Do innovations really pay off?

Total stock market returns to innovation

Innovation is one of the most important forces for fueling the growth of new products, sustaining incumbents, transforming industries and promoting the global competitiveness of nations. But some critics assert that an earnings-focused, short-term approach to boosting the stock price may undercut investments in innovation that typically have a long payoff. This view is based on the assumption that stock markets respond positively to announcements of immediate earnings, but negatively to announcements of investments in innovation that have an uncertain longer-term payoff. As a result, many researchers, analysts and managers believe that firms are not investing enough in innovation. Some go so far as to complain that the US may be losing its competitive edge and leadership in innovation relative to other nations, due to falling investment in R&D. Firms may under-invest in R&D because of the potentially high costs, the long delay before seeing a return, if ever, and the difficulty of adequately measuring the potential return. Therefore, accurately assessing the market return on innovation may be critical to understanding how markets respond to innovation and motivating firms to invest in innovation.

Logic of event study

The event study method is one of the best means of assessing the true returns on an innovation project.[1] Its basic underlying assumption is the efficient market hypothesis, which states that a stock price at a particular point in time fully reflects all available information up to that point.

1 Fama, Fisher, Jensen, and Roll (1969); Fama (1998)

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Thus, any change in the price of a stock due to new information reflects the present value of all expected current and future profits from that new information. The method has been widely used in the available literature to assess the market response to new information.

However, past research has focused on isolated innovation events (e.g., alliances, patents or new product launches) to estimate the returns to innovation rather than looking at the entire project. The problem with this approach is that it may lead to a substantial underestimation of the total returns. On the one hand, if the returns on the entire innovation project could be estimated from a single target event during the project, then returns for other events would not vary significantly. That target event would be critical, with important implications for firms and investors. On the other hand, if firms continue to experience incremental returns on various events over the innovation project, ignoring certain events would result in underestimating the total returns on innovation.

Market returns to innovation projects

For the purposes of this study, we defined an innovation project as the total of a firm's activities in the research, development and introduction of a new product based on a new technology, from the initiation of the technology to about a year after introduction of the new product. We defined technology as a distinct principle or platform for producing products to serve a consumer need.[2] For example, neon lamps are based on fluorescence technology, which produces light based on the distinct scientific principle of fluorescence. Several new products and models (e.g., hard disks, floppy drives, tapes) could be developed on a single technology platform (e.g., magnetic storage).

We also identified the activities in innovation projects: initiation; development and commercialization (see Table 1).

Table 1. Activities in innovation projects

Phase	Setup/initiation	Development	Market/commercialization
Events unique to this study	Funding (grants, advanced order, funded contracts) Expansion (new development or manufacturing facilities)	Prototypes (working prototypes, identification of new materials, processes or equipment, demonstration in exhibitions)	New product commercialization (shipments, new applications)
	This research (positive and negative events are recorded separately for announcements of all activities)		
Events covered by prior research	Alliances (joint ventures, acquisitions)	Patents Pre-announcements (more than one week ahead of future events)	New product commercialization (launches) Awards (external recognition of quality)

Source: Own research

2 Sood and Tellis (2005)

- **Initiation activities** include alliances, joint ventures and acquisitions, funding, grants, advanced orders, funded contracts and expansions for the start of new innovation projects. Announcements about initiation activities may lead to negative returns because of high investments, long gestation periods, associated uncertainty and risk. Nevertheless, such announcements may lead to positive returns as they enable market expansion, deter competitor entry, improve the probability of success and enhance firms' competitiveness.
- **Development activities** include working prototypes, demonstration in exhibitions and new materials, equipment and processes, patents, and pre-announcements (of future events more than a week in advance). Announcements about development activity plans may lead to negative returns because they can alert competitors, trigger imitators or lead to excessive discounting of the technical content. Having said that, returns on development activities may be positive as they reduce uncertainty, signaling confidence, competence and optimism about the future.
- **Commercialization activities** include new product launches, initial shipments, new applications and awards (external recognition of quality). Announcements about market events may lead to negative returns because launched products fall below expectations, promotion and commercialization costs seem high, or the competitive advantages from commercialization seem fleeting. However, announcements of market events may lead to positive returns because they signal competitiveness, a successful innovation project and the expansion of the product portfolio.

The rival arguments for positive and negative market returns on these activities suggest the need for empirical research to resolve the conflict.

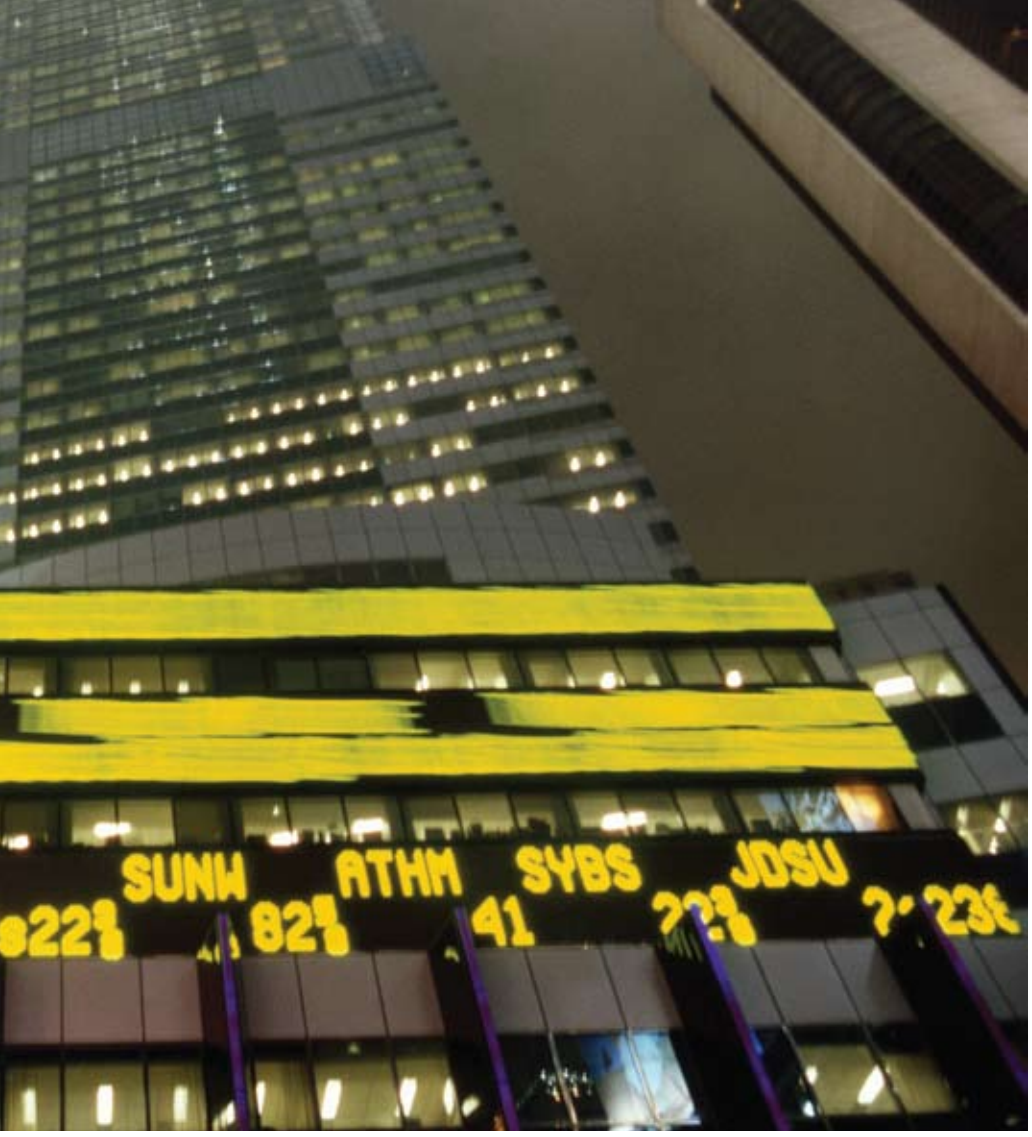
Total returns on innovation

We proposed that the total returns on innovation can only be estimated if the whole innovation project is analyzed. As such, we included eight important events spanning the entire innovation project — alliances, funding, expansion, prototypes, patents, pre-announcements, launch and awards. The total returns on innovation are the sum of returns on all of the events in an innovation project. As well as thoroughness, the benefit of considering all of the events in an innovation project is that consideration compensates for suboptimal or strategic announcements of the firm. For example, if the firm under-promises in the early stages of an innovation project but over-delivers in later stages, potentially low market returns in early stages will be compensated by high returns in later stages. Conversely, if a firm over-promises and then under-delivers, taking all events into consideration will compensate for possibly too high returns in the earlier stages.

Method

We collected data, using the historical method,[3] on 19 technologies in 5 categories: external lighting; display monitors; computer memory; data transfer technologies; and desktop printers (see Appendix A). We identified all major firms and all technologies within each industry. We collected all of the announcements related to innovation projects made by the firms for each activity of the project. There was substantial innovative activity in all of the categories during this period. We identified a total of 69 firms in the 5 industries and collected a total of 5,481 announcements from 1977 to 2006 (see Table 2). This present study went further than previous studies in two important aspects.

3 Golder (2000)



First, we identified all of the major firms and technologies within each category. Second, we collected all of the announcements related to innovation projects made by the firms for each activity of the project.

We estimated market returns using the Fama French-Momentum four factor model,[4] which includes the three factors of the Fama-French model and Carhart's Price-Momentum Factor to capture one-year momentum in returns.[5] Market returns during the innovation project may be affected by the firm's announcement strategy or structure. For this reason, we included two strategic variables (announcement frequency and research productivity) and two structural variables (size of firm and age of technology) as control variables.

Table 2. Sample characteristics

Category	External lighting	Display monitors	Desktop memory	Data transfer	Printers
Number of firms	19	17	18	17	11
Total number of announcements	696	1,100	1,239	1,323	1,123
Sample period	1977–2006	1980–2006	1979–2006	1982–2006	1981–2006
Setup activities	155	278	270	327	117
Development activities	171	305	274	183	126
Market activities	370	517	695	813	880
Number/type of platform technologies	5	5	5	3	4
	Incandescence, arc-discharge, gas-discharge, LED, MED	CRT, LCD, plasma, display panels, OLED	Magnetic, magneto-optical, optical	Copper/aluminum, fiber optics, wireless	Dot matrix, inkjet, laser thermal

Source: Own research

4 Famaand French (1993)
5 Carhart (1997)

Markets respond promptly and substantially to announcements about innovation at all stages of the innovation project.

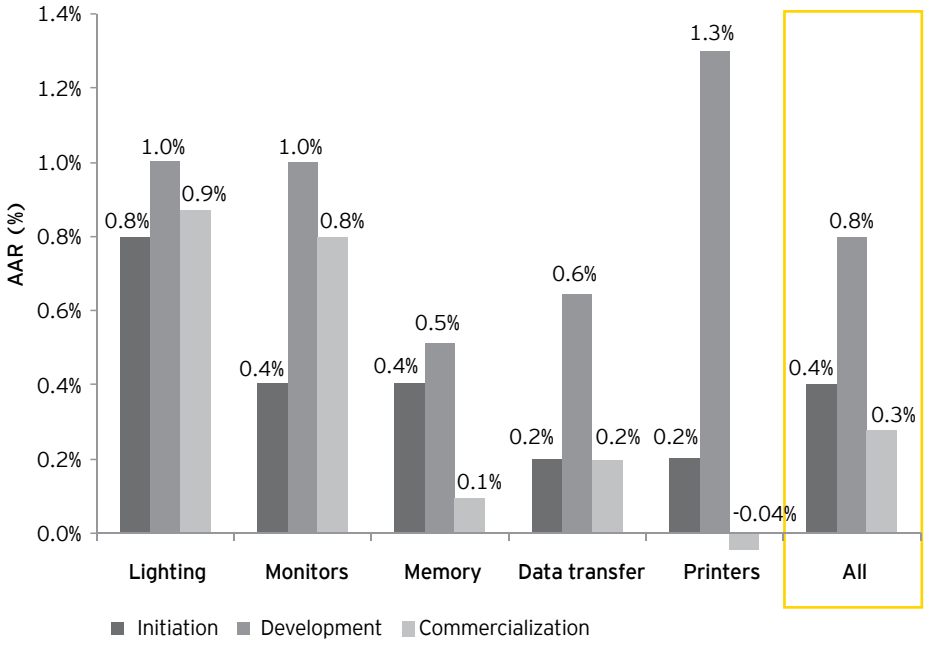
Results

We separated the announcements, based on their content, into either positive information or negative information (see Appendix B). The number of negative announcements across all three sets of activities was approximately 5% of the number of positive announcements. We estimated the cross-sectional average return to each event in each set of activities after controlling for various strategic and control variables. The returns on most of the sets of activities and events differed significantly from zero (see Figure 1).

In summary, we found the following about market returns to innovation:

1. Estimating the return on an innovation project by focusing on only single events leads to severe underestimation of the total return.
2. Across all categories, the returns for development activities are significantly greater than those for initiation and commercialization. Even at the individual category level, the returns on development are more than those for initiation and commercialization in all five categories (see Figure 1).
3. Returns to events related to the initiation phase occur 4.7 years ahead of launch. This suggests that investors do not have to wait for those sales if they want to gain from a successful R&D project.
4. Returns on events related to a new product launch are the lowest for any event.
5. Returns on negative events are higher in absolute value than those on positive events.

Figure 1. Average abnormal returns (AAR) in each set of activities of innovation project



Source: Own research

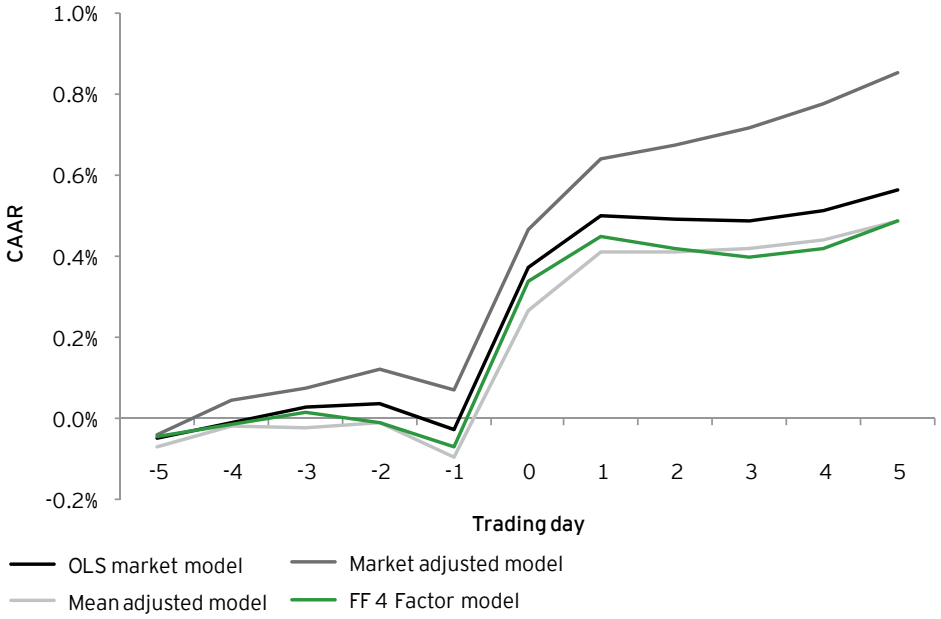
6. Returns are consistently higher for small firms than for large firms and for those that focus on few rather than many technologies.
7. Number of prior announcements or time since the last announcement has no effect on the market returns on innovation.

We carried out a number of analyses to test the robustness of the results, including regression diagnostics, alternative method to estimate returns, alternate market index, non-parametric tests, and accounting for lack of clean estimation period (see Figure 2).

Analysis of total returns

The sum of returns on all of the events in an innovation project provides the total returns on that innovation project. We exclude firms where data on shares outstanding are not available. The total returns by category are about 13.10% for projects on lighting, 19.80% for monitors, 7.02% for memory products, 7.40% for data transfer and 3.80% for printers. More importantly, the simple average return for any event is 0.60% which is comparable with estimates of returns on innovation reported by prior studies. However, this value is substantially lower than the mean of 10.30% for the whole innovation project (see Table 3). This figure demonstrates that to ignore the totality of events in

Figure 2. Cumulative average abnormal returns (CAAR) using OLS market, mean adjusted, market adjusted and FF 3 factor (+ momentum) models



Source: Own research

Table 3: Total abnormal returns to innovation by category

Stage	Total abnormal returns (%)	Total abnormal returns (USD million)
All	10.3	972
Lighting	13.1	712
Monitors	19.8	1,275
Memory	7.02	446
Data transfer	7.4	2635
Printers	3.8	432

Source: Own research

an innovation project, when estimating returns, severely underestimates the total return on innovation.

To estimate the dollar value of returns on the projects, we computed dollar returns on the announcements. We then followed the same procedure as described above to compute the dollar value of returns on an event or an innovation project, and that for the whole project. Across the five markets, the average return on an event was US$49 million, while the average total return on any project was US$643 million.

Returns to first announcement

It is not unreasonable to assume that the first announcement of an innovation project would yield higher returns than any subsequent announcement. The reason may be that the first announcement tells of a whole new project or product by the firm. Subsequent announcements may not have as big an informational or signaling impact. We tested this hypothesis. We defined the first announcement as the first ever release of information on an innovation project and later announcements as all other announcements during the project. We found that the difference between the returns for the first announcement of any project and the returns for any later announcement (all subsequent) did not vary significantly. These results belie the expectation that the first announcement is more important. A possible reason may be that later announcements may have equally large (or larger) returns since what they lack in "news" value they make up for by indicating increasing confidence that the project will succeed. Similarly, results for older technologies and projects are the same as those for newer ones.

Returns relative to competitors

How do the returns to the announcing firm affect returns to competitors in each of the three sets of activities? We extended the analysis to examine the returns to firms relative to its competitors at various set of activities of the innovation project. We created a portfolio of all firms that did not make any announcement on the day the focal firm makes an announcement. Consistent with the findings of prior literature, we found that in all three sets of activities, the returns to competitors were negative.

Implications for managers

This study has several implications for managers. First, markets do respond promptly and substantially to announcements about innovation at all stages of the innovation project. When considering the value of innovation, it is inappropriate to

limit the analysis to only one event in the innovation project. The frequently cited "under valuation" of innovation may be due, not to markets not appreciating the full value of innovations immediately, but rather to researchers computing returns to isolated events in an innovation project.

Second, the findings on various announcement strategies indicate that firms cannot play the system by over-announcing or making multiple announcements of a single event. Moreover, the first announcement of a project is no more important than later announcements.

Third, the absolute value of a negative announcement is greater than that for a positive announcement. This means that firms should be careful not to exaggerate progress in their innovation projects. Otherwise, they lose the opportunity of increasing market capitalization from such announcements.

Fourth, returns are highest for development activities. As such, it is important that firms exploit the progress in development activities by fully announcing all of them. The most surprising finding was that the markets actually react more to the development phase than the commercialization phase, which suggests that the stock market is not so short term in its outlook. Because the stock markets reward firms for making announcements in the development phase, it is in the firms' interest to be open to the market and to give regular progress updates on an innovation project.

Finally, small firms do not seem to suffer any disadvantage relative to large firms when announcing innovations.

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6 *Marketing Science*, Vol.28, No.3, May-June 2009, pp. 442 – 456

7 Adapted from Sood and Tellis, 2005

Appendix A

Operating principles of sampled technologies[7]

Technology		Principle
External lighting		
1	Incandescence	Generates light by heating up thin metallic wires with an electric current
2	Arc-discharge	Emits light by arc formed between two electrodes oppositely charged by an electric current in a high-pressure gas chamber
3	Gas-discharge	Electrons excited by passing an electric current in a low-pressure gas chamber emit light
4	Light emitting diode (LED)	Emission of the light in n-p transition zone under influence of an electric potential
5	Microwave electrode less discharge (MED)	Emission of light by microwaves from induction coil inside the bulb to excite the gas
Display monitors		
1	Cathode ray tube (CRT)	Forms an image when electrons, fired from the electron gun, converge to strike a screen coated with phosphors of different colors
2	Liquid crystal display (LCD)	Creates an image by passing light through molecular structures of liquid crystals
3	Plasma display panel (PDP)	Generates images by passing a high voltage through a low-pressure electrically neutral highly ionized atmosphere utilizing the polarizing properties of light
4	Organic light emitting diode (OLED)	Generates light by combining positive and negative excitons (holes emitted by anodes and electrons emitted by cathodes) in a polymer dye through the principle of electroluminescence
Desktop memory		
1	Magnetic	Records data by passing a frequency modulated (FM) current through the disk drive's magnetic head, thereby generating a magnetic field that magnetizes the particles of the disk's recording surface
2	Optical	Stores data using the laser modulation system, and changes in reflectivity are used to store and retrieve data
3	Magneto-optical	Records data using the magnetic-field modulation system, but reads the data with a laser beam

Technology		Principle
Computer printers		
1	Dot-matrix	Create an image by striking pins against an ink ribbon to print closely spaced dots that form the desired image
2	Inkjet	Form images by spraying ionized ink at a sheet of paper through micro-nozzles
3	Laser	Form an image on a photosensitive surface using electro-static charges, then transfer the image on to a paper using toners, and then heat the paper to make the image permanent
4	Thermal	Form images on paper by heating ink through sublimation or phase-change processes
Digital data transfer		
1	Cu/Al	Transmit data in the form of electrical energy as analog or digital signals
2	Fiber optics	Transmit data in the form of light pulses through a thin strand of glass using the principles of total internal reflection
3	Wireless	Encodes data in the form of a sine wave and transmits it with radio waves using a transmitter-receiver combination

Source: Own research

Firms cannot play the system by over-announcing or making multiple announcements of a single event.

Appendix B

Examples of positive and negative announcements

Joint ventures

Positive: Cree Research and Philips sign joint agreement; new laser diodes will increase optical storage capacity; ARPA provides US$4 million funding

Negative: Hitachi, GE dissolve lighting joint venture

New funds

Positive: Intel to invest US$100 million in Hitachi, Ltd.'s joint venture Elpida Memory Inc.-DJ

Negative: Storage Technology loses loan

New prototypes

Positive: IBM says it set record for bits of data on disk

Negative: Gentex delays new LED technology

New patents

Positive: Universal Display Corporation announces issuance of the 14th patent in the Organic Light Emitter Project

Negative: Seagate files patent infringement lawsuit against Storage Computer Corp.

Pre-announcements

Positive: Sony Corp of Japan said on Tuesday it will launch a home-use optical-type videodisc player, "Laser Max," on 21 April

Negative: Sony to delay mass production of digital audio tape (DAT) heads

Product launch

Positive: Sony Expands 5.25 inch magneto-optical library line to include permanent WORM configurations

Negative: Sony to delay mass production of digital audio tape (DAT) heads

Quality awards

Positive: EPA names Lexmark International "Energy Star Printer Partner of the Year"

Negative: No examples