1-2011

Inventions and Innovations: Does Stage of Development Matter in Assessments of Market Attractiveness?

Stephen C. Jones

Tamya Jean Knotts

Gerald G. Udell

INVENTIONS AND INNOVATIONS: DOES STAGE OF DEVELOPMENT MATTER IN ASSESSMENTS OF MARKET ATTRACTIVENESS?

Stephen C. Jones, Arkansas Tech University
Tami L. Knotts, Louisiana State University-Shreveport
Gerald G. Udell, Missouri State University

ABSTRACT

The purpose of this study is to determine whether market attractiveness is affected by the product's developmental stage—specifically, invention vs. innovation. Two databases were combined for this study to assess prototype or market-ready products (innovations) and ideas submitted by inventors and manufacturers (inventions). On average, invention stage products were more attractive to evaluators than were innovation stage products; however, one critical factor – the ability to create a new venture from the product – was significantly higher for innovations. In addition, overall market readiness was on average more than 10 percent higher for innovation stage products than those at the invention stage. Stepwise regression results indicate that stage of development and new venture likelihood are more critical than other factors in deciding the market viability of a product.

INTRODUCTION

Both invention and innovation are vital to a country's economic growth; however, their meaning and overall role in the innovation process differ. Invention is generally defined as the development of a new and useful product, while innovation refers to the ability to commercialize the invention based on a successful business model (Schoen, Mason, Kline, & Bunch, 2005; Attridge, 2007). Invention and innovation are important steps in new product development, but other steps exist in the innovation process which determine the type of invention created and the success of the innovation. A linear explanation suggests that basic research occurs first, leading to new knowledge or a better understanding of how something works. This knowledge is then applied to create an invention. Once the invention is produced or marketed, it becomes an innovation. Finally, when customers first use the product, this is known as acceptance or diffusion (Godin, 2005).

Conventional wisdom would suggest that as products progress through the innovation process they become more functionally sound and commercially viable. However, we are not aware of any research that test this belief using large databases of retail products at different stages of development—specifically, invention and innovation. Therefore, we compare which

factors make products more attractive to the marketplace at these two stages. For this study, products in the invention stage were submitted by independent inventors to an evaluation firm for assessment regarding their feasibility. Products in the innovation stage were submitted by small manufacturing firms to Wal-Mart as part of a mass retailer screening program. Both groups of products were assessed using the same evaluation instrument. The remainder of the paper describes the concepts of invention, innovation, and market attractiveness in more detail, followed by a discussion of our methodology, results and conclusions.

LITERATURE REVIEW

INVENTION VS. INNOVATION

An early perspective on the relationship between invention and innovation was based on the views of Joseph Schumpeter. Schumpeter (1939) regarded inventions as simply "acts of intellectual creativity with little importance for economic analysis". Innovation, on the other hand, was seen as a key factor in the economy and considered to be independent of invention. Innovation could occur without invention (Godin, 2005).

Later views on invention and innovation presented the concepts as more connected and linear in nature. For example, Maclaurin (1953) identified a five step sequence focused on research, invention, innovation, financing, and acceptance. Unlike Schumpeter, he noted that when innovations occurred, they were the result of commercially introduced inventions. Redwood's (1987) "investment-innovation" cycle showed a similar sequential process. His model suggested that inventions led to patents and then product innovations, also known as saleable products. These innovations, once trademarked and branded, became commercialized products that eventually produced revenues for the firm.

A more recent explanation of the innovation process focuses on a non-linear approach. Schoen et al. (2005) suggested that previous sequential models were not realistic. While the authors recognized the role of basic research, invention, and innovation in the development of a commercialized product, they argued that the innovation process did not occur in order. Instead, the innovation cycle model proposed that the path from invention to innovation was more random in nature. An invention could result from either basic research or from market needs, and delays could occur at any stage—research, invention, or innovation—making the time to market longer than anticipated. The innovation cycle model also emphasized the importance of a business model for product commercialization.

MARKET ATTRACTIVENESS

According to Schoen et al. (2005), the outcome of invention is a useful product, while the goal of innovation is to bring a product to market that has strong customer appeal. In the retail

marketplace, producing a saleable product is only half of the commercialization equation. Products still have to be accepted by retailers in order for consumers to purchase them, and retail product acceptance depends greatly upon product attractiveness (Swift & Gruben, 2000). Kaufman, Jayachandran, and Rose (2006) broadly define product attractiveness as any differentiating characteristic, such as product features, market demand, or promotional strategy that gives a new product a competitive advantage over an existing product. In this paper, we use the term "market attractiveness" as an indicator of product attractiveness at the retail level.

Prior research has identified product acceptance criteria for firms wanting to supply the retail market. For example, St. John and Heriot (1993) reported price, quality, and uniqueness as attractive features. Research by Pearson and Ellram (1995), Piercy and Cravens (1997), and Verma and Pullman (1998) echoed these findings. Retail buyers expected quality products and fair prices from those individuals or organizations who wanted to do business with them. In the mass retail market, Kim, Jones, and Knotts (2005) found that other factors including demand stability, amount of product testing, and promotional requirements increased the overall attractiveness of the product, which in turn, influenced the product's mass merchandising potential or market readiness.

For some buyers, firm characteristics were more important in their product acceptance decisions. Piercy and Cravens (1997) and Verma and Pullman (1998) identified trust, communication, delivery reliability, and flexibility as essential criteria for product acceptance. Trustworthiness and speed of development were factors that were also used by small business executives in their decision making process (Park and Krishnan, 2001). In the mass merchandising market, Kim et al. (2005) found that management experience and support for R&D were necessary to introduce new products that would satisfy consumers' diverse and ever-changing tastes, thereby making them more attractive to consumers and market ready.

The purpose of this study is to determine whether market attractiveness is affected by the product's developmental stage. It seems that products further along in the innovation process would be more appealing to retailers looking for a commercial product. If this is the case, which factors make a difference in market attractiveness for products at the invention and innovation stages?

THE STUDY

The sample firms for this study were participants in one of two separate projects undertaken by the Innovation Institute. The first program evaluated small U. S. manufacturing firms in the 1990s that participated in a mass merchandising screening program developed at a regional Midwest university. The screening program consisted of two assessments: an external review of the firm's submitted product and a self-appraisal of the firm's management practices. For the purpose of the paper, only the product evaluation measure will be examined. Each product was either rejected from the program or sent on to the mass merchandiser for buyer

review based upon the results of these evaluations. The final decision as to whether the forwarded product was placed on-shelf was left entirely to the retailer.

All of the participating firms in this first program were independently-owned manufacturers who wanted to be suppliers for Wal-Mart. Out of 2113 potential suppliers, 1729 firms (81.8 percent) completed the entire evaluation process. These participants were from all states, and none were dominant in the industry. The products ranged in suggested retail price from inexpensive and/or point-of-purchase to major purchase levels. No racial, ethnic, or other minority data were kept as part of the main database. Of these 1729 firms, 795 (46.0 percent) of the firms submitted products that were already on the market at retail. These products are not part of this study. The 934 products submitted that were at the prototype or market-ready level but not yet on the market are part of this study. These prototype or market-ready products were part of the innovation stage.

An argument could be made that the prototype and market-ready levels are not the same, and, technically, this is true. However, both of these levels require that a party have an actual, functioning product, and this level of development is critical to an evaluator or buyer assessing the actual viability of the product on the market. If a functioning version of the idea is not yet developed, many hurdles still face the inventor or innovator. Riquelme and Watson (2002) suggested that venture capitalists are looking for a working product before making a decision, and Richardson (1995) asserted that a facilitated innovative community develops the prototype (and subsequently a market-ready version) after several levels of idea evaluation have already been passed. Auerswald and Branscomb (2003) placed the two levels together at the fourth stage (of five) of their product development model. However, one study (Clarysse, Wright, Lockett, Mustar & Knockaert, 2007) tested the differences in venture capital interest at various stages of the development process and found that market-ready versions did in fact attract more funds than prototypes, however their analysis was done on 135 European academic spin-offs and not on retail-bound inventions and innovations. It is probably true that the distinction between prototype and market-ready products is potentially significant, but for the purposes of this study we do not distinguish between these product levels.

The second program evaluated product ideas from independent inventors and manufacturers that wished for an external, third-party review of the idea before attempting to take the product through further development. These projects were not yet under manufacture and were at the idea level only (invention stage). Some 2297 ideas were submitted for review between 1997 and 2005. As with the first program, these products were largely intended for consumer use.

METHODOLOGY

These two separate but related databases were combined for this study: the earlier program evaluating existing firms with a prototype or market-ready product (innovations) and

the later program evaluating product ideas submitted by inventors and manufacturers (inventions). The first program required that firms have at least a functioning prototype of the product because the aim of the program was to screen potential suppliers to an existing retail base. The second program did not require this level of development and was, instead, a screening process to encourage market-worthy ideas for further development. Products and ideas that were evaluated as having questionable future market interest were given feedback that encouraged further development only with extreme caution or were generally discouraged from further development. Those receiving more positive feedback were educated in how to best proceed with future development for the market.

This study examines the evaluation results for products in both programs. Conventional wisdom suggests that products that are better developed will be more attractive to the marketplace, but, to our knowledge, no studies using large databases of products at these two stages (invention vs. innovation) have addressed this question. Therefore, we assess market attractiveness for both groups of products using the measure described below.

The market attractiveness measure for both programs consisted of items based on the Product Innovation Evaluation System (PIES) developed at the University of Oregon (Udell, O'Neill, and Baker, 1977). Product areas included societal impact, business risk, demand analysis, market acceptance, competitive capabilities, and experience and strategy. An independent, trained evaluator completed this portion of the assessment process. The independent evaluator was typically a current or former retail buyer or an experienced small firm owner with a retail background whose role was to assess the mass market potential of the product.

Products were judged on a five-point ordinal scale using specific achievement levels rather than a sliding subjective scale. The three-point (or middle) response was the minimum performance level acceptable to retail buyers. The independent evaluators rated each product using items like the one below:

> Functional Feasibility. In terms of its intended functions, will it do what it is intended to do? This product:
>
> (1) is not sound; cannot be made to work.
> (2) won't work now, but might be modified.
> (3) will work, but major changes might be needed.
> (4) will work, but minor changes might be needed.
> (5) will work; no changes necessary.

Additionally, an overall rating on a 0-to-100 point scale was given by the evaluator for the project. A rating of at least 40 was needed to receive a positive assessment for further market development.

Not Recommended	(00 - 29)
Should Be Very Limited And Cautious	(30 - 34)
Should Be Limited And Cautious	(35 - 39)
Recommended But Need To Resolve Unknowns	(40 - 41)
Recommended For Limited Development/Commercialization	(42 - 43)
Recommended For Moderate Development/Commercialization	(44 - 45)
Recommended For Significant Development/Commercialization	(46 +)

A full listing of the individual items used for this evaluation can be found in Table 1.

RESULTS

Table 1 shows the results of a series of Mann-Whitney tests done on the individual evaluation items across development stages. We compared the mean rank independent evaluator results for each item for the invention stage (INV) versus the developed but not on market cases—innovation stage (INNOV). We chose the Mann-Whitney non-parametric tests for this data because of the nature of the responses themselves (ordinal instead of scale). Products with higher evaluations scored higher on the item scales. The bolded figures indicate which product stage had the higher mean rank for each item. The table also includes the mean rating for each stage and the level of significance of statistical difference between the stages when one exists.

It is interesting to note that the results were nearly evenly split. On average, invention stage products were more attractive to evaluators than were innovation stage products on 18 of the 39 items in the study (four items were not significantly different between the two stages). Three of the competitive factors and one societal factor were not significantly different between the development stages. Generally, business risk and demand analysis factors were judged more favorably for the innovation stage products, while the inventions were more favorably viewed with respect to experience and strategy. However, one critical experience and strategy factor – the ability to create a new venture from the product – was significantly higher for innovations. And the evaluator's overall assessment item of market attractiveness was on average more than 10 percent higher for innovation stage products than those at the invention stage (39.72 vs. 35.66).

A stepwise linear regression analysis was then run using the overall evaluator assessment rating (market attractiveness) as the dependent variable and the individual assessment items as independent variables in the model. The stage of development (0 = invention stage; 1 = innovation stage) was also entered into the model. The intent of this process was to determine if, in the minds of evaluators, certain assessment factors were more critical than others in deciding the market viability of a project.

Table 1
Mann-Whitney Variable Mean Ranks Test for Invention Stage vs. Innovation Stage Cases

	Mean Rank		Mean		Std Dev		
Variable Name	Inv	Innov	Inv	Innov	Inv	Innov	Signif.
N =	2297	934	2297	934	2297	934	
Societal - Legality	1556.38	1651.91	4.53	4.63	0.68	0.59	0.01
Societal - Safety	1583.10	1577.38	3.91	3.91	0.56	0.47	NS
Societal - Environmental Impact	1685.26	1318.73	4.00	3.75	0.38	0.54	0.001
Societal - Societal Impact	1672.74	1352.40	4.08	3.85	0.46	0.50	0.001
Business Risk - Functional Feasibility	1403.73	1981.08	4.23	4.66	0.62	0.50	0.001
Business Risk - Production Feasibility	1897.15	769.85	4.93	4.18	0.32	0.50	0.001
Business Risk - Commercialization Stg	1314.80	2251.13	2.44	3.91	1.36	0.74	0.001
Business Risk - Investment Costs	1421.07	2006.10	3.76	4.23	0.63	0.71	0.001
Business Risk - Payback Period	1621.10	1486.14	3.64	3.55	0.62	0.63	0.001
Business Risk - Profitability	1451.30	1921.43	3.47	3.82	0.61	0.64	0.001
Business Risk - Marketing Research	1517.16	1762.23	3.56	3.73	0.61	0.66	0.001
Business Risk - Research & Development	1440.39	1943.17	4.18	4.57	0.67	0.67	0.001
Demand Analysis - Potential Market	1704.95	1274.45	3.58	3.09	0.86	0.85	0.001
Demand Analysis - Potential Sales	1542.21	1691.93	2.60	2.73	0.57	0.70	0.001
Demand Analysis - Trend of Demand	1448.69	b	3.05	3.42	0.51	0.58	0.001
Demand Analysis - Stability of Demand	1547.28	1691.51	2.80	2.95	0.52	0.75	0.001
Demand Analysis - Product Life Cycle	1555.02	1669.82	2.44	2.65	0.67	1.13	0.001
Demand Analysis - Product Line Potential	1480.53	1860.77	1.97	2.28	0.52	0.74	0.001
Market Acceptance - Use Pattern Compatibility	1462.11	1904.59	2.85	3.21	0.64	0.56	0.001
Market Acceptance - Learning	1636.72	1453.05	3.97	3.80	0.59	0.81	0.001
Market Acceptance - Need	1605.87	1538.14	2.87	2.79	0.70	0.88	0.05
Market Acceptance - Dependence	1736.98	1194.78	3.81	3.17	0.82	1.05	0.001
Market Acceptance - Visibility	1674.30	1356.22	3.78	3.49	0.68	0.70	0.001
Market Acceptance - Promotion	1453.35	1928.65	2.60	2.99	0.52	0.67	0.001
Market Acceptance - Distribution	1439.81	1963.61	2.71	3.12	0.49	0.62	0.001
Market Acceptance - Service	1380.68	1292.07	4.53	4.45	0.69	0.73	0.001
Competitive - Appearance	1558.33	1583.93	3.14	3.14	0.50	0.54	NS
Competitive - Function	1616.80	1464.08	3.42	3.33	0.56	0.55	0.001
Competitive - Durability	1463.73	1614.85	3.04	3.16	0.33	0.46	0.001
Competitive - Price	1552.72	1541.02	2.83	2.83	0.67	0.75	NS
Competitive - Existing Competition	1667.77	1367.31	2.92	2.62	0.97	0.96	0.001
Competitive - New Competition	1598.79	1551.19	2.90	2.86	0.75	0.76	NS
Competitive - Protection	1318.54	981.87	3.36	2.63	1.32	1.31	0.001
Experience & Strategy - Marketing Experience	1658.94	1397.00	2.97	2.78	0.40	0.58	0.001
Experience & Strategy - Technical Experience	1882.89	817.91	4.38	3.37	0.73	0.61	0.001
Experience & Strategy - Financial Experience & Resources	1785.02	1052.36	3.44	2.88	0.59	0.53	0.001
Experience & Strategy - Management / Production Experience	1757.00	1134.74	3.58	3.13	0.63	0.46	0.001
Experience & Strategy - Technical Experience	1745.08	1162.82	2.69	2.02	0.95	1.01	0.001
Experience & Strategy - New Venture	1372.96	2096.32	2.62	3.28	0.76	0.68	0.001
Overall Rating	1386.06	2156.42	35.66	39.72	4.91	3.70	0.001

NOTE: INV = Invention Stage Case INNOV = Innovation Stage Case

The results are shown in Table 2. While the overall model contains ten variables and explains 20.1 percent of the variation in the overall rating, the first two variables entered account

for 17.8 percent of the total variation (nearly 90 percent of that explained by the model). The stage of development and new venture likelihood variables both have a positive coefficient in the model and favor those projects in which the innovator has a developed product. Three of the coefficients are negative in the model, and the variables associated with those coefficients are ones which are more highly assessed by evaluators for invention stage projects.

Table 2
Regression Analysis (Dependent: Evaluator Overall Rating)

Variable Entered	MW Result	R-Sq Change	Sig. F Change	Coeff.
Constant			0.000	34.544
Stage of Development	INNOV	0.161	0.000	1.899
Experience & Strategy - New Venture	INNOV	0.017	0.000	0.605
Business Risk - Payback Period	INV	0.005	0.001	-0.91
Business Risk - Profitability		0.005	0.000	0.503
Societal - Societal Impact	INV	0.004	0.003	-0.832
Business Risk - Investment Costs	INNOV	0.003	0.005	0.646
Market Acceptance - Need	INV	0.003	0.006	0.365
Demand Analysis - Potential Sales	INNOV	0.002	0.016	0.439
Competitive - Appearance		0.002	0.019	0.458
Experience & Strategy - Management / Production Experience	INV	0.002	0.048	-0.375
	NOTE:	INV = Invention stage case		
		INNOV = Innovation stage case		

DISCUSSION

The results of the statistical tests seem to indicate that evaluators (including retail buyers and those trained to behave like them) prefer cases in which the inventor or innovator has a more fully developed product. This should not be a surprise since both conventional wisdom and emerging research would seem to support it. However, the results of the Mann-Whitney tests are interesting in that they do not clearly favor the innovation stage products over the invention stage products. While the reasons behind this are not completely clear, it is likely that the value of the product to the market (consumer demand) is not linked directly to any one specific criterion. Even poorly developed ideas can often be embraced by the marketplace if they meet a demand that is not already being satisfied by another product or service. However, products that are better developed and which hold a better prospect for creating a new venture seem to be more

attractive to evaluators and, by proxy, to potential investors. Having a good idea but no way to get that idea into the marketplace would seem to inhibit investor interest.

Evaluators appeared to more favorably assess innovations with regard to both business risk and demand analysis, and business risk was the most common factor grouping in the model. It would make sense that the downside of investing and of accepting a product for retail sales would be the chance of the business failing. Both buyers and investors are keenly aware that the health of the business that produces the good they are associating with can have immediate effects on the success of their own investments. While the invention stage projects may have been better prepared in the experience and strategy criteria, the perceived new venture weakness may have been a critical factor for evaluators.

CONCLUSION

Does stage of development matter in assessments of market attractiveness? The answer appears to be yes. Stepwise regression results indicate that stage of development and new venture likelihood are more critical than other factors in deciding the market feasibility of a product. While the overall model explained about twenty percent of the variation in market attractiveness, these two variables accounted for nearly 90 percent of the variance explained by the model. This finding supports the work of Schoen et al. (2005) who emphasized the importance of a business model in order for a product to progress from invention to innovation.

REFERENCES

Attridge, J. (2007). Innovation models in the biopharmaceutical sector. *International Journal of Innovation Management, 11*(2), 215-243.

Auerswald, P. & L. Branscomb (2003). Valleys of death and Darwinian seas: Financing the invention to innovation transition in the United States. *Journal of Technology Transfer, 28*(3-4), 227-239.

Clarysse, B., M. Wright, A. Lockett, P. Mustar & M. Knockaert (2007). Academic spin-offs, formal technology transfer and capital raising. *Industrial and Corporate Change, 16*(4), 609-640.

Godin, B. (2005). The linear model of innovation: The historical construction of an analytical framework. *Project on the History and Sociology of S & T Statistics,* Working paper No. 30, Montreal, Canada.

Kaufman, P., S. Jayachandran & R. L. Rose (2006). The role of relational embeddedness in retail buyers' selection of new products. *Journal of Marketing Research, 43*(4), 580-587.

Kim, K., S. C. Jones & T. L. Knotts (2005). Selecting and developing suppliers for mass merchandisers. *International Journal of Manufacturing Technology and Management, 7*(5-6), 566-580.

Maclaurin, W. R. (1953). The sequence from invention to innovation and its relation to economic growth. *Quarterly Journal of Economics, 67*(1), 97-111.

Park, D. & H. Krishnan (2001). Supplier selection practices among small firms in the United States: Testing three models. *Journal of Small Business Management, 39*(3), 259-272.

Pearson, J. & L. Ellram (1995). Supplier selection and evaluation in small versus large electronics firms. *Journal of Small Business Management*, *33*(4), 53-65.

Piercy, N. & D. Cravens (1997). Examining the role of buyer-seller relationships in export performance. *Journal of World Business, 32*(1), 73-86.

Redwood, H. (1987). *The pharmaceutical industry – Trends, problems and achievements*. Felixstowe: Oldwicks Press.

Richardson, B. (1995). Learning contexts and roles for the learning organization leader. *The Learning Organization, 2*(1), 15-33.

Riquelme, H. & J. Watson (2002). Do venture capitalists' implicit theories on new business success/failure have empirical validity? *International Small Business Journal, 20*(4), 395-420.

Schoen, J., T. W. Mason, W. A. Kline & R. M. Bunch (2005). The innovation cycle: A new model and case study for the invention to innovation process. *Engineering Management Journal, 17*(3), 3-10.

Schumpeter, J.A. (1939). *Business cycles: A theoretical, historical, and statistical analysis of the capitalist process*. 2 vols. New York: McGraw-Hill.

St. John, C. & K. Heriot (1993). Small suppliers and JIT purchasing. *International Journal of Purchasing and Materials Management, 27*(2), 11-16.

Swift, C. & K. Gruben (2000). Gender differences in weighting of supplier selection criteria. *Journal of Managerial Issues, 12*(4), 502-511.

Udell, G., M. O'Neill & K. Baker (1977). *Guide to invention and innovation evaluation*, Washington, DC: National Science Foundation.

Verma, R. & M. Pullman (1998). An analysis of the supplier selection process. *Omega, 26*(6), 739-750.