing a simulation model on strategic investment, I consider the potential threat of entry because the products (services) of the early competitors can substitute those of rapid-growth startups. The early competitors can give two types of signals to the original markets of rapid-growth startups: 'enter' or 'not enter'. In this paper, innovation represents market perceived innovation, and thus the value of the startups' innovations depends on the potential market entry of their early competitors. If early competitors threaten to enter, consumers in the original markets of a startup would withhold their consumption undervaluing the startup's current innovation because large conglomerates can enter with better products (services). Hence, the startup's market perceived innovation would be lower in this case. If they signal not to enter, the consumers in the original markets would value the startup' innovation more highly, which increases the startup's market perceived innovation. Such innovation value interaction through entry signaling determines market perceived innovation, and this mechanism affects strategic investment behavior ultimately.

Concerning on firm performance analysis[8], firm and industry effects are a conventional empirical issue in the fields of industrial organization and business. However, there must be something more than the firm and industry effects in the puzzle of rapid-growth startups. Innovation and market luck are different concepts from the firm and industry effects that capture the lump-sum contributions of firm characteristic and idiosyncratic industry characteristic on firm performance. Innovation represents firm-specific capability that is not explained by the productivity of inputs

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awarded as the best PC maker in 1994, 1996, and 1998. The entry market of *Costco Wholesales* was membership-based wholesaler market that was preoccupied by Sam's Club; however, it differentiated by providing more than 4,000 products including fresh food as well as car and home insurance, mortgage and real estate services, and travel packages. *Home Depot* entered the "Do-It-Yourself" market that was created by *Lowe's* in 1928, but *Home Depot* is the first chain that has explored the nationwide DIY market with the minimum efficient scale in 1978. All these innovations are now standard business models both in related and diversified areas.

[7] For instance, university level knowledge input is important to the growth of entrepreneurial firms (Cassia, Colombelli, and Paleari, 2009; Bania, Eberts, Fogarty, and Michael, 1993). Jayaraman, Khorana, Nelling, and Covin (2002) interrelates venture firm's performance to CEO founder status.

[8] The cost performance approach proposed by Bogdan, Stoica, Mircea, and Sinioros (2010) can be applied to be another analytical tool. However, this paper adopts a simulation approach with some supporting panel empirical evidences on four business scenarios because the cost data on 44 rapid-growth startups is not accessible in reality.

and market luck means market fluctuation that is exogenous to all market participants. When a favorable market luck occurs, market entry would increase and vice versa.

A simple but straightforward way to construct a strategic investment racing game is a scenario analysis. I present four investment scenarios using the high-low combinations of the two factors based on entry signaling: {high market perceived innovation, high luck}, {high market perceived innovation, low luck}, {low market perceived innovation, high luck}, and {low market perceived innovation, low luck}, named as $\{IV_H^{NE}, IV_L^{NE}, IV_H^{E}, IV_L^{E}\}$. From the perspective of rapid-growth startups, a high market perceived innovation represents the case where early competitors signal 'not enter' and a low market perceived innovation does the case where early competitors signal 'enter'. They represent four investment scenarios under the potential threat of entry and it is interesting to see that, under which scenarios, rapid-growth startups are likely to grow quickly overcoming hostile M&A threats.

The paper is structured as follows. In section 2, rapid-growth startups and their early competitors are identified. Section 3 introduces an innovation race model and presents some simulation results. Section 4 suggests empirical frameworks and discusses test results. In section 5, several key implications are summarized.

II. Rapid-Growth Startups and Their Early Competitors

2.1. Market Fluctuation and New Fortune 500 Entrants

A simple OLS is tested given to equation (2.1). y_i is the number of new Fortune 500 entrants in each industry. gs_i is the GDP share growth rate between 1987 and 2001 that represents business opportunity. The 2001 GDP share of individual industry (gdp_i^{2001}) and the natural log of individual industry's 2001 GDP ($\ln gdp_i^{2001}$) are used for controlling market size. The GDP growth rate between 1987 and 2001 (gg_i) is a proxy for product life cycle. According to PLC, an industry experiences rapid growth during pre-maturing period, but its growth rate diminishes while the number of firms in the industry decreases in maturing period. The size of incumbents becomes larger, and they earn higher markups as the industry matures (Klepper, 1996). Since Fortune 500 Index reports revenue-based ranking, industries experiencing relatively low GDP growth rates can be regarded as matured industries, and thus one can expect that they would have more new Fortune 500 entrants and vice versa. A deregulation dummy (dr) is created by giving the value of one to 13 industries[9] that have experienced remarkable deregulations among 57 industries.

$$y_i = c + gs_i + gdp_i^{2001}(+\ln gdp_i^{2001}) + gg_i + dr + \varepsilon_i \tag{2.1}$$

[9] They are energy, financial, insurance, health, telecommunication, transportation, homebuilding industry groups.

According to Table 1, the GDP share growth rate increases the number of new Fortune 500 entrants, which strongly suggests that business fluctuation provides business opportunity significantly. Two size variables are also positive and significant, and thus industry size is critical for raising large corporations. The deregulation dummy has positive and significant effects too but its effects are smaller than the effects of the GDP share growth rate. The negative GDP growth rate in Table 1 demonstrates that the number of large firms increases as industry matures, which supports Klepper(1996)'s prediction. Based on the estimation results of equation (2.1), the role of market shock cannot be simply overlooked. This is the fundamental reason why industry effect is treated as one of key success factors in related literatures.

Table 1. OLS: Market Opportunity and the number of New Fortune 500 Entrants

Variable	Dependent Variable: The Natural Log of Number of New Fortune 500 Entrants of Individual Industries		
Constant	1.3182*** (.4886)	.4065** (.0685)	-.5526 (.3767)
Growth Rate of GDP Share of Individual Industries: 1987~ 2001	2.4600* (1.4118)	-	-
GDP Share of Individual Industries (2001)	-	.0581** (.0269)	-
The Log of GDP of Individual Industries (2001)	-	-	.2202*** (.0798)
GDP Growth Rate of Individual Industries between 1987 and 2001	-1.6236* (.9326)	-.0098 (.0289)	-.0291 (.0298)
Deregulation Dummy	.5107*** (.1146)	.4467*** (.1165)	.4287*** (.1138)
R^2 Adj. R^2	0.3023 0.2628	0.3217 0.2833	0.3550 0.3184
Observations	57		

*1. The numbers in parentheses are standard errors, and *** indicates significance at 1% level.*

2.2. Rapid-Growth Startups and Their Early Competitors

In order to construct early competitor panel data, I collect the competitors of 44 rapid-growth startups in each five-year interval, i.e. 1985, 1990, 1995, 2000, and 2003 and I define them as the competitors by period. If a startup is a single-focused firm, for example founded in 1998, the competitors by period in 2000, whose primary SIC business segments are identical to the primary SIC of the startup, are tracked through the *Company Profile Search* in *Lexis-Nexis*. If a startup is a diversified firm, its competitors in diversified segments are also searched. In this case, I classify as the competitors by period if their primary SIC segments are identical to the diversified SIC segments of the startup. As a result, there are 402, 556, 725, 657, and 645 competitors by period. Eliminating overlapped observations among the competitors by period, I have 530 early competitors with the average foundation year being 1958. Figure 1 depicts the evolution of market capitalizations of two groups of firms. The average market value of rapid-growth startups started to outweigh that of their early competitors since 1993. Both the sales and total employees of startups surpassed those of early competitors since the mid-1990s (see Figure 2). The ROI and ROA in Figure 3 reveal that the startups' investment was profitable. In contrast, early competitors recorded negative average ROI and ROA throughout the period. According to Figure 4, the total M&A of rapid-growth startups is equivalent to the evolution of their total market capitalization.

Figure 1. Market Cap. and Capital Expenditure

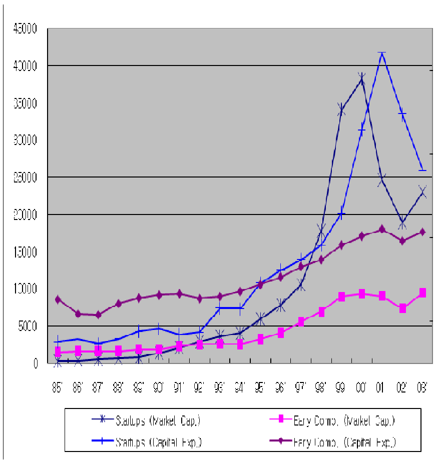


Figure 2. Sales and Employees

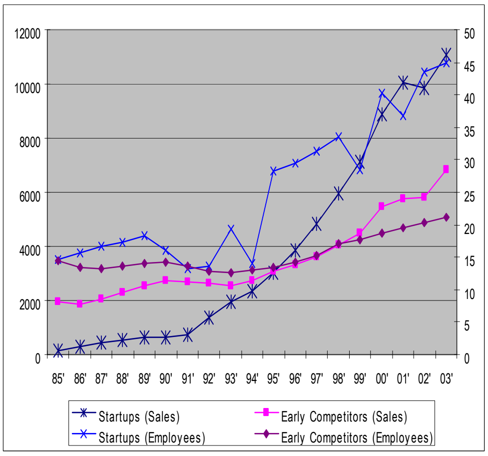


Figure 3. ROA and ROI

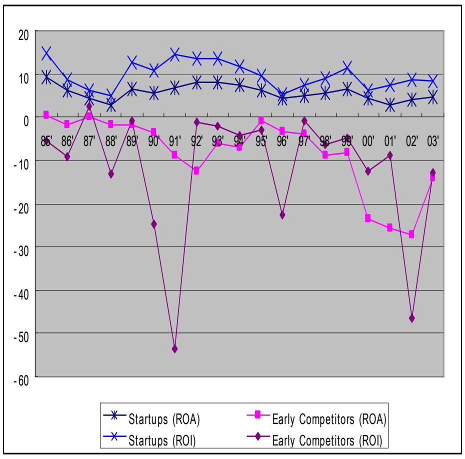
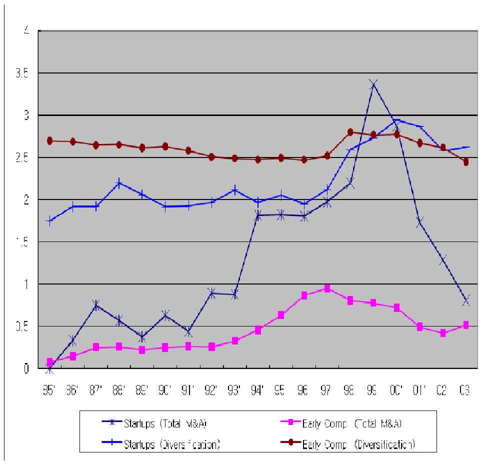


Figure 4. Total M&A & Diversification



III. The Model

The most peculiar feature of rapid-growth startups is that their capital expenditure, as described in Figure 1, coincides perfectly with firm value evolution. The capital expenditure, earned from *Compustat*, in the paper includes all investments in both tangible and intangible assets other than those spent for mergers and acquisitions, which provides a clue to model the strategic pathway of rapid-growth startups. Another desirable feature is that such capital expenditure can be applied to both manufacturers and service firms without incurring industry bias. Therefore, I simulate a game theoretic innovation racing model introduced by Reinganum (1989) that forecasts strategic investment.[10]

3.1. Initial Conditions

In stage-I, two large conglomerates, i.e. firm 1 and firm 2, work in market *A*. In my framework, they are early competitors and market *A* is an incumbent market. The innovation of firm 1 is assumed to be superior to that of firm 2: $\theta_{A1,I} > \theta_{A2,I}$ where the subscript I indicates the stage-I and subscripts 1, 2, and *A* represent firm 1, firm 2, and market *A*, respectively. They earn profits using $\theta_{A1,I}$ and $\theta_{A2,I}$ in a stage-I marketing stage. In stage II, a rapid-growth startup, firm 3, is assumed to win a stage-II innovation race and it obtains $\theta_{B3,II}$. Then, the startup opens market *B* with $\theta_{B3,II}$ rather than it penetrates into market *A* where the subscript B, 3 and II represents market B, the startup, and the stage-II innovation of the startup. The startup makes its profit with $\theta_{B3,II}$ in a stage-II marketing stage subsequent to the stage-II race. In stage II, two early competitors remain in market *A* with their initial qualities. Market *B* corresponds to a differentiate product (service) market while market *A* stands for old product (service) one. The order of qualities is $\theta_{A1,I} > \theta_{A2,I} > \theta_{B3,II}$ since the startup is not competitive yet. Because market *A* matures, no further innovation race is considered in market *A*.

[10] Maladzhi, Jacobs, Yan, and Makinde (2010) supports the importance of strategic innovation as Innovative leadership quality play a significant role in achieving competitive edge and successful new product development within SMEs. According to Suciu (2010), strategic investment must be accompanied with financing but, in this paper, each race participants are assumed to be able to finance its strategic investment. Filson and Gretz (2004) is a first empirical approach for Reinganum(1989)'s racing model, which explains technology expansion routine through spinning-off in rigid hard disk industry. Yim (2008) scrutinizes how rapid-growth startups could have leapfrogged their early competitors through quality innovation races. Yim (2010) uses a four-scenario approach in order to explain the astonishing performance of pioneers, which is limitedly applicable to niche marketers only due to its simple competition structure; in that, its four scenarios are constructed without considering any quality signaling interaction between competitor groups.

Now, a stage-III innovation race occurs in market *B*. All three firms participate in the stage-III innovation race in order to obtain the newest innovation, $\theta_{B,III}$, where $\theta_{B,III} > \theta_{A1,I}$ and $\theta_{B,III} > \theta_{B3,II}$. Two early competitors can enter market *B* with $\theta_{B,III}$ if they win the stage-III innovation race. In this case, they are able to expand their product (service) lineups to market *B*. The startup can improve its current level of innovation from $\theta_{B3,II}$ to $\theta_{B,III}$ if it wins, which strengthens its market power.

An M&A stage follows the stage-III innovation race. A winner firm can sell $\theta_{B,III}$ once it is more profitable. An acquirer can market with $\theta_{B,III}$ in a stage-III marketing stage subsequent to the stage-III M&A stage while an acquired firm remains at its *ex ante* stage-III race innovation level. Then, firms market in a stage-III marketing stage. If firm 3 sells its innovation, it cannot grow to be a Fortune 500 firm.

3.2. Profit Structure

Consumers can purchase only one good. It is assumed that consumers in market *B* do not purchase from market *A* while consumers in market *A* can purchase from both markets. A consumer h in market m purchases firm i's good (service) from market n maximizing:

$$U_{ni}^{h,m} = \alpha_{mn}\theta_{ni} - p_{ni} + \varepsilon_{ni}^{h,m} \tag{3.1}$$

$U_{ni}^{h,m}$ is the utility of the consumer choosing i's good. θ_{ni} is i's innovation and p_{ni} is the price that consumers have to pay for using θ_{ni}. $\varepsilon_{ni}^{h,m}$ is an individual-specific shock assumed to be independently and identically distributed according to a distribution $e^{-e^{-\varepsilon_{ni}^{h,m}}}$. The probability that consumers in *A* choose an early competitor i in *A* ($\lambda_{AA,i}$) when there are i and firm 3 in *B* is given to (3.2) and the probability that consumers in *A* choose i in *B* ($\lambda_{AB,i}$) is similarly defined to (3.3). The probability that consumers in *B* choose the early competitor i is derived in (3.4). $\lambda_{AB,3}$ and $\lambda_{BB,3}$ are similarly defined.

$$\lambda_{AA,i} = \frac{e^{\alpha_{AA}\theta_{Ai} - p_{Ai}}}{1 + e^{\alpha_{AA}\theta_{Ai} - p_{Ai}} + e^{\alpha_{AA}\theta_{Aj} - p_{Aj}} + e^{\alpha_{AB}\theta_{Bi} - p_{Bi}} + e^{\alpha_{AB}\theta_{B3} - p_{B3}}} \tag{3.2}$$

$$\lambda_{AB,i} = \frac{e^{\alpha_{AB}\theta_{Bi} - p_{Bi}}}{1 + e^{\alpha_{AA}\theta_{Ai} - p_{Ai}} + e^{\alpha_{AA}\theta_{Aj} - p_{Aj}} + e^{\alpha_{AB}\theta_{Bi} - p_{Bi}} + e^{\alpha_{AB}\theta_{B3} - p_{B3}}} \tag{3.3}$$

$$\lambda_{BB,i} = \frac{e^{\alpha_{BB}\theta_{Bi} - p_{Bi}}}{1 + e^{\alpha_{BB}\theta_{Bi} - p_{Bi}} + e^{\alpha_{BB}\theta_{B3} - p_{B3}}} \tag{3.4}$$

Own price elasticity is negative: $\partial\lambda_{mn,i} / \partial p_{ni} = -\lambda_{mn,i}(1-\lambda_{mn,i})$. The differentiated product (service) of firm 3 substitute old one, and so there exists a business stealing effect: $\partial\lambda_{mn,i} / \partial p_{nj} = \lambda_{mn,i}\lambda_{mn,j}$. Firm i in market B solves $\pi_{Bi} = \max_{p_{Bi}}(p_{Bi} - c)(n_A\lambda_{AB,i} + n_B\lambda_{BB,i})$ and the F.O.C. is given as follows.[11]

$$(n_A\lambda_{ABi} + n_B\lambda_{BBi}) - (p_{Bi} - c)\left[n_A\lambda_{ABi}(1-\lambda_{ABi}) + n_B\lambda_{BBi}(1-\lambda_{BBi})\right] = 0 \qquad (3.5)$$

3.3. The Innovation Race

Three firms solve the value function in equation (3.6) in the stage-III race. Because each race is a single prize innovation race, a race is over as soon as a winner is determined. The innovation production function is memoryless, and thus the outcome of current race is independent from previous race outcomes. The value function of firm i is

$$V_i = \int_0^\infty e^{-rt} e^{-\sum_j h_j(x_j)t}\left[\pi_i^0 - x_i + h_i(x_i)V_i^i + \sum_{j\neq i} h_j(x_i)V_i^j\right]dt \qquad (3.6)$$

where V_i^i (i.e., π_i^i / r) is the post-race value of i received if i wins and V_i^j (i.e., π_i^j / r) is that of i when j wins. r is a discount rate and π_i^0 is one-stage ahead racing profit. $h_i(x_i)$ is a hazard rate (i.e., the probability that i wins by t), which is assumed to be a twice differentiable concave function. Simplifying,

$$V_i = \frac{\pi_i^0 - x_i + h_i(x_i)V_i^i + \sum_{j\neq i} h_j(x_j)V_i^j}{r + \sum_j h_j(x_j)} \qquad (3.7)$$

Firm i maximizes w.r.t. x_i and the first-order condition is

$$-r - \sum_j h_j(x_j) + h_i'(x_i)\left[rV_i^i - \pi_i^0 + x_i + \sum_{j\neq i} h_j(x_j)\left(V_i^i - V_i^j\right)\right] = 0 \qquad (3.8)$$

The system of equations (3.2)-(3.4), (3.5), and (3.8) determine equilibrium values simultaneously: the non-linear equation system composed of the equations (3.2)-(3.4) and (3.5) determines equilibrium prices in markets A and B and the stage-III equilibrium investments of all race participants are determined by equation (3.8).

Market fluctuation affects equilibrium investments exogenously because it simply enlarges the size of profits. In contrast, firm specific innovation affects endogenously

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[11] In market *A*, an early competitor i solves $\pi_{Ai} = \max_{p_{Ai}}(p_{Ai} - c)n_A\lambda_{AA,i}$.

because it influences the prices and demands of three firms and then investment. The replacement effect $(rV_i^i - \pi_i^0)$ and the efficiency effect ($\sum_{j\neq i} h_j(x_j)(V_i^i - V_i^j)$) interact with each other, and they virtually determine the order of investment. The replacement effect, a driving force to leapfrog a market leader, is strongest to a most innovation inferior firm, while the efficiency effect, a driving force to maintain current competition structure, becomes the strongest to an innovation leader.

3.4. M&A

A stage-III M&A occurs between a stage-III race and a stage-III marketing stage; a winner firm can either market or sell the innovation of the stage-III race. Suppose that early competitor i markets $\theta_{B,III}$, then it obtains $\pi_{Ai,III}(p_{Ai,III}(\theta_{Ai,I},\theta_{Aj,I}))/r$ $+\pi_{Bi,III}(p_{Bi,III}(\theta_{B,III},\theta_{B3,II}))/r$ and early competitor j earns $\pi_{Aj,III}(p_{Aj,III}(\theta_{Ai,I},\theta_{Aj,I}))/r$ only. If startup markets the innovation, its profit becomes $\pi_{B3,III}(p_{B3,III}(\theta_{B,III}))/r$ and early competitors i and j obtain $\pi_{Ai,III}(p_{Ai,III}(\theta_{Ai,I},\theta_{Aj,I}))/r$ and $\pi_{Aj,III}(p_{Aj,III}(\theta_{Ai,I},\theta_{Aj,I}))/r$ only because they cannot enter market *B*.

Let the profit of firm j be $\pi^i_{Bj,III}(p^i_{Bj,III})$ when firm i markets $\theta_{B,III}$ in market *B*. Gains from merger must be greater to zero in order for j to acquire i 's innovation. Therefore, the following condition must be satisfied in order for i to sell $\theta_{B,III}$ to j . When an M&A occurs, a fixed transaction cost (f_l) is involved.

$$\frac{\pi^j_{Bj,III}(p^j_{Bj,III})+\pi^j_{Bi}(p^j_{Bi,III})}{r} - f_l \geq \frac{\pi^i_{Bi,III}(p^i_{Bi,III})+\pi^i_{Bj,III}(p^i_{Bj,III})}{r} \tag{3.9}$$

IV. Empirical Test

4.1. Innovation and Luck

Firm-specific Innovation is derived by total factor productivity (TFP). The inter-firm total factor productivity model including cross product terms is as follows. $\ln Q = A + f_i + \sum_{k=1}^{m}\alpha_k \ln L_k + \sum_{h=1}^{l}\sum_{k=1}^{m}\beta_{hk}\ln L_k \ln L_h$. All firms in industry j share the same slope in the inter-firm translog production function in period t but intercepts vary between firms, which determine the production functions in whole periods (Mundlak, 1961). Q is the vector of total sales of all participants in industry j at time t . A is an industry quality shift parameter. L_k represents production inputs: capital expenditure deflated by the CPI (1984=100) from the *Department of Labor* and total number of employees. f_i is a firm dummy, which captures the contribution of innovations that is not explained by the productivity of the inputs, and thus the firm dummy is a proxy for firm specific innovation. As a proxy for market size, annual constant dollar industry GDP (1996 basis) is collected from the "Gross Output by Detailed Industry" from the *Bureau of Economic Analysis,* which includes information from 1987 to 2001. Since the industry classification of the *Bureau of Economic Analysis* is different from Fortune's, the GDP data is modified into Fortune's industry classification. The residual of by-industry GDP AR(1) is considered to be exogenous market luck: $\ln GDP_t = c + \ln GDP_{t-1} + e_t$.

4.2. Simulation

4.2.1. Four Stage-III Innovation Race Scenarios

I use three particular years, i.e., 1990, 1996, and 2001. The year 1990 represents stage-I value, the year 1996 does stage-II value, and the year 2001 does stage-III value. Normalizing the 1996 level of innovation of rapid-growth startups as one, the average level of early competitors' innovation in 1990 becomes 2.2434. I set this as firm 1's stage-I innovation level ($\theta_{1A,I}$). The firm 2's stage-I innovation level ($\theta_{2A,I}$) is set to be the half of firm 1's and it is still higher than the normalized 1996 innovation level of the startup. The normalized innovation of rapid-growth startup in 2001 is used as the stage-III innovation ($\theta_{B,III}$).

$$\begin{pmatrix} \theta_{1A,I} & \theta_{2A,I} \\ \theta_{3B,II} & \\ \theta_{B,III} & \end{pmatrix} = \begin{pmatrix} 2.2434 & 1.1217 \\ 1 & \\ 3.0339 & \end{pmatrix}$$

Next, the natural logs of industry GDP in the years 1990, 1996, and 2001 are considered as the proxies to measure stage-I, II, and III market sizes where $\{n_{A,I},\ n_{B,II},\ n_{B,III}\} = \{7.0740,\ 7.1460,\ 7.2743\}$ and it is assumed $n_{A,III} = n_{A,II} = n_{A,I}/2$ as market *A* declines. An advantage for this architecture is that firm 1 and firm 2 become to have stronger incentives to enter market *B*, which makes it more difficult for the startup to maintain market leadership.

Now, the entry signaling of two early competitors occurs right after the stage-II race. Firms 1 and 2 can either enter or not enter market *B*, which affects the market perceived innovation of rapid-growth startup. A random market shock, either high or low, occurs at the same time. Therefore, four stage-III innovation race scenarios are possible: $\{S_H^{NE}, S_L^{NE}, S_H^E, S_L^E\}$. For instance, S_H^E represents a scenario where two early competitors signal 'enter' with a high market luck, and S_L^{NE} represents a scenario where the two competitors signal 'not enter' under a low market luck. S_L^E and S_H^{NE} are similarly defined. If two early competitors signal not to enter market *B* through the stage-III race, consumers value the startup's stage-II innovation more highly. If they signal to enter, the startup's market perceive innovation would be lower because consumers would wait a next racing stage outcome. The scenario matrix is

$$\begin{bmatrix} S_H^{NE} & S_L^{NE} \\ S_H^{E} & S_L^{E} \end{bmatrix} \equiv \begin{bmatrix} \hat{\theta}_{3B,II}^{NE}, \hat{n}_{B,II}^{H} & \hat{\theta}_{3B,II}^{NE}, \hat{n}_{B,II}^{L} \\ \hat{\theta}_{3B,II}^{E}, \hat{n}_{B,II}^{H} & \hat{\theta}_{3B,II}^{E}, \hat{n}_{B,II}^{L} \end{bmatrix}$$

where $\hat{\theta}_{3B,II}^{NE}$ and $\hat{\theta}_{3B,II}^{E}$ represent the market perceived innovations of *ex post* entry signaling, and $\hat{n}_{B,II}^{H}$ and $\hat{n}_{B,II}^{L}$ represent a high market luck or a low market luck, respectively. Consequently, rapid-growth startup markets either $\hat{\theta}_{3B,II}^{NE}$ or $\hat{\theta}_{3B,II}^{E}$ with a combination of a market shock either $\hat{n}_{B,II}^{H}$ or $\hat{n}_{B,II}^{L}$ in the stage-II marketing stage. After then, three firms participate in stage-III race for obtaining $\theta_{B,III}$.

The parameters for simulation are set to be the followings. The market perceived innovation of rapid-growth startup when firms 1 and 2 signal to withhold entry is $\hat{\theta}_{3B,II}^{NE} = \omega^2 * \theta_{3B,II}$. When firms 1 and 2 threaten to enter, it is $\hat{\theta}_{3B,II}^{E} = (\omega/2) * \theta_{3B,II}$ where $1.1 \le \omega \le 1.6$.[12] Note that $\hat{\theta}_{3B,II}^{E}$ can be even lower than $\theta_{2A,I}$. Because GDP has increased continuously since 1988, market luck must be set between '90 GDP and '01 GDP. A market shock is defined as the function of the natural log of '90 GDP, i.e., $n_{B,I} = 7.0740$. A high market shock is given to $\hat{n}_{B,II}^{H} = n_{B,I} + (\omega/10)$ and a low market shock is $\hat{n}_{B,II}^{L} = n_{B,I} + (\omega/20)$ where $1.1 \le \omega \le 1.6$. The marginal cost is 1, and the discount rate is .1.

The hazard rate is given as $h_i = (x_i)^{1/2}$ and f_I =.26. Consumer preferences in market A is set to be $0.1 \le \alpha_{AB} \le 0.3$. In contrast, it is set to be $\alpha_{BA} = 0$, which indicates that consumers in differentiated market B do not purchase from market A.[13]

[12] The range of ω is particularly set to be $1.1. \le \omega \le 1.6$. If $1.1 \le \omega \le 1.4$, the market perceived innovation of rapid-growth startup would be higher than firm 2's initial innovation level ($\theta_{2A,I}$) when two incumbents signal 'not enter', which sets the lower bound. If $1.5 \le \omega \le 1.6$, the startup's market perceived quality would be higher than firm 1's initial quality ($\theta_{1A,I}$) in market A but it is still lower than $\theta_{B,\,III}$, which sets the upper bound. If $1.5 \le \omega \le 1.6$, $n_{B,II} < \hat{n}_{B,II}^{H} < n_{B,III}$. If $1.1 \le \omega \le 1.4$, $\hat{n}_{B,\,II}^{L} < n_{B,II}$, which represents a low market luck.

[13] First, $\alpha_{BA} = 0$ ensures consistent demands on firm 3, and second, early competitors struggling in a sluggish market A become to have stronger incentives to penetrate into market B.

4.2.2. Simulation Predictions

Table 2 summarizes the simulation results on investment behavior. If $\omega \leq 1.4$, a rapid-growth startup is likely to maintain its leadership in market *B*. As the scale factor is $\omega = 1.5$, the startup invests the most in all scenarios when α_{AB}=.1 and firm 2 invests more than firm 1 does. Interestingly, when early competitors signal 'not enter' (S_H^{NE} and S_L^{NE}), firm 2 invests more than the startup does if α_{AB}=.2. Alternatively speaking, the startup is inclined to decrease its investment when two incumbents are not likely to enter. This shows that a rapid-growth startup and potential entrants play separate equilibrium because the replacement effect of a quality inferior potential entrant becomes greater than the efficiency effect of the rapid-growth startup. In contrast, the rapid-growth startup is likely to protect market *B* when both firms 1 and 2 threaten to enter. If α_{AB}=.3, the startup invests the least by observing 'not enter' signal because the replacement effects of two potential entrants that have no original products (services) in market *B* dominate the efficiency effect of the startup in S_H^{NE} and S_L^{NE}. Therefore, a high market perceived innovation makes rapid-growth startup invest less, which makes its market position vulnerable in future competition; however, the startup invests more in S_H^{E} and S_L^{E}.

Table 2. Equilibrium Investment under Alternative Values of ω

		Scenario	The Ranking of Investment Order (from Left to Right)		
$\omega \leq 1.4$	$\alpha_{AB} \leq .3$	For all scenarios	Startup	Firm 1	Firm 2
ω=1.5	$\alpha_{AB} = .1$	For all scenarios	Startup	Firm 2	Firm 1
	$\alpha_{AB} = .2$	S_H^{NE}	Firm 2	Startup	Firm 1
		S_L^{NE}	Firm 2	Startup	Firm 1
		S_H^{E}	Startup	Firm 2	Firm 1
		S_L^{E}	Startup	Firm 2	Firm 1
	$\alpha_{AB} = .3$	S_H^{NE}	Firm 2	Firm 1	Startup
		S_L^{NE}	Firm 2	Firm 1	Startup
		S_H^{E}	Startup	Firm 2	Firm 1
		S_L^{E}	Startup	Firm 2	Firm 1
	Under Which Scenario the Startup Invests the Most				
For all ω	For all α_{AB}	$S_L^{E} > S_H^{E} > S_L^{NE} > S_H^{NE}$			

These results demonstrate that competition enhances the survival and success of rapid-growth startups. The rapid-growth startup is more likely to maintain market leadership when its original market is expected to be more competitive. Rather, the startup is likely to lose when it expects that entry is not likely to happen. Thus, competition rather than protection is desirable in order to incubate rapidly growing startups.

Now, let us consider in which scenario the startup invests the most. For all ω, the order of the startup's investment scenario is found to be S_L^E, S_H^E, S_L^{NE}, and S_H^{NE}. When early competitors are expected to enter market *B*, rapid-growth startup becomes to have a strong incentive to invest more because its market perceived quality becomes lower. If market luck happens to be a low one at the same time (i.e. S_L^E), the startup is inclined to invest aggressively in order to overcome the internal and external difficulties. In contrast, it is less inclined to invest in S_H^{NE} because explosive market enlarges its profit scale exogenously. In other words, the startup would invest the least because no entry is expected while they can enjoy a high market luck. Most of all, the order of the startup's investment virtually depends on the potential threat of entry rather than market luck. This suggests that firm specific innovation plays a more important role in explaining the expansion of rapid-growth startup.

Table 3. M&A under Alternative Values of ω

		M&A		Scenario			
		Acquiring Firm	Acquired Firm	S_H^{NE}	S_L^{NE}	S_H^E	S_L^E
ω =1.3	$0.1 \le \alpha_{AB} \le 0.3$	Startup	Firm 1	Yes	Yes	Yes	Yes
		Firm 2	Firm 1	-	-	-	-
		Startup	Firm 2	Yes	Yes	Yes	Yes
		Firm 1	Firm 2	-	-	-	-
		Firm 1	Startup	-	-	-	-
		Firm 2	Startup	-	-	-	-
ω =1.4	$0.1 \le \alpha_{AB} \le 0.3$	Startup	Firm 1	Yes	Yes	Yes	Yes
		Firm 2	Firm 1	-	-	-	-
		Startup	Firm 2	-	-	Yes	Yes
		Firm 1	Firm 2	-	-	-	-
		Firm 1	Startup	-	-	-	-
		Firm 2	Startup				
ω =1.5	$0.1 \le \alpha_{AB} \le 0.3$	Startup	Firm 1	-	-	Yes	Yes
		Firm 2	Firm 1	-	-	-	-
		Startup	Firm 2	-	-	Yes	Yes
		Firm 1	Firm 2	-	-	-	-
		Firm 1	Startup	-	-	-	-
		Firm 2	Startup	-	-	-	-

1. The sign of "-" means that no M&A occurs.

Table 3 presents M&A experiment results. When ω =1.3, no M&A between early competitors happens; however, firms 1 and 2 sell $\theta_{B,III}$ to rapid-growth startup when they win stage-III race. If ω = 1.4, the startup can acquire firm 1's stage-III innovation in all scenarios but firm 2 does not sell $\theta_{B,III}$ to the startup in S_H^{NE} and S_L^{NE}, rather, firm 2 markets for its own sake. If ω = 1.5, both firm 1 and firm 2 do not sell $\theta_{B,III}$ in S_H^{NE} and S_L^{NE} while they sell $\theta_{B,III}$ in S_H^{E} and S_L^{E}.

It is obvious that M&A depends on the scale of two factors. As the scale enlarges, early competitors tend to market for themselves, whereas they stay away from the original market of the rapid-growth startup when the scale is too small. Two important implications are derived from Table 3. First, a rapid-growth startup never sells its innovation to potential entrants, which satisfies aforementioned sufficient condition.. Second, a rapid-growth startup can grow to be a large firm through M&A even when it fails to win the stage-III race.

4.3. Panel Analysis

4.3.1. Empirical Framework

It would be ideal to be able to verify the predictions of racing simulation but, in practice, it is not possible to identify in which year early competitors have entered the original markets of rapid-growth startups. Technically, a panel data is not appropriate to replicate the one-shot stage game of entry signaling. Therefore, I construct four business environment using relative innovation and market luck. As a first step, I calculate the relative innovation level of rapid-growth startup against early competitors by comparing the TFP innovation of each rapid-growth startup with the average TFP innovation of its early competitors. I create a high (low) TFP relative innovation dummy for each startup by giving the value of one if the relative innovation level of the startup lies above (below) a whole sample average. I create a high (low) market luck dummy by giving the value of one if the residual of individual Fortune industry's GDP AR(1) is greater (smaller) than zero.[14]

The four business scenarios are HH_{GDP}^{TFP}, HL_{GDP}^{TFP}, LH_{GDP}^{TFP}, and LL_{GDP}^{TFP}. HH_{GDP}^{TFP} is created by multiplying a high relative TFP (sales) innovation dummy with a high market luck dummy. HL_{GDP}^{TFP}, LH_{GDP}^{TFP}, and LL_{GDP}^{TFP} are created similarly as well but LL_{GDP}^{TFP} is dropped off due to perfect multicollinearity. In equation (4.1), $ep_{i,t}$ is the capital expenditure that is realized by CPI. Equation (4.2) tests firm performance under four business environments. $y_{i,t}$ is three firm performance measures: total market

[14] This is because the average of individual Fortune industry's GDP AR(1) residuals are close enough to zero.

capitalization, sales, and gross profits. The natural log of total working year ($\ln yr_{i,t}$) is a controlling variable on market experience. Two important strategic behaviors, diversification and M&A, are included because they can interact with the three performance measures as omitted variables. The level of diversification ($div_{i,t}$) is measured by the number of SIC segment, which represents the degree of focus, and total M&A ($mna_{i,t}$) represents aggressiveness.[15] The natural logged total employees ($\ln emp_{i,t}$) is used to control size discrepancy.

$$ep_{i,t} = f + j + t + HH_{GDP}^{TFP} + HL_{GDP}^{TFP} + LH_{GDP}^{TFP} + LL_{GDP}^{TFP} + \ln yr_{i,t} + div_{i,t} + mna_{i,t} + \ln emp_{i,t} + \varepsilon_{i,t} \tag{4.1}$$

$$y_{i,t} = f + j + t + HH_{GDP}^{TFP} + HL_{GDP}^{TFP} + LH_{GDP}^{TFP} + LL_{GDP}^{TFP} + \ln yr_{i,t} + div_{i,t} + mna_{i,t} + \ln emp_{i,t} + \varepsilon_{i,t} \tag{4.2}$$

4.3.2. Empirical Results

Table 4 summarizes the strategic investment of rapid-growth startups under four business environments. I divide into two periods: 1988-1995 and 1996-2001. Considering that the average foundation year of rapid-growth startups is 1984, the 1988-1995 period represents an incubation stage and the 1996-2001 period does a rapid growth stage. Because U.S. economy had experienced a boom since the mid 1990s, the 1996-2001 period must be a more competitive period. Although no statistically significant outcomes are found in Table 4, the estimation result is still consistent to the prediction of the innovation racing simulation. Among four environments, rapid-growth startups invest more in LH_{GDP}^{TFP} while the startups tend to decrease investment when their relative innovation against early competitors is high (i.e., HH_{GDP}^{TFP} and HL_{GDP}^{TFP}) in the 1996-2001 period. In other words, rapid-growth startups increase investments when their relative innovation is low.[16] On the contrary, the startups invest more when they experience high relative innovations and high market lucks simultaneously in the incubation period. Therefore, one can say that startups are opting for high innovations and favorable market lucks initially, but, as market becomes competitive, successful startups become to obtain sustainable competency overcoming large conglomerates through strategic investment. Table 5

[15] The information on the degree of diversification is tracked through the *Industrial Annual Reports* in *Compustat*. M&A information is tracked through *Business News* in *Lexis-Nexis*, which contains more than 600 data sources including *Business Wire*, *PR News Wire*, *Business Week*, *Newsweek, Mergers and Acquisitions Reports, Mergers and Acquisitions Journal* (see Figure 4). Only completed M&A's are counted.

[16] The LH seemingly represents S_H^E .

shows the performance of rapid-growth startups under four business environments. The stock market evaluation, size growth, and profitability of rapid-growth startups increase when they can obtain high innovations and the three performance measures become the largest ones when relative innovations are high with enjoying high market lucks at the same time (HH_{GDP}^{TFP}).

Table 4. Four Business Environments and Strategic Investment

Variables	1988-2001	Variables	1988-1995	Variables	1996-2001
Constant	-3.9174*** (0.3077)	Constant	-2.4764*** (0.7783)	Constant	-1.0666** (0.4307)
HH_{GDP}^{TFP}	0.1085 (0.0839)	HH_{GDP}^{TFP}	0.2131 (0.2089)	HH_{GDP}^{TFP}	-0.0211 (0.0836)
HL_{GDP}^{TFP}	0.0103 (0.0894)	HL_{GDP}^{TFP}	-0.0043 (0.1568)	HL_{GDP}^{TFP}	-0.0015 (0.0811)
LH_{GDP}^{TFP}	0.0557 (0.0580)	LH_{GDP}^{TFP}	-0.0650 (0.0892)	LH_{GDP}^{TFP}	0.0378 (0.0613)
LL_{GDP}^{TFP}	-	LL_{GDP}^{TFP}	-	LL_{GDP}^{TFP}	-
$\ln yr_{i,t}$	1.0435*** (0.2215)	$\ln yr_{i,t}$	0.4590 (0.3059)	$\ln yr_{i,t}$	1.0904*** (0.3212)
$div_{i,t}$	0.0601*** (0.0199)	$div_{i,t}$	0.0514 (0.1203)	$div_{i,t}$	0.0290* (0.0167)
$ma_{i,t}$	0.0181** (0.0073)	$ma_{i,t}$	-0.0133 (0.0254)	$ma_{i,t}$	0.0214*** (0.0075)
$\ln emp_{i,t}$	0.8575*** (0.0762)	$\ln emp_{i,t}$	0.9696*** (0.1207)	$\ln emp_{i,t}$	0.6661*** (0.0985)
Adj. R^2	0.7512	Adj. R^2	0.5898	Adj. R^2	0.8410
Obs.	388	Obs.	182	Obs.	206

*1. *, **, and *** indicate significance at 10%, 5%, and 1% levels.*
2. The numbers in the parentheses are robust consistent standard errors correcting heteroscedasticity and autocorrelation.
3. Firm, time, and industry dummies are not reported.

Table 5. Four Business Environments and Rapid-Growth Startups' Performance

	Rapid-Growth Startups		
	Market Cap.	Sales	Gross Profit
Cons.	-1.0192*** (0.3136)	-1.5373*** (0.2376)	-1.1709*** (0.2091)
HH_{GDP}^{TFP}	0.2818*** (0.0984)	0.1950*** (0.0719)	0.0799* (0.0444)
HL_{GDP}^{TFP}	0.1822* (0.0941)	0.1561* (0.0837)	0.1881** (0.0639)
LH_{GDP}^{TFP}	0.1108 (0.0791)	0.0934 (0.0639)	0.0360 (0.0343)
LL_{GDP}^{TFP}	-	-	-

$\ln yr_{i,t}$	1.4173*** (0.2039)	1.4393*** (0.1932)	0.4916*** (0.0857)
$div_{i,t}$	0.0811*** (0.0214)	0.0721** (0.0193)	0.0305 (0.0240)
$ma_{i,t}$	0.0494*** (0.0087)	0.0125*** (0.0059)	0.0369*** (0.0090)
$\ln emp_{i,t}$	0.6125*** (0.0670)	0.7076*** (0.0561)	0.1549*** (0.0361)
Adj. R^2	0.6815	0.6956	0.5029
Obs.	402	409	409

*1. *, **, and *** indicate significance at 10%, 5%, and 1% levels.*
2. The numbers in the parentheses are robust consistent standard errors correcting heteroscedasticity and autocorrelation.
3. Firm, time, and industry dummies are not reported.

V. Conclusions

Major experimental findings are summarized as follows. First, firm specific innovation, not market luck, plays a more important role in accelerating the extraordinary success of rapid-growth startups. Second, rapid-growth startups are more likely to obtain market leaderships in their original markets when the markets become more competitive. Third, rapid-growth startups can circumvent hostile M&A threats and they are able to acquire early competitors. However, as the original markets of the startup enlarge, such M&A opportunities vanish away.

Relying on these findings, I can draw three policy implications. First, competition is desirable because it makes startups invest more actively. It is obvious that startups cannot bear direct competitions with large conglomerates because they lack capital and labor. There must be supplementary infrastructure such as IPO, credit finance, angel investor, and M&A service. America is a good example in this sense. Second, it is not clear if government subsidy is an effective policy based on my empirical result. According to my model, government subsidy may be desirable once it can supplement weak business infrastructure mentioned in the above. In reality, a few Asian countries with government subsidy policy failed to raise startups to be large corporations. Hence, government driven startup incubation policy seems to be effective in the short run only. Third, we need to pay more attention to the role of M&A because M&A has played as a shortcut to the expansion of rapidly growing but recently founded startups. The active M&A of rapid-growth startups has a non-negligible impact on their performance. M&A market is a part of business infrastructure that enables to trade technologies and firm ownership. In this paper, rapid-growth startups have implemented a series of M&A's, which means that U.S. M&A market works efficiently. For instance, more than 57 percent of total sales of American security companies originated from M&A services in 2006; however, only less than 3 percent in Korea in the same year.

The most salient contribution of this paper is that firm-level investment must be considered as a key success factor. Therefore, policy makers have to put policy emphasis on developing financial aid systems that can facilitate the active investment of startup companies. As long as fair competition is assured, market mechanism can provide affluent business opportunities to newly founded startups on the condition that startup incubating business infrastructures are well-organized. This is the fundamental reason why America, frequently quoted as the most dynamic economy, has produced 44 rapid-growth startups while government-driven venture policy has failed recently in some Asian countries.

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