The Role of Customer Experience in Technology Strategy: Implications for Product Adoption in Information Technology

by

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Abstract

This research identifies and describes the impact of customer experience on the adoption of information technology products. The research findings are applied to the business case of a global technology firm entering into in the cloud computing space.

We chose a customer-centric lens in order to better understand how information technology is turned into value for the customer. We complemented well-defined industry-level models of technology adoption by building an original system dynamics model of the relationships of the technology firm with its enterprise customers. Important dynamics were derived from the review and analysis of selected leading edge managerial frameworks that were best suited for the studied business. The market analysis includes interviews with potential enterprise and small business cloud customers, market analysts, and executives at several companies selling cloud computing services.

At the firm level, we modeled the effect of different product launch and development strategies and the impact of organizational learning on new business development. The system dynamics model is a management flight simulator that overcomes the limitations of classical management frameworks. The model was calibrated against historical product adoption data that was provided by a leading global information service provider. By running different scenarios, managers may simulate the impact of investments in research and development and marketing. Managers may also test the implications of successfully designing a positive customer experience and of adopting a culture of continuous improvement and business experimentation.

The results of this study show that in order to survive and compete in the digital economy, information technology companies need to shed a comfortable yet myopic focus on technology advantage and acquire the capability to develop and execute business strategies focused on excellent and inimitable customer experience. The willingness to experiment and ability to learn are critical success factors. Sustainable competitive advantage also hinges on having the ability to run business experiments, fail, learn from failures and effectively spread that knowledge through the organization.

Thesis Supervisor: Henry Birdseye Weil
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Finally, I want to dedicate this thesis to my children Layla Marie Vernon and Liam Michael Vernon.

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Introduction

"The innovations which create real value for companies, e.g., the iPod, are not primarily about technology. The winners are companies who manage the social side of technology—the complete customer experience" (Weil 2007).

1.1. Motivation

The motivation of this thesis is to understand the underlying drivers of successful product adoption in technology markets. Before enrolling in graduate school at MIT, I gained experience working at two technology start-ups. The first one, an original equipment manufacturer, initially raised over 150 million dollars to manufacture innovative fiber optics components for the Telecom industry. As the company matured, it began to launch products in the defense and pharmaceutical industries. Eight years later, the company was sold to a medical device company for 21.5 million dollars. The second company, in contrast, closed its doors after nine years of business, which is occurring while I begin to write this thesis.

Technologists, such as the founders of my past employers, wish to turn innovative technologies into successful products and services. Backed-up by an enthusiastic management board and investors, technologists optimize the product design according to their technical expertise, and they bring it to the market they know best or to the market that is willing to try it out first. Seemingly innovative products are often met by a small and slow to adopt customer base, despite delivering to the market an apparently high-performance product. While competitive forces and an unfortunate timing of the Telecom bubble burst in 2000 may explain the downfall of my previous start up, other companies in similar business areas managed to survive and even thrive in the same business climate. Why do some innovative technology organizations thrive while others fail at the same time in the same markets? This dilemma, from personal experience, is a strong driver in the exploration of this thesis.

1.2. Technology strategy and customer experience

This thesis is inspired by a paper summarizing "important building blocks in the application of system dynamics to corporate strategy " and thirty-five years of expert

practice in the field (Weil 2007). In a hypercompetitive environment where innovations can be quickly replicated, outsourced and therefore commoditized, technology companies must focus on managing the customer's experience as a sustainable means of capturing and retaining value.

A quick look at Dell, Microsoft and Apple in the consumer technology market space reveals that the clear winner over the past five years is Apple, which is due to its strength in focusing on and successfully designing the customer's experience.

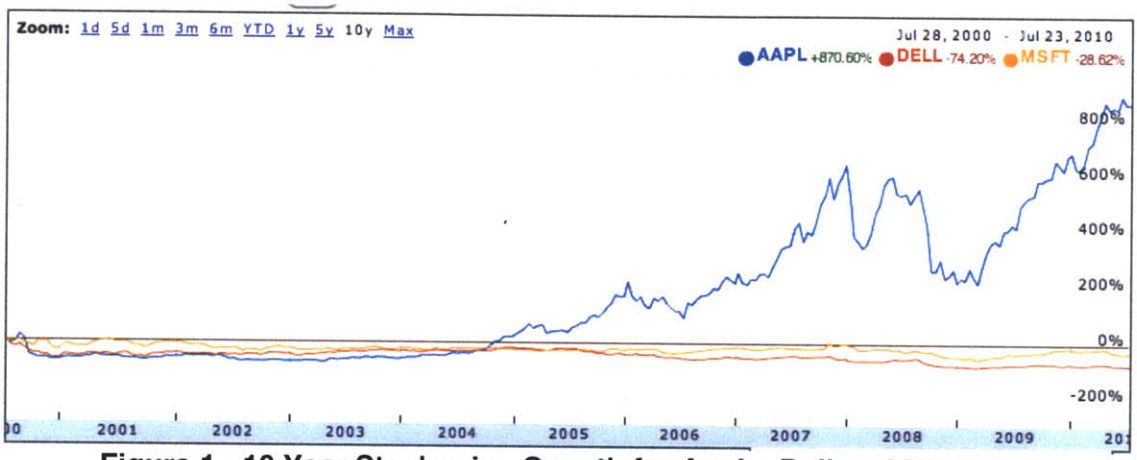

Figure 1 - 10 Year Stock price Growth for Apple, Dell and Microsoft (Source: Google Finance)

1.3. Research approach

Many factors contribute to the success and failure of companies within technology markets. We will first review selected academic literature on competitive dynamics and innovative technologies. This review will be followed by a synopsis of both personal experience and related findings from several current research projects. An analysis will then be presented of this comprehensive review, to include identified common blind spots as defined by the technology firm's ability to build a unique source of sustainable advantage by perfecting the customer experience. This research review will seek to gain insights related to the impact of customer experience on the adoption of technology-intensive products and services in order to deliver a set of strategic recommendations for successful market entry.

1.4. Business cases

Several papers were chosen from a survey of academic research on technology adoption to feed into a system dynamics model to build scenarios and discuss strategies for successfully addressing the challenges of new business and product development in technology markets. These academic papers allow the introduction of strategic frameworks for two business cases within the domain of information technology and services. Both business cases are located in the business-to-business (B2B) space.

Going forward, when referring to ***information technology products or services***, we shall use the shorthand of ***products***.

- Firm A is a global information service provider serving the professional market place. This study addresses the business case of one of its leading products that delivers an online search service to legal professionals.
- Firm T is a global Telecom service provider. This focus business case pertains to its global business division as it explores entering into a new information technology business, as a cloud computing service provider to enterprise customers.

Our research leverages the exclusive access to proprietary data obtained from the Legal Professional Business Unit of Firm A via interviews with both the Senior Vice President of New Product Development and the Chief Scientist. New product adoption data and interview insights from Firm A were used to validate an original system dynamics model of technology adoption a posteriori at the firm level. We then generated several scenarios as a means to help guide the managerial decision-making process of Firm T a priori as it enters into the new business area of cloud computing.

While the first business case is historical, the second business case of Firm T is forward looking. Primary and secondary market research was conducted around business models and opportunities around cloud computing to build a richer context for the business case of Firm T's entry into cloud computing. We apply the aforementioned strategic frameworks to better understand the position of Firm A and

Firm T as each launch a new product. Strategic implications for a leading global Telecom company, Firm T, when entering the cloud computing space are drawn from insights provided by scenarios derived while applying the system dynamic model. Finally, we discuss the cultural and organization challenges that stem from our recommendations to transform innovative technology firms into customer experience design firms.

"Competing on intangibles requires quite different capabilities from competing on product or service price and performance" (Weil 2007).

2. Literature survey of technology adoption

"Until businesses understand, anticipate, and respond to the psychological biases that both consumers and executives bring to decision making, new products will continue to fail" (Gourville 2006)

We surveyed and selected academic papers that delivered the most relevant insights into the challenges faced by technology companies when entering into new business sectors. The selected academic papers provide the foundation for this research. In this section, we shall summarize key findings from each paper and highlight the concepts that were integrated into the original system dynamics model.

2.1. Dynamic capabilities framework

"We worry that fascination with strategic moves and Machiavellian tricks will distract managers from seeking to build more enduring sources of competitive advantage. The approach unfortunately ignores competition as a process involving the development, accumulation, combination, and protection of unique skills and capabilities" (Teece, Pisano et al. 1997)

Teece and Pisano build upon the resource-based view of the firm to define a dynamic capabilities framework that delivers a different approach to strategic management than Porter's competitive forces and Shapiro's game theory approach. This framework is presented as better suited to build "*competitive advantage in increasingly demanding environments*". The digital economy represents an acceleration of the pace of competition and that a static view of competitive advantage is therefore limiting and inadequate for survival.

Pisano describes that the limitation of Porter's five forces is to assume that the firm is altering its position in the industry, which structure plays "a central role in determining and limiting strategic action". A firm is blindsided when competition arises from firms from other industries and with radically different business models.

Shapiro's game theory approach to strategy works well when competitors are "closely-matched" and assumes that advantage can be achieved by exploiting the manager's intellectual ability to excel at game theory. The dynamic capabilities framework emphasizes the importance of assessing, understanding and responding to market dynamics, "when time-to-market and timing are critical, the rate of technological change is rapid, and the nature of future competition and markets difficult to determine". The dynamic capabilities framework is built from the resource base view of the firm (Wernerfelt 1984).

The authors define the term capabilities to emphasize "*the key role of strategic management in appropriately adapting, integrating, and reconfiguring internal and external organizational skills, resources, and functional competences to match the requirements of a changing environment*"(Teece, Pisano et al. 1997). This paper helped us identify the important dynamic capabilities for the adoption of technology products.

"Capabilities cannot easily be bought; they must be built. From the capabilities perspective, strategy involves choosing among and committing to long-term paths or trajectories of competence development." (Teece, Pisano et al. 1997)

2.2. Familiarity matrix

From "Entering New Businesses: Selecting Strategies for Success" (Roberts and Berry 1985), we retain the two "basic strategic questions":

1) Which product–markets should a corporation enter?
2) And how should the company enter these product–markets to avoid failure and maximize gain?"

Many entries of new businesses with a "new product–market" fail despite large investments. The authors propose a framework, the familiarity matrix, for selecting a successful entry strategy when considering a new business area. Figure 2 illustrates

the familiarity matrix and the proposed entry strategy as a function of the firm's location on the matrix. The first step in using the proposed framework is to acknowledge and understand the firm's familiarity with the market and with the technology. The firm locates its position on the 3 x 3 technology–market familiarity matrix as illustrated in Figure 2.

Roberts and Berry propose a set of business development strategies for each location on the familiarity matrix. For instance, in the base/base location, the firm may consider the full range of proposed entry strategies by the authors: internal development, joint venturing, licensing, acquisition, and minority investment of venture capital. All these options are valid from a corporate familiarity standpoint although other factors may also influence the decision on how to approach the entry strategy.

The most attractive mechanism is internal development in order to fully leverage the familiarity with the underlying technology and market. The risk of failure increases as the firm's familiarity with the market and the technology decreases. Consequently in the new unfamiliar/unfamiliar position, the firm's best approach is to consider a minority investment as a venture capital in order to establish a window to the unfamiliar area. Another strategy may be an educational acquisition with venture capital investment into a firm for which the market/technology is base/base. The purpose of an educational acquisition is to bring on board talent with the adequate level of familiarity of both the market and technology. The educational acquisition approach presents risks including the possibility of losing key talent after the acquisition. Figure 3 illustrates the various levels of corporate involvement that are associated with each entry strategy.

The interviews implied that there was a lack of internal understanding of the firm's familiarity with both cloud computing technology and with the target enterprise market. The executives surveyed were shown Figure 4 and asked to position firm T's enterprise cloud computing product in respect to enterprise customers. The results are shown in Figure 5.

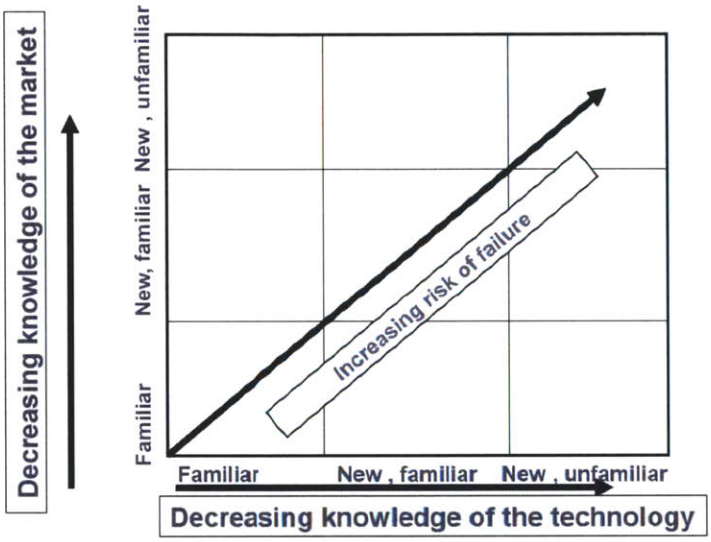

Figure 4 - Familiarity matrix - Interview tool

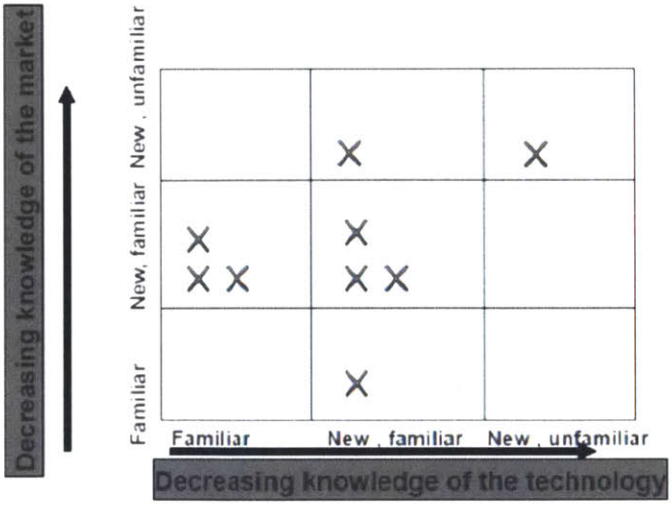

Figure 5 - Firm T survey (sample size = 9)

This survey suggests that the firm does not have the ability to optimize its entry strategy since different internal stakeholders do not agree on the firm's position on the familiarity matrix. The only agreement is that cloud computing and enterprise customers are not in the familiar/familiar quadrant.

2.3. The 9x effect

We rely on the paper "Eager Sellers, Stony buyers" (Gourville 2006) to introduce the concepts of loss aversion, perceived benefit and switching costs. Gourville presents that "companies assume that consumers will adopt new products that deliver more value or utility than existing ones." Firms tend to over-estimate the relative benefit of the new product. In particular, Technology firms measure performance improvements in a set of parameters that are assumed to be important and often under-estimate not only the inherent technical trade-off resulting from reaching the performance improvement but also underestimate the bias of customers for the incumbent product. We shall illustrate this cognitive bias later when describing the business cases of Firm A and Firm T.

Gourville argues that Everett Rogers' concept of "relative advantage" as the single most important driver of new product adoption is incomplete, as Rogers' theory does not take into account the "psychology of gains and losses". Gourville's theory of new product adoption describes four principles that are summarized as follow:

- Consumers make decisions about a new product not on its actual relative benefit over the incumbent product but on it perceived value
- Consumers evaluate a new product in comparison to the incumbent, which they overvalue
- Relative benefits are treated as gains but any shortcomings are treated as loss product
- "Losses have significantly greater impact on people than similarly sized gains". This phenomenon is called loss aversion

Consumers often value the incumbent product significantly more due to loss aversion. As a result, they tend to stay with the incumbent product even when there

may be a better alternative. Innovations always demand a trade-off. Successful technology companies must understand the trade-off from the customer's perspective in order to adequately reduce barriers to adoption of the new product.

Two examples include:

- E-books provide easy portability but customers are giving up the durability of paper books (Gourville 2006).
- Mobile insurance claim apps allow for streamlined claim reporting but customers are giving up the reassuring interaction with a human insurance representative

Gourville introduces the concept of the "9x Effect" to quantify the cumulative effect of the overly optimistic perception by the firm of its innovation and of the overly pessimistic average behavior of the consumer when presented with the new product.

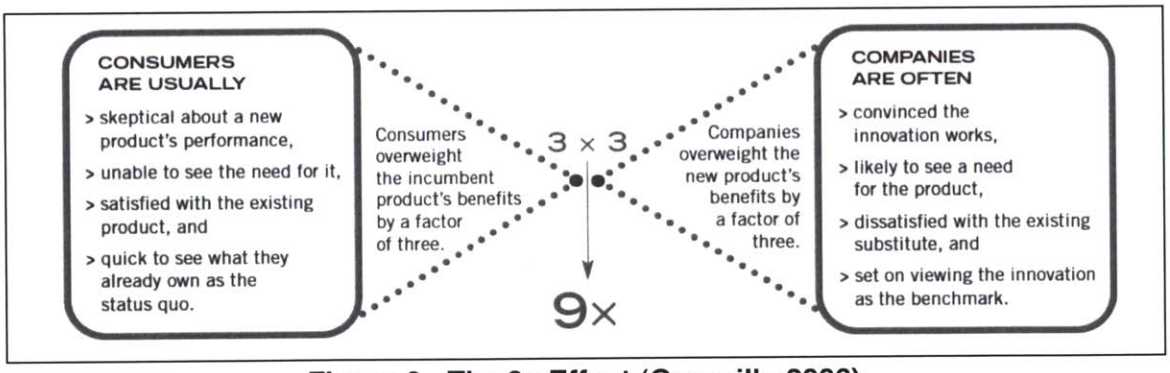

Figure 6 - The 9x Effect (Gourville 2006)

The 9x effect leads to a framework to assess the rate of adoption and market penetration for a given product. "While companies can create value through product changes, they can capture it most easily by minimizing the need for consumers to change. As the chart shows, that dynamic leads to four types of innovations" (Gourville 2006). We shall refer to this framework as the Gourville framework, as shown in Figure 7. We shall apply it in our analysis of our two business cases of Firm A and Firm T.

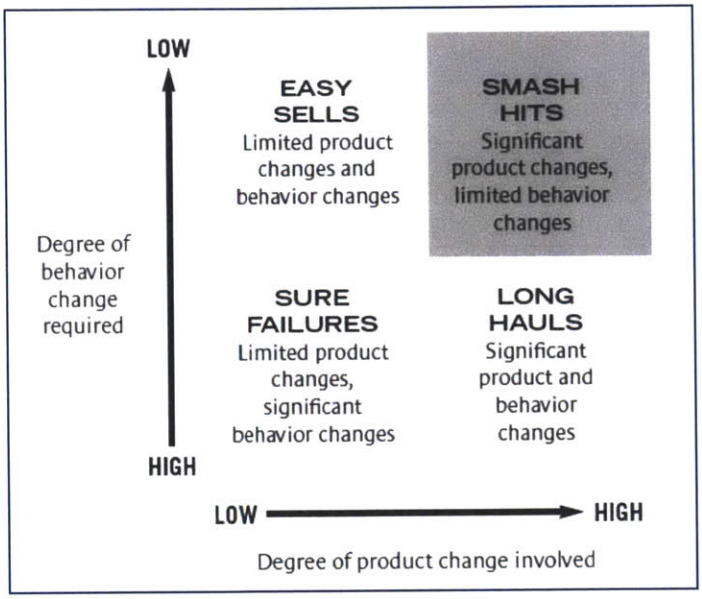

Figure 7 - The Gourville Framework – Capturing Value from Innovations (Gourville 2006)

- **Easy sells:** The most common new products fall into this category. They offer limited benefits for the consumer and the company. The benefit of the new product over the incumbent is small but the at the same time, very little behavior change is required from the consumer.
- **Sure failures**: This category describes products that offer limited benefit over the incumbent product and yet require significant behavior changes. Technologists who are overly enthusiastic about their innovations tends to go to market with products that many deliver significant performance improvement but not in the category that is necessarily most valued by the consumer. In addition, the consumer may need a significant behavior change to use the new product.
- **Smash hits:** Some innovations deliver significant benefits to the consumer but require minimal behavior changes. These products stand the best chance of both short-term and long-term success. Such products result in rapid adoption supported by a positive word of mouth effect that accelerates their success in the market place.
- **Long hauls**: "Many new products offer technological leaps, creating great value. However, they also require significant behavior change" (Gourville 2006). These products require a different go-to-market strategy. Such a product may be

a great investment and enable the firm to establish a leading position in the market. However, the firm needs to be patient and ready to invest in the cost required to help the consumer learn the required behavior. Technology firms often launch products in this category when hoping to launch a "smash hit" because of the 9x effect. The perceived benefit of the new technology combined with the technologist culture jointly lead firms to severely undervalue customer experience and real switching costs that result in a slower if any adoption of a new technology product. By contrast, when firms anticipate the slow adoption, they can design strategies that are better suited for success or launch products that are perceived by the customer as 10x better than the incumbent's.

2.4. Dynamics of social factors in technological substitutions

Dattée and Weil expand traditional diffusion models of technology innovation beyond an epidemic structure in order to take into account the decision-making process of the consumer and more importantly to fully account for market heterogeneity (Dattée and Weil 2005).

Market heterogeneity is the key concept that is retained for our purposes from this paper. Consumers and market are heterogeneous when adopting new technology-based product. Dattée and Weil built a system dynamics model of technological substitution to incorporate sociological and psychological factors at the individual and market level. The system dynamics model illustrates the "delay to perceive the true performance value of the technology". This delay may not only be explained by an information delay - information about the new technology is not instantaneously available to the consumer - but also by "the system of personal constructs biased criteria or even selective exposure" that prevents the consumer from perceiving the true impact of the new technology (Dattée and Weil 2005).

Another input into market heterogeneity is the consumer's perception of the riskiness of choice alternatives and the individual's degree of risk aversion. "Evaluating innovative products in terms of measurable performance attributes could be seen as limited because it does not delve deeply into customers underlying motivations" (Dattée and Weil 2005). Different level of risk aversion, loss aversion and information

asymmetry contribute among other factors to the existence of several categories of adopters: technology enthusiasts, early adopters, mainstream adopters, pragmatics, late majority and laggards. Each category of adopters has a different set of motivations and behaviors in reaction to different sets of information about the product, the technology and the firm. These varying perspectives result in market heterogeneity. When a firm recognizes the importance of social factors in technology adoption, a firm can better target the right category of early adopters in order to effectively leverage their relevancy and credibility as lead users for the rest of the market. In addition, the firm must set realistic expectations during the initial phase of product launch to prevent risks such as" giving up too soon, overconfidence, and the risk of technological spark that fails to achieve mainstream takeoff" (Dattée and Weil 2005).

The concept of market heterogeneity is an important one to incorporate in our model of adoption of new technology products. More complete and useful models of technology product adoption shall incorporate the sociological and psychological factors that feed into the consumers' decision to adopt a product and into their attitude towards the firm. The firm may employ different strategies to increase the effectiveness of the word-of-mouth and diffusion of information regarding the benefit of the new product when it better understands the makeup of the market it is addressing. The firm must also take into account the heterogeneous behavior of consumers when they consider adopting the new product.

2.5. Dynamics of innovative industries

This paper analyzes the dynamics of innovative industries using a conceptual system dynamics model which is by design "generic and simple" (Weil and Utterback 2005). The abovementioned system dynamics model provided a starting point and element of structure to the one developed for this thesis. Furthermore, this paper delivers a comprehensive and elegant supply-side, industry-level view of technology adoption thus providing the inspiration for our demand-side, firm-level focus on innovation as an attempt to deliver complementary analysis. In particular, we attempt to answer selected questions from the next steps section:

- "How do the decisions of established firms and start-ups differ?
- What roles do social and contextual factors play?
- Are dynamics different for services?" (Weil and Utterback 2005)

We describe below Weil and Utterback's dynamic model and identify the key concepts that feed into this thesis. The integrated conceptual model is shown in Figure 8. While this view is at the industry level, we retain the concept of research and development (R&D) productivity, R&D expenditure and level of technology. These concepts are also applicable at the firm level. Technology firms invest in R&D with R&D expenditure. An R&D organization has a characteristic productivity that is characteristic of its organizational structure, culture and industry. The goal of R&D is to increase the level of technology, which in turn increases the benefit of a new product. The benefit of a new product is defined by increased performance and/or decreased cost in comparison to the incumbent product.

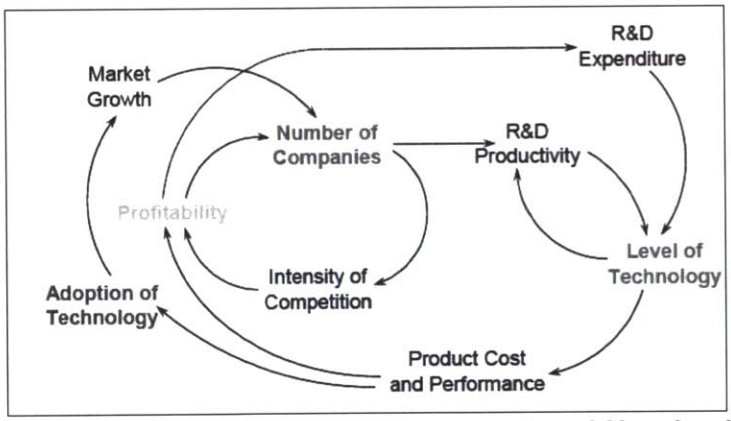

Figure 8 - Integrated Conceptual Model (Weil and Utterback 2005)

Weil and Utterback also discuss the factors feeding into the consumer's willingness to adopt. These factors include the perceived level of risk in the early stages of the technology and the quality and quantity of information available. As more users, specifically "reference users" adopt, the quality and quantity of information improves, thus encouraging the next category of users to adopt. The "reference users" legitimize the new product and reinforce a notion of "must-have" that can also be either initially created with marketing by the firm or be an emergent property of the

reference users interaction with the new product. The perceived benefit of the new product is either improved by marketing and/or positive word of mouth that is initiated by influential "reference users" group.

These five frameworks address various considerations that firms must take into account when deciding whether or not to launch a new product or service. While each one provides insight, separately they only partially address that important decision. By combining critical aspects of each of these frameworks into a more inclusive, cohesive and dynamic model, we can not only help firms decide whether or not to launch a new product or service but also how they should go about doing it.

3. Definitions

3.1. Word of mouth

Two effects are spread by word of mouth: network effect and bandwagon effect. Network effect is the effect that one user has on the value of the product for other users. For instance, the adoption of the telephone illustrates the concept of network effect: the more users, the more valuable was the telephone. The bandwagon effect refers to the increased preference of users for a product as more people start adopting it. As more people purchased IBM products, more people chose to buy IBM products because of the increased reputation that the brand carried. As the old adage went *"Nobody ever got fired for buying IBM equipment"*.

These effects are also illustrated by the data on adoption of Enterprise Planning Software (ERP) in the 1990's in the automotive industry. The adoption of ERP solutions for 54 companies in the automotive industry between 1994-2005 is shown in Figure 9 (Léger, Pellerin et al.).

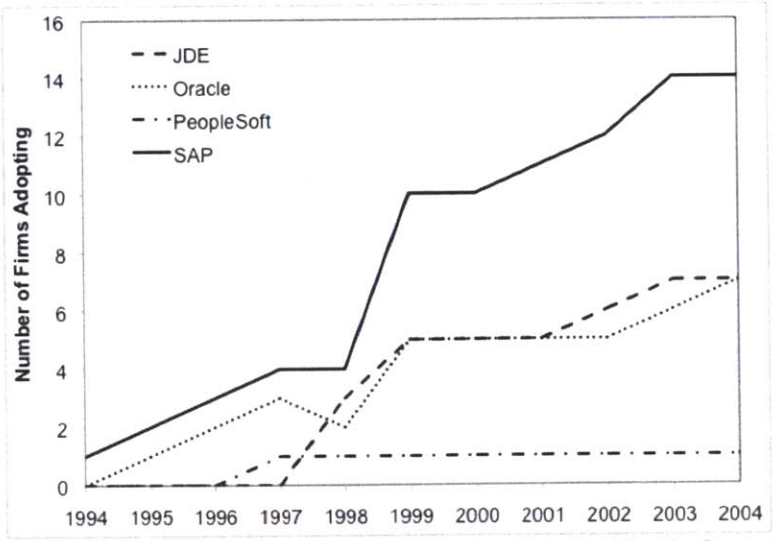

Figure 9 - Adoption of ERP in the automobile section in North America for 1994-2005

Although our system dynamic model combines both effects into an aggregate word of mouth effect, we describe the important difference between the two effects with the example of an ERP system.

- **Network effect**: "the adoption of a given ERP system will be positively influenced by the use of that same ERP system by trading partners" (Léger, Pellerin et al.) "Network effects can be quite powerful, where the value increases non-linearly as a function of the number of users" (Weil and Utterback 2005). Since automotive manufacturers may share some suppliers and contract manufacturers, the adoption of the ERP system by early adopters trigger the adoption by other companies that seek to replicate the benefits captured by the first adopters. In the example of the automotive industry, "ERP implementation is part of a larger attempt to increase profitability" (Léger, Pellerin et al.).
- **Bandwagon effect**: "the adoption of a given ERP system will be positively influenced by peer influence (imitation)" (Léger, Pellerin et al.) Marketing by the firm may jumpstart the bandwagon effect by targeting the "reference users" therefore causing other users to want to imitate them. However, word of mouth is a more credible mechanism to sustain the adoption rate of the new product. "Decision makers seek legitimacy more than efficiency" (Léger, Pellerin et al.). This mechanism most likely explains the establishment of SAP as a dominant design

because the decision makers bought the solution that was adopted by major players, the reference users, of the automotive industry.

3.2. Customer experience

"Customer experience encompasses every aspect of a company's offering—the quality of customer care, of course, but also advertising, packaging, product and service features, ease of use, and reliability." (Meyer and Schwager 2007)

We define the term ***customer experience*** to describe the "the social side of technology—the complete customer experience" (Weil 2007). Other definitions focusing on customer experience as the next frontier to product management are also consistent with ours.

"Customer experience is the internal and subjective response customers have to any direct or indirect contact with a company". (Meyer and Schwager 2007)

To highlight the importance of the non-technical success factors of technology firms, we chose to decompose customer experience into two variables in our system dynamics model as shown in Figure 10. The customer is experiencing a new technology product by evaluating the incremental benefit of the new technology. Her perception of the new product is a function of her degree of loss aversion towards the incumbent solution and by her degree of enthusiasm towards new technologies. The customer is also considering a set of non-technical criteria when considering the adoption of new technology product. This set of criteria is captured by the average switching costs.

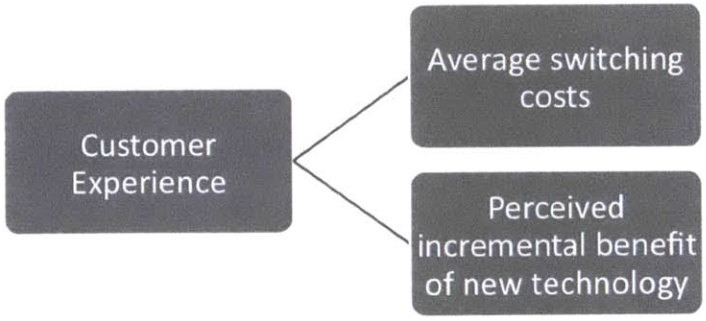

Figure 10 - Customer experience - decomposition

Technology firms underestimate investing in good customer experience even though it is an essential part of successful entry. New products that are based on incremental technological change require an understanding of the impact of customer experience. Does the customer perceive the new technology product as beneficial considering the disruption of a new installation and re-training? On the other hand, "when companies are faced with radical technological changes decision-making cannot be based on existing understandings of customer needs, values, and expectations" (Weil 2009). Winning in technology markets assumes that the firm has the skills to design and manage a new category of positive customer experiences. Apple's iPhone transformed the customer's relationship with its phone, camera and computer.

3.3. Switching costs

"You just cannot compete effectively in the information economy unless you know how to identify, measure, and understand switching costs and map strategy accordingly." (Shapiro and Varian 1998)

We refer to switching costs as the costs incurred by the customer to switch to the new technology product. Since this research is focused on information technology products, we had to capture the importance of modeling switching costs. There are three types of switching costs: transaction costs, learning costs, and artificial or contractual costs. (Farrell and Klemperer 2007). These costs are explicit.

"Transaction costs are costs that occur to start a new relationship with a provider and sometimes also include the costs necessary to terminate an existing relationship. Learning costs represent the effort required by the customer to reach the same level of comfort or facility with a new product as they had for an old product." (Chen and Hitt 2002)

There are implicit switching costs that pertain to the customer's degree of loss aversion and willingness to be an early technology adopter. Implicit switching costs include cultural biases towards acceptable attributes of information technology products such as data privacy.

"Despite the critical role of switching costs in ecommerce strategy, there is surprisingly little empirical evidence about the presence, magnitude, or impact of switching costs on customer behavior." (Chen and Hitt 2002)

Switching costs are assumed heterogeneous. There is a normal distribution of switching costs for customers. The system dynamics model described in chapter 4 attempts to link the role of switching costs to customer's willingness to adopt a new technology product. The model captures the heterogeneous behavior of customers.

4. Description of system dynamics model

"People discover that their own policies inevitably generate their troubles. That's a very treacherous situation because if you believe these policies solve the problem, and you do not see that they are causing the problem, you keep repeating more of the very policies that create the problem in the first place. This can produce a downward spiral toward failure." Jay Forrester (Fischer 2005)

4.1. Choice of system dynamics as a methodology

System dynamics modeling was developed by Jay Forrester at MIT in the 1950s. Its been applied to numerous domains such as strategy, management and public policy. The goal of system dynamics is to overcome the limitations of bounded rationality and of our mental capacity to model complex systems.

Business decision makers rely on simple mental models, which have significant limitations. They become increasingly deficient, as business problems grow more complex, as the competitive environments evolves more rapidly, and as the number of decision makers increases. The "amplification and tipping dynamics typical of highly coupled systems, for example, bandwagon and network effects" that are defined in chapter 3, are not anticipated. "Behavioral factors play critical roles in the evolution of markets" (Weil 2009).

A system dynamics model was created and built using the software Vensim DSS. The purpose of the model is to study the dynamic behavior of a firm's product development activity and of the role of customer experience in the adoption of new technology products. Our motivation was to build a model of the firm and its relationship with its customers in order to identify the high leverage points for effective intervention. The model was built from scratch to capture the learning from the classical frameworks in chapter 2, market research and interviews with senior executives in Firm A and T. In this chapter 0, we describe the important elements of the system dynamics model. The full system dynamics model, including a description of the stocks, flows, and look-up tables, is documented in the Appendix.

The model took into account the learning and important dynamics of a system dynamics model of innovative industries (Weil and Utterback 2005). An interesting feature of the model is the incorporation of the 9x effect framework (Gourville 2006). Overestimation of the new technology product by the firm and overestimation of the incumbent product by the customers are modeled.

We also captured insights from the dynamic capabilities framework described in section 2.1. We modeled three categories of capabilities. The model is described in detail in chapter 3.

- **Technological**: Technological assets and opportunities. Technological assets matter when they are difficult to imitate. For instance, hyper-efficient data centers owned by the social media company Facebook represent a technological asset that new entrants cannot replicate easily.
- **Ability to reduce switching costs**: This category includes "reputational assets", ability to understand the customer's unmet needs and relationship to the product to be displaced. We are particularly interested in ways to reduce the non-financial switching costs (emotional, psychological). The model includes a normal distribution of switching costs.
- **Learning**: The ability for the organization to experiment with business models, product design, pricing strategies, customer care models, to learn from customers and to disseminate information effectively inside the organization. Organizational learning is particularly challenging in large global companies because of scale and geographic limitations. Furthermore, counter intuitive policies prevent effective collaboration and information exchange. For example, travel budgets are the first ones to be cut in hard times, leading to less exchange of tacit knowledge and spontaneous team formation, therefore hindering organizational learning. Large organizations often operate in silos. Learning from customers does not organically spread through global locations and strategic business units. The firm needs to proactively manage the use and reuse of the learning from the customer and from within the organization.

4.2. System dynamics model assumptions

It must be noted that in order to properly define the model within the scope of this thesis and calibrate it to available data, a series of assumptions were made:

- The model time horizon covers the development and release of one product as opposed to a series of releases that may be part of a product line.
- Switching costs are assumed heterogeneous. There is a normal distribution of switching costs for customers.
- Word of mouth is an aggregate of network and bandwagon effect as described in section 3.1.
- The target customer perception for the firm's marketing campaign is constant throughout the life cycle of the product.
- Price is an exogenous variable.
- The process by which the technology firm learns from their customers, being coupled to the product adoption rate, does not begin until product launch. However, the firm may choose a limited and exclusive product launch. The firm would be able to run a series of A/B experiments in order to improve its product strategy such as product features, complementary offering, pricing model, service level agreements.

4.3. Important dynamics

The dynamics of new technology adoption and customer experience are interrelated. In this section, we describe the important dynamics and their linkages. The important dynamics are composed of reinforcing and balancing loops. A reinforcing loop produces an exponential growth or decay. A balancing loop produces a curve that tends towards a goal meaning that the curve reaches a plateau.

4.3.1. Technology investments and understanding the customer

This is an important loop. It captures the customer's perception of the new technology and the resulting product adoption. Technology firms invest in research and development (R&D) to increase the benefit of the new technology. Their focus is on gaining a technological advantage, which would be achieved by investments in R&D. However, there are diminishing returns in investments in R&D for a given

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product. As the benefit of a new technology increases, the productivity of R&D expenditures decreases. This dynamic can be illustrated by the photographic film industry or the microprocessor technology. At some level, the investments in making a better film or a better microprocessor provides less value both to the firm and to the customer. The diminishing returns of investments in R&D loop assumes that the firm is producing incremental innovations in the absence of the second and important dynamic of learning shown in red on Figure 11.

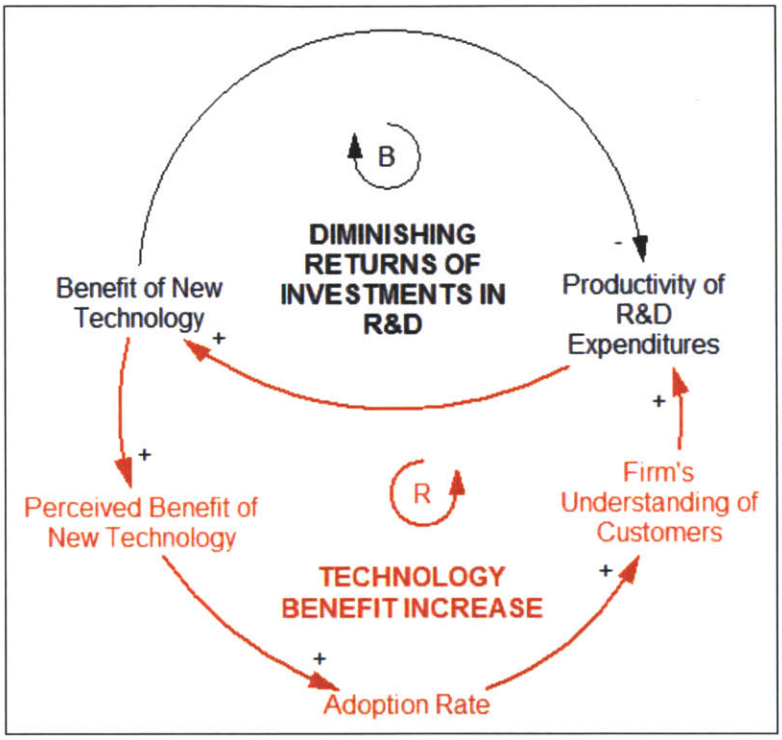

Figure 11 – Technology investments and benefit - Causal loop diagram

The loop labeled "diminishing returns of investments in R&D" is a balancing loop, while the technology benefit increase is a reinforcing loop. As the benefit of the new technology increases, the customer's perception of new technology increases. The rate of improvement of customer perception may be slow as described by the "long haul" scenario in the Gourville framework in section 2.3. We assume that the customer's perception of the new technology cannot deteriorate as the benefit of the new technology increases. As the perceived benefit of the new technology increases, the adoption rate increases. With more adopters, the firm learns from its

customers and increases its understanding of the customers. Better understanding of the customers' needs increases the productivity of R&D expenditures, which in turn increases the benefit of the new technology.

This reinforcing loop illustrates the importance of learning and understanding customers. Using the system dynamics model and scenario analysis, we will illustrate in section 6.2.1 the implications of the technology benefit increase loop. A firm that takes the initiative to learn from their customers with each sale will improve its understanding of the objective and emotional factors that can increase the customer's willingness to adopt the new product. *"(..) customers' willingness to adopt depends both objective and emotional factors*" (Weil and Utterback 2005).

4.3.2. Marketing investments and word of mouth

We define marketing as the activities of the firm to improve the customer's perception of the new technology as the product is launched. Investments in marketing impact the effectiveness of marketing. Effective marketing improves the customer's perception of the new technology product and helps kick start the word of mouth effect, which eventually becomes the primary marketing effect. This loop captures the firm's marketing strategy in developing customer perception and its execution as a transition from firm-focused outbound marketing into and customer-driven word of mouth. The role of marketing is to reach and influence customers when there are not enough adopters to benefit from positive word of mouth. As the effect word of mouth increases, incremental investments in marketing efforts become less impactful. The loop labeled "diminishing returns of investments in marketing" is a balancing loop and is shown in Figure 12.

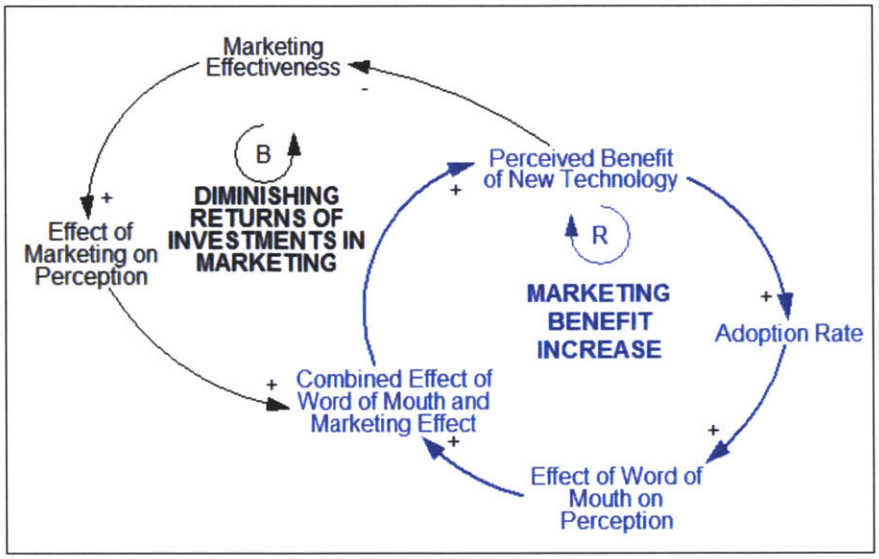

Figure 12 - Marketing investments and effectiveness - Causal loop diagram

Word of mouth has the same role as marketing but it is free to the firm. As more adopters discover the advantage of the new product, word of mouth improves customer's perception. The combined effect of marketing and word of mouth improves customers' perceptions that in turns increases the adoption rate. The loop labeled "marketing benefit increase" is a reinforcing loop.

4.3.3. Integration of technology and marketing loops

In this section, we show how technology and marketing are interrelated and influence the customer's perception of the new technology and the adoption rate.

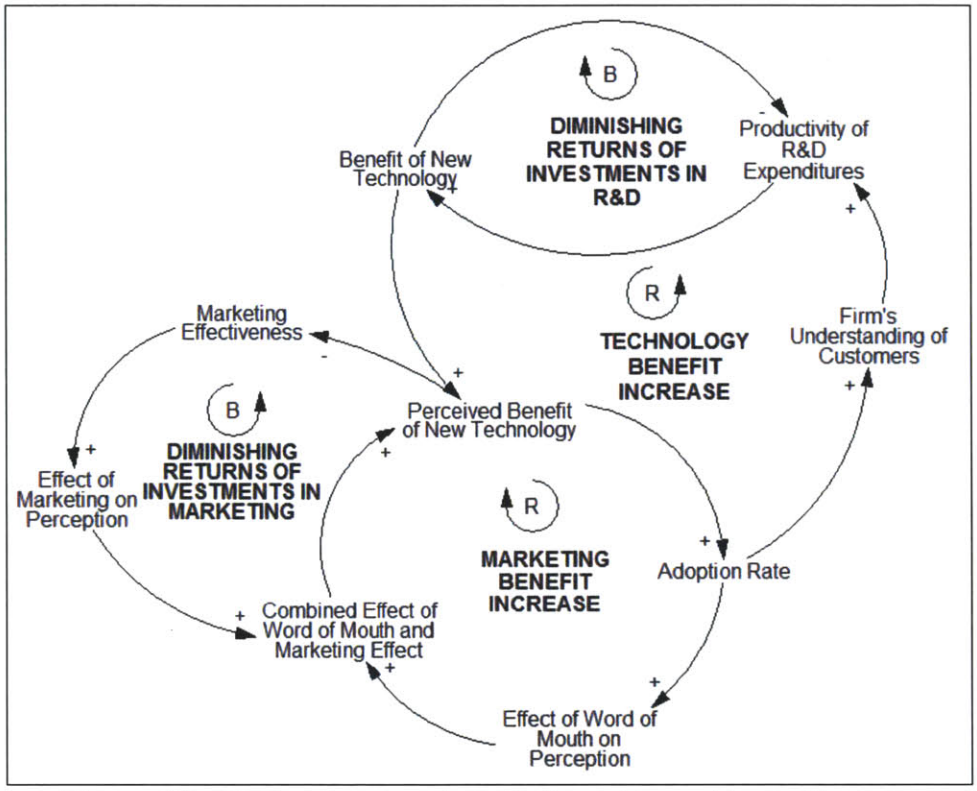

Figure 13 - Technology and marketing - Causal loop diagram

We are able to observe that technology and marketing activity both increase product adoption in two distinct ways. Technology is focused on the capability to deliver a benefit to the customer through a product. Marketing is focused on shaping the expectations of the market to align to the benefits delivered by the product incorporating the technology. Both activities serve to increase product adoption rate by increasing the customer's perception of the benefit of new technology.

Unmanaged, the perceived benefits of a product shaped by marketing often do not align well with the capabilities delivered by a new technology, leading to a lack of product adoption. A pro-active focus on understanding the needs of customers is a crucial means to ensure the continued alignment between technology and marketing. It allows R&D groups to focus on technologies that deliver the benefits that marketing is promising to customers.

It must be noted that marketing and word of mouth are focused on the perception of the technology and do not impact the customer's switching costs. Also, R&D investments and technology benefits are focused on technical capability and its value to the customer, and not to switching costs of adoption.

4.3.4. Switching costs reduction

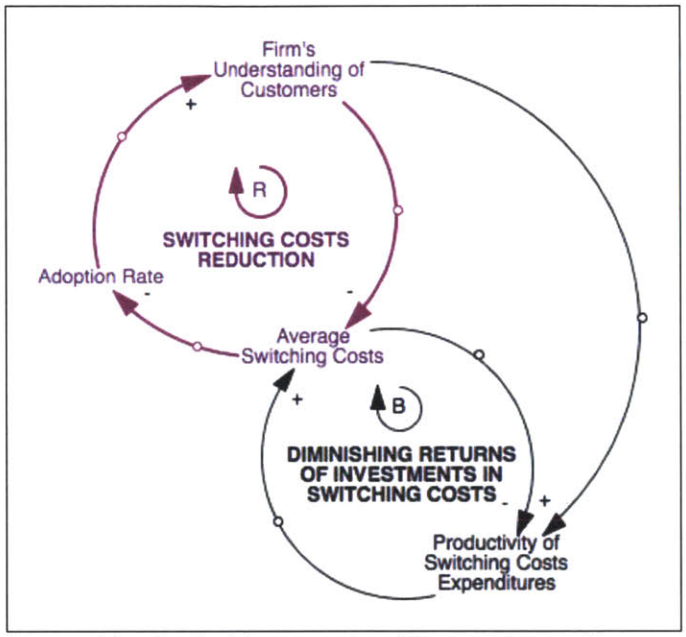

Figure 14 - Switching costs - Causal loop diagram

Switching costs were defined in section 3.3. The causal loop diagram shown in Figure 14 allows for the introduction of heterogeneous profile of customers in respect to switching costs. In the full system dynamics model, we included statistical functions to capture the assumption of a normal distribution of switching costs. The variable labeled average switching costs represents the switching costs for the entire target market. The loop labeled "switching costs reduction" illustrates that customers are more likely to adopt when their switching costs are reduced. As switching costs for product adoption are decreased, the barriers to entry for new customers are lowered. This lowered barrier to entry incentivizes mainstream majority customers to adopt, creating the opportunity for the new technology product to become dominant in the market. The firm's ability to understand its customer drives its ability to reduce average switching costs, which in turn increases the adoption rate. As described in

section 4.3.1, the increased number of adopters enables the firm to improve its understanding of its customers by learning from its customers. Figure 14 also illustrates that there are diminishing returns on investments aimed at reducing switching costs. At some point, investments in reducing switching costs results in lower productivity of switching costs expenditures. The firm can improve the productivity of switching costs expenditures by improving its ability to learn and understand its customers.

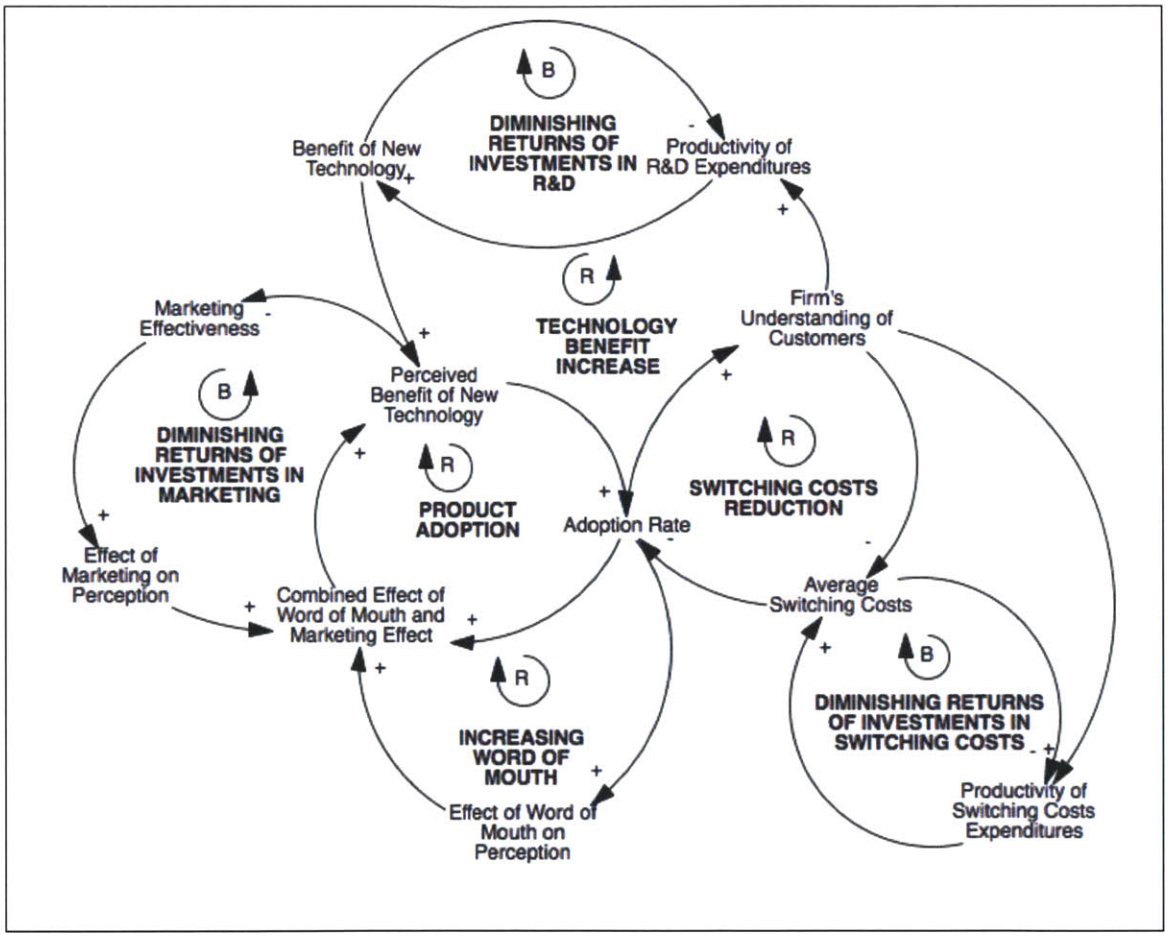

Figure 15 - Firm's investment levers and ability to understand customers

A firm has limited resources and must constantly ask itself where it makes the most sense to invest its next dollar. Our model (Figure 15) shows that the answer to this question changes over time based on previous investment decisions and that focusing exclusively on any one area leaves significant value on the table. Our model suggests that a firm can optimize its returns on investment by taking a

balanced approach across all three major investment areas. The primary way to achieve balanced investments is through learning from customers and effective dissemination of customer understanding within the organization.

4.3.5. Product adoption dynamics

From our previous observations, we can conclude that there is a central sequence of events related to customer adoption of a technology product, shown in Figure 16.

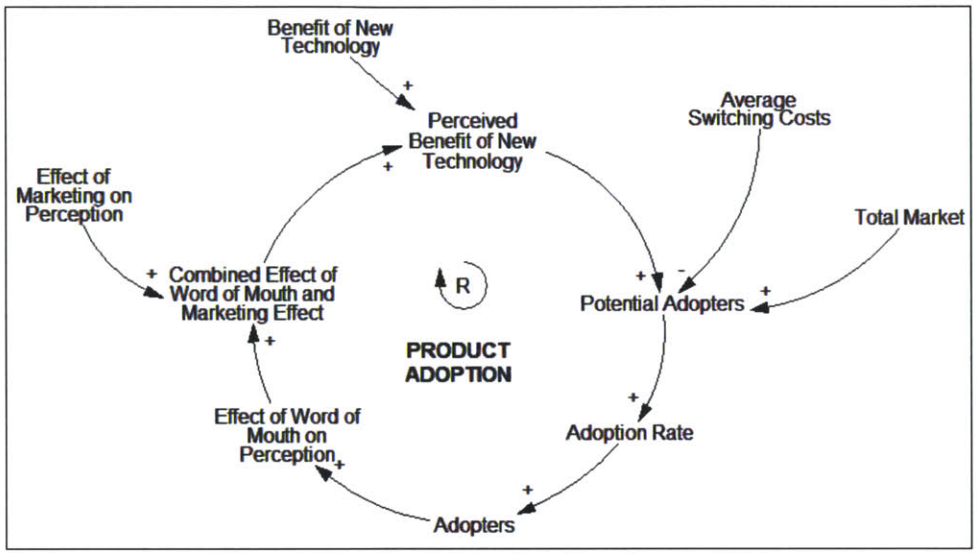

Figure 16 - Product adoption dynamics

This central product adoption behavior is the customer-focused nexus at which the other activities meet:

- Marketing increasing and shaping customer perception of the product
- Technology R&D increasing the benefit of new technologies to the customer
- Understanding of customer's needs increasing technology value delivery
- Understanding of customer's needs lowering average switching costs

When properly managed, these relationships are capable of driving product adoption. However, as presented in Figure 17, there is a limit to product adoption -- and that is when the market becomes saturated. The good news is that the point at which a firm's market becomes saturated depends not only on the total size of the market but also on the firm's ability to learn from its customers and to incorporate

these learnings into designing a better product and addressing its customers' switching costs.

Although beyond the scope of this thesis, it is not beyond reason to postulate that firms committed to learning from and understanding their customers are well positioned to not only capture a large portion of the total market as it may be defined initially but to also understand how they might even broaden the total market by identifying new customer needs that its product may address.

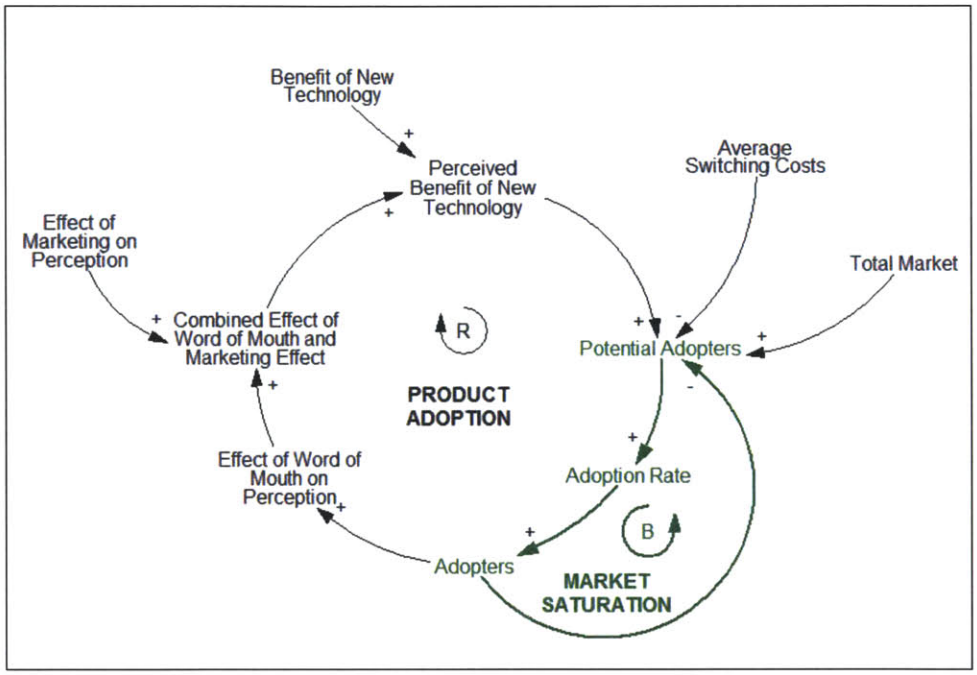

Figure 17 - Product adoption and market saturation

There are always limits to growth, and every product progresses through a natural lifecycle from early adoption to late adoption. Our model captures this dynamic not only for the diminishing returns on investment across the three major investment areas but also for the overall growth of a firm's customer base.

4.4. Detailed description of the system dynamics model

In this section, we describe in more detail the important feedback loops of the system dynamics model and run the model using the software Vensim to illustrate

the dynamics described with each feedback loop. The full model documentation may be found in the Appendix.

4.4.1. Product adoption reinforcing feedback loop

The firm's product development and marketing activities is designed to influence the behavior of the Consumer Adoption reinforcing feedback loop, as illustrated below.

A necessary first step in the adoption of a new technology is the customer realizing its benefits relative to incumbent products. This perception of benefit is captured in the variable, ***Customer Perceived Benefit of New Technology***, a function of the initial benefit of this technology, additional benefits from technology maturity, and the impact of various forms of marketing.

The level of technology is a measure of the technical features of the product. Accordingly, we must consider the net benefit of the technology product to the customer. ***Customer Perceived Incremental Benefit*** captures the net benefit of a new technology when related to the price of the newly released product.

Most new technology products require the customer to undergo a learning process upon adoption, resulting in a temporary loss in efficiency and utilization. This difficulty is known as a switching cost. The ***Fraction of Population Willing to Switch*** captures the statistical fraction of customers in a market that would be willing to adopt a new technology with its current perceived incremental benefits and average switching costs.

As the statistical normal distribution of users willing to switch increases, the actual ***Population Willing to Switch*** increases, which is a function of the size of the Total Market for the product. As the population willing to switch to a new product increases, the actual ***Adoption Rate*** and its accumulation of ***Adopters*** for the product increase. An additional variable, ***Product Launched***, serves as a binary factor based on whether or not the firm has released a new technology product.

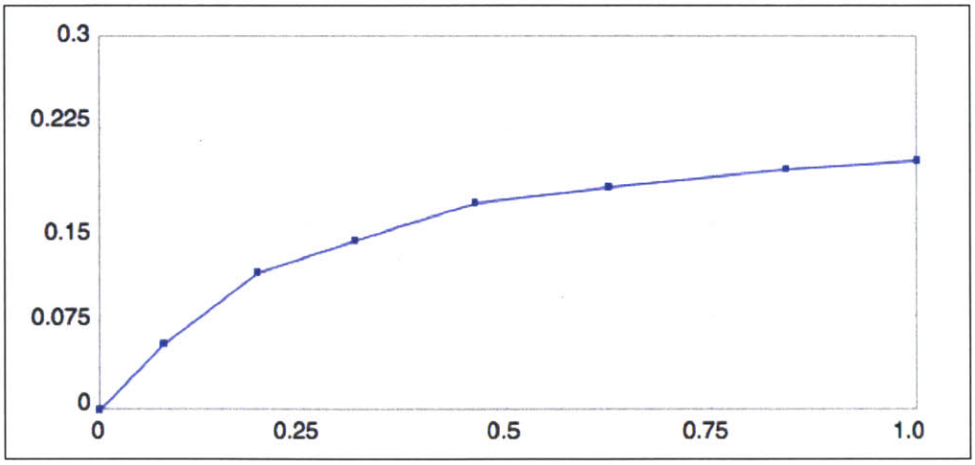

Figure 18 - Strength of Word of Mouth Table Function Plot:
Adopters / Total Market (X-Axis)
Effect of Word of Mouth on Customer Perception (Y-Axis)

As the number of ***Adopters*** of the product increases, the ***Effect of Word of Mouth on Customer Perception*** increases. This growth in viral marketing and its relationship to the number of adopters is described in the table function, ***Strength of Word of Mouth***.

There is a sharp increase in the ***Effect of Word of Mouth on Customer Perception*** in the initial phases of market penetration. This phenomenon reflects the benefits of viral marketing as a driver for early product diffusion and adoption. However, as the market penetration increases, the ***Strength of Word of Mouth*** is seen to asymptotically approach 0.225.

As will be seen in further detail in section 4.4.2 that describes the Marketing Loop, an increase in either the ***Effect of Marketing on Perception*** or the ***Effect of Word of Mouth on Customer Perception*** leads to an increase in the ***Combined Effect of Marketing and Word of Mouth on Customer Perception***.

4.4.2. Marketing balancing feedback loop

Effective marketing is a key component in the success of a newly released technology product. This model makes a clear distinction between two types of marketing for a technology product:

- Marketing campaigns to create and manage customer product perception.

- Viral "Word of Mouth" marketing that grows among customers and is driven by the customer adoption cycle.

The Product Adoption Loop focuses directly on the organic evolution of viral marketing among customers. By contrast, the Product Marketing Loop is focused on influencing this growth through the firm's marketing campaign. These two loops and their interaction demonstrate the evolution of marketing from a firm-focused outbound activity into a viral customer-focused trend.

Marketing reaches its maximum effectiveness shortly after product launch, serving to accelerate customer adoption of a new product until viral inter-customer marketing becomes sustainable. As this milestone is achieved, firm outbound marketing decreases to a fraction of its peak.

Once a product is released, ***Target Marketing Effectiveness*** is established for the firm's marketing campaign. This target is a function of the difference between the firm's goal for ***Target Consumer Perception*** of the technology and the current level of the ***Effect of Word of Mouth on Customer Perception***, reflecting the current perception of the product within the market.

As the ***Target Marketing Effectiveness*** increases, there is an increase in ***Marketing Effectiveness***, resulting in an accumulative ***Effect of Marketing on Perception***.

The ***Effect of Marketing on Perception*** combines with the ***Effect of Word of Mouth on Customer Perception*** into a ***Combined Effect of Marketing and Word of Mouth on Customer Perception***, leading to an increased ***Customer Perceived Benefit of New Technology***. As discussed in detail in the Customer Adoption Loop section, this increase in customer perception eventually leads to an increased number of ***Adopters*** and amount of ***Effect of Word of Mouth on Customer Perceptions***.

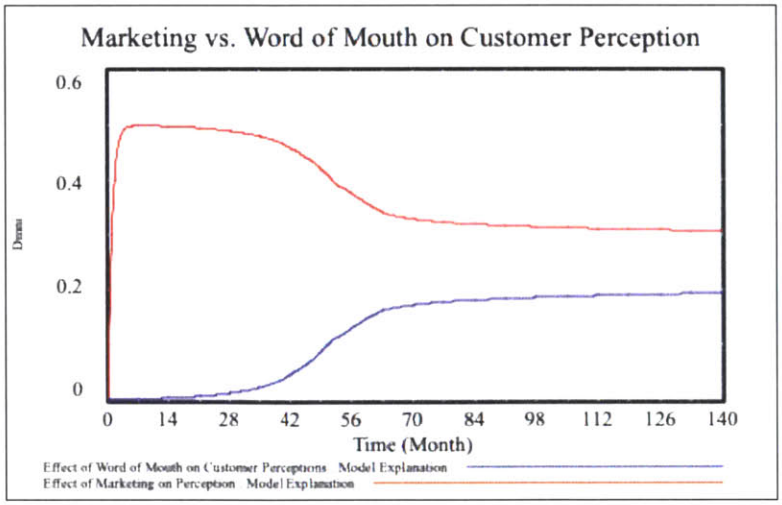

Figure 19 - Marketing vs. word of mouth on Customer Perception

The balancing nature of the Product Marketing Loop can be observed in its behavior in the months after initial launch. As the ***Effect of Word of Mouth on Customer Perceptions*** increases, the ***Target Marketing Effectiveness*** decreases as customers' perceptions evolve to meet the firm's constant ***Target Customer Perception***. This leads to a decrease in the Effect of Marketing on Perception, while still maintaining a stable ***Combined Effect of Marketing and Word of Mouth on Customer Perception***.

4.4.3. Diminishing returns on R&D investments

The ability of research and development to deliver value to customers in products incorporating new technology is a crucial step in successful market adoption.

At the beginning of the product R&D cycle, there is a defined ***Initial (INIT) Benefit of New Technology***, which is influenced by the technology and market history preceding the current technology product. This baseline benefit, in combination with the table function relating **Decreasing Returns on R&D Expenditure**, demonstrates that in the early R&D process, there is the potential for a continuous decline in the **Productivity of R&D Expenditures**.

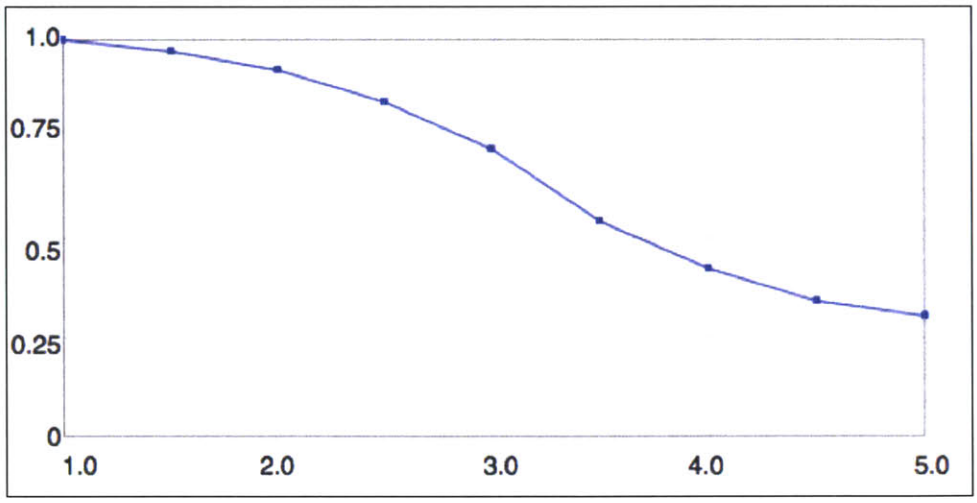

Figure 20 - Decreasing Returns in R&D Expenditure Table Function Plot: Existing Benefit / Initial Benefit of New Technology (X-Axis) Effects on Returns of R&D Expenditures (Y-Axis)

However, this decline is prevented in the early stages of product release by the **Effect of the Firm's Understanding of Productivity of Expenditures** due to the firm's increasing understanding of the needs of the customer. The understanding of the customer is a key component in the effectiveness of the R&D process to deliver perceived benefit to the customer and will be explored in further detail in a later section.

The enhanced productivity of the R&D process, combined with appropriate **R&D Expenditures** by the firm, leads to an **Increase in Technology** and an accumulated **Benefit of New Technology** for the customer

4.4.4. Customer switching costs balancing loop

The adopter of a new technology product often needs to learn new skills or change their behavior in order to use a new technology product. This product "Switching Cost" often serves as a barrier to entry into some markets. As a technology matures, development firms expend resources to lower the technology switching costs and increase market penetration.

Based on the technology firm's product development strategy, a decision is made how to reduce switching costs for potential customers. The timing of when to **Begin Switching Costs Expenditures** involves both a **Toggle to Start Reducing**

Switching Costs After Product Launch and a **Month to Start Reducing Switching Costs**. This structure allows the model to simulate a firm's strategy to either begin switching cost reduction before product release or at a set month after product launch.

The actual rate at which there is a ***Reduction in Switching Costs*** is a function of not only the current ***Average Switching Costs*** for the technology and the firm's strategy of when it ***Begin Switching Costs Expenditures*** to actively reduce these costs, but also the firm's actual investment of ***Switching Costs Expenditures*** and its related ***Productivity of Switching Costs Expenditures*** in this endeavor. While the timing and resource allocation related to switching cost reduction are directly controllable by the technology firm, the actual ***Time to Reduce Switching Costs*** is an aggregate measure of the factors exogenous to the firm that affect the rate at which switching costs can be reduced. Such exogenous factors include the similarity of the new technology to incumbents, and the product line's average life cycle.

The Switching Cost Reduction balancing loop is the result of the ***Effect of Returns on Switching Costs Expenditures*** on the ***Productivity of Switching Costs Expenditures***, which is a major driver of the rate of ***Reduction in Switching Costs***. The Effect of Returns on Switching Cost Expenditures is governed by the ***Decreasing Returns Expend Switching Costs*** table function, adopted from the DEVLPPDY product development model, and the ratio of the current ***Average Switching Costs*** to the ***Initial (INIT) Switching Costs***.

The relationship between the Average Switching Costs of a new product and its impact on the effectiveness of Switching Cost Expenditures is captured in the following graph of the table function, Decreasing Returns Expend Switching Costs.

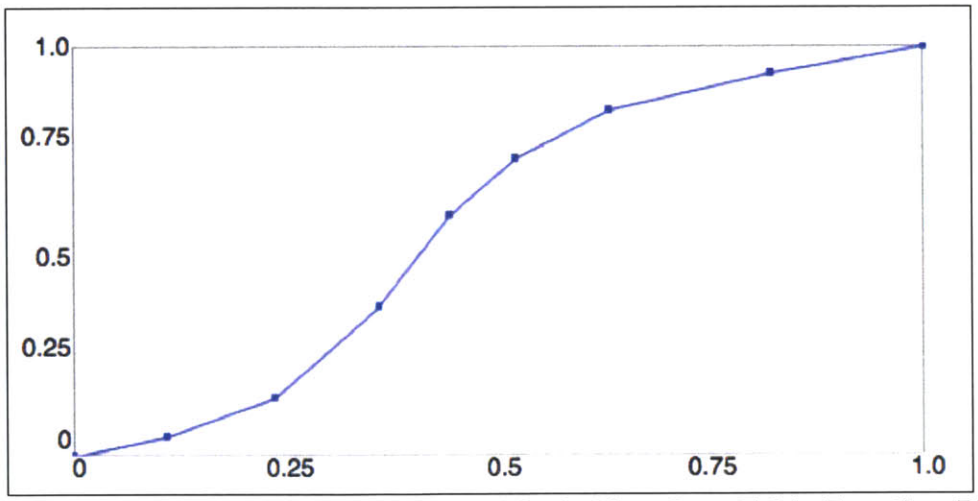

Figure 21 - Decreasing Returns Expend Switching Cost Table Function Plot:
Average / Initial Switching Cost Ratio (X-Axis)
Effects on Returns of Switching Cost Expenditures (Y-Axis)

As can be seen on Figure 25, there is a slight linear decrease in the return from switching cost expenditures as Switching Cost Ratio is decreased from its initial value of 1.0 at the beginning of the product development process. As the Average Switching Cost drops below 0.75 times its initial value, there is an exponential decrease in the benefit to the firm of increased expenditures in the reduction of switching costs.

As ***Average Switching Costs*** is reduced further with respect to its initial value, it becomes more difficult to obtain further reductions. As a result, the ***Effect of Returns on Switching Costs Expenditures*** decreases, reducing the ***Productivity of Switching Costs Expenditures***. As expenditure productivity reduces, the rate of the ***Reduction of Switching Costs*** decreases, leading to a leveling off of the ***Average Switching Costs*** for the product.

4.4.5. Customer understanding reinforcing feedback loop

A key differentiator between technology product market leaders and their mainstream competitors is responsiveness to the needs of the customer. The firm's responsiveness to customer needs derives from enhanced organizational learning gained directly from their customers. The organizational learning results in a lowering

of ***Average Switching Costs*** and an increase of ***Benefits of New Technology*** compared to competing products from other firms.

As the ***Adoption Rate*** for a new technology product increases, there is an increase in the rate in which new customers are facing the current ***Average Switching Costs***. As the ***Adoption Rate*** increases, the rate at which a firm is ***Learning from Customers*** increases, raising the total level of ***Firm Understanding of Customers***. The ***Average Learning per Sale***, which impacts the rate of learning, reflects not only the type of product being offered, but also the effectiveness of the firm's activities to capture and leverage customer insights.

A firm's insights into customer needs in dynamic technology markets lose relevance over time. A firm will suffer a rate of ***Loss of Customer Knowledge*** at an industry specific ***Decay Time***, reducing the total ***Firm Understanding of Customers***. An increase of the ***Firm Understanding of Customers***, mapped through the ***Increase in Productivity from Understanding Customers***, results in an increase in the ***Effect of Firm Understanding on Productivity of Expenditures***.

The benefit of enhanced customer understanding on the ability of a technology firm to expend its resources is captured in the following graph of the table function, ***Increase in Productivity from Understanding Customers***.

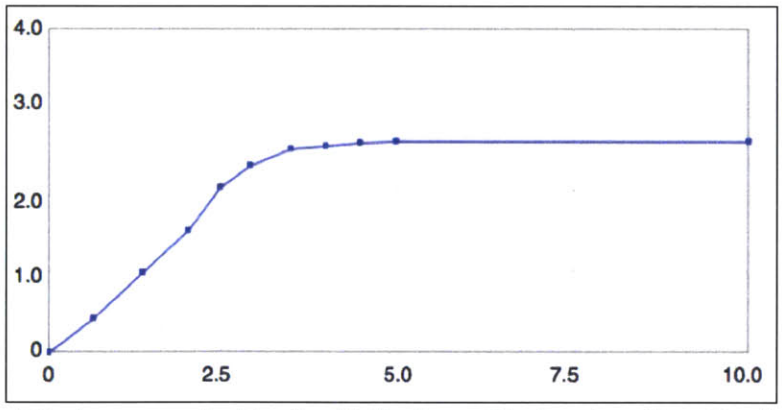

Figure 22 - Increase in Productivity from Understanding Customers
Table Function Plot:
Current Understanding / Initial Understanding Ratio (X-Axis)
Effects on Firm Productivity of Expenditures (Y-Axis)

As can be seen in the graph, there is an initially linear increase in the firm's expenditures productivity as they gain insight from their customers. However, as the firm passes 2.5 times their initial level of customer understanding, there is an asymptotic benefit to their expenditure productivity, leveling off at a factor of approximately 2.6.

The above table in Figure 27 suggests that learning from the customer base promises significant improvements over initial market or technical research upon product launch. It also indicates a later diminishing return as the level of customer insight becomes too detailed to be generally relevant to the product development process.

4.4.6. Relationship of customer understanding to switching costs

Increased understanding of customer needs fosters the development of a collaborative technology product development organization. In such organizations, general insight into the effectiveness of their operations leads to many impacts throughout the product development process.

The rapid increase in a firm's insight into the nature of their expenditures allows the firm to temporarily counteract the decreasing ***Effect of Returns on Switching Costs Expenditures***. This results in an initially increasing ***Productivity of Switching Costs Expenditures***, as illustrated in the following comparative plot.

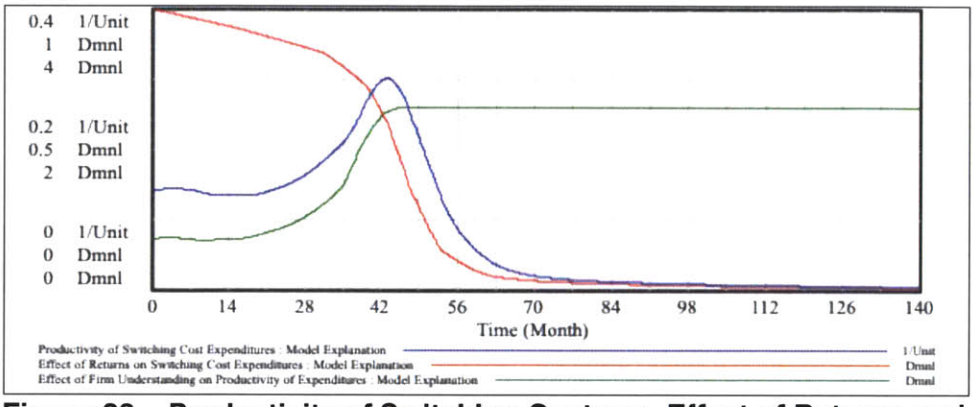

Figure 23 – Productivity of Switching Costs vs. Effect of Returns and Understanding of Productivity

As can be seen in the following comparative plots, this behavior reflects the reality that a product development firm that learns from their customers is better aware how

to effectively focus their efforts and becomes more efficient at improving their product.

An increase in efficiency allows enhanced long-term reductions in the ***Average Switching Costs***. This minimization of switching cost further lowers the barriers to market entry, allowing for increased customer adoption across a wider spectrum of the market.

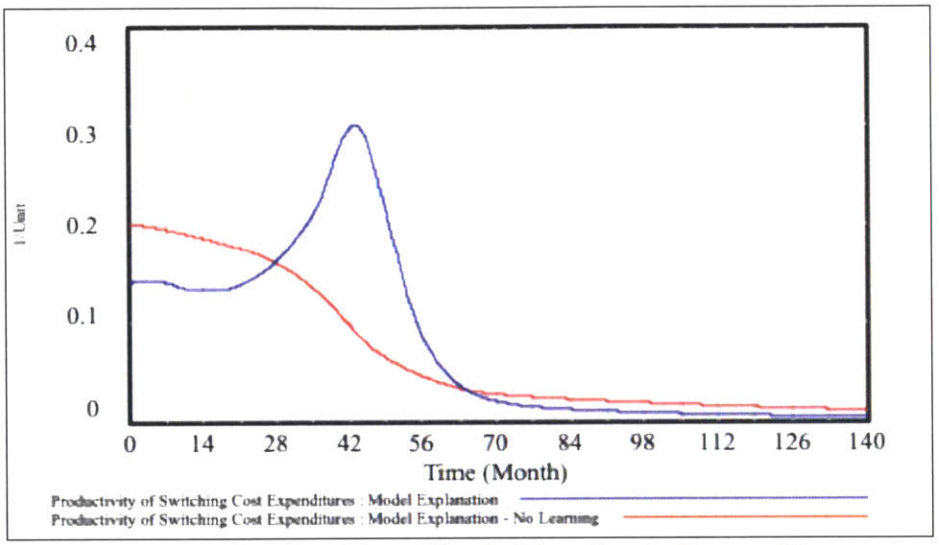

Figure 24 - Productivity of Switching Costs Expenditures

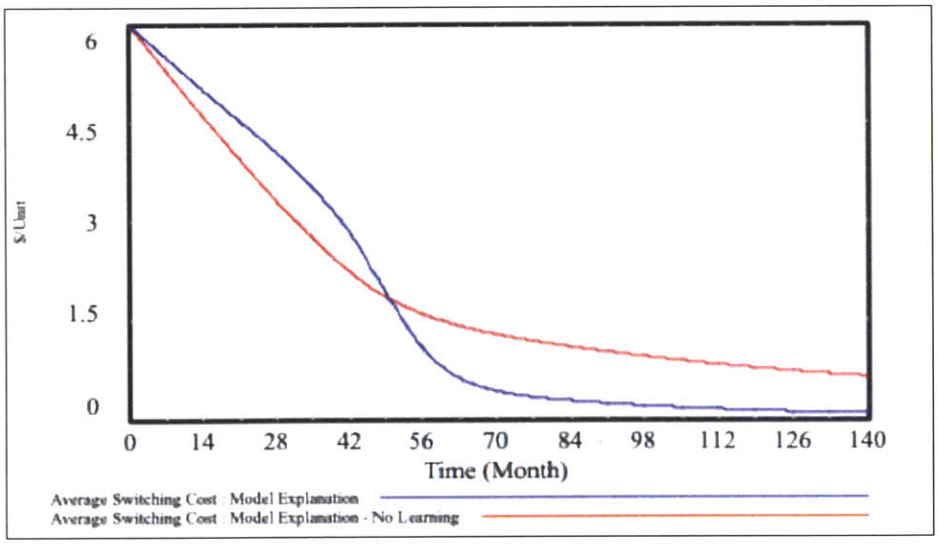

Figure 25 - Average Switching Costs

4.4.7. Relationship of customer understanding to the productivity of R&D

The Effect of Firm Understanding on Productivity of Expenditures also has a significant impact on an effective development of technology. An increase in the

Effect of Firm Understanding on Productivity of Expenditures serves to increase and maximize the overall ***Productivity of RD Expenditures***, which is eventually limited by the decreasing ***Effect of Decreasing Returns on RD Expenditures***.

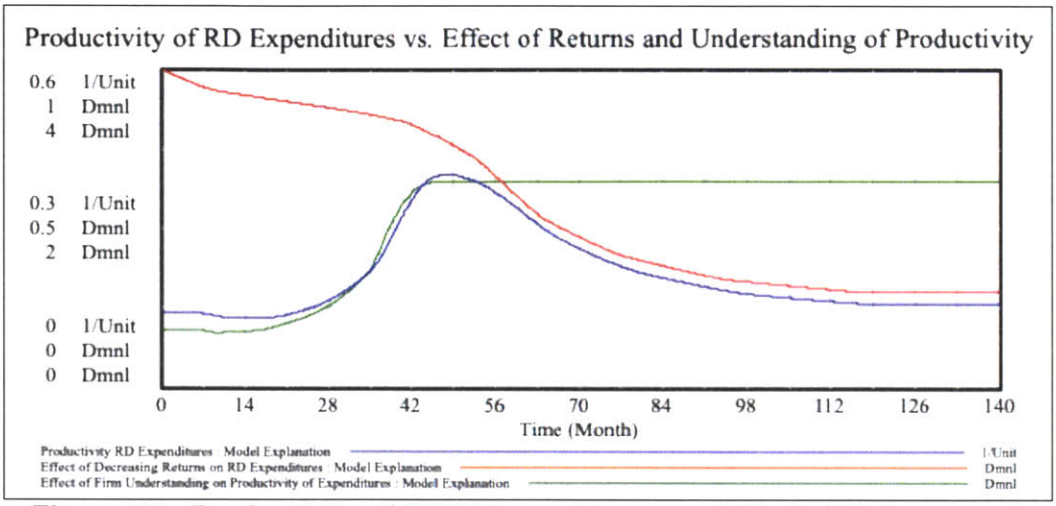

Figure 26 - Productivity of R&D Expenditures vs. Effect of Returns and Understanding of Productivity

The impact of the addition of an ***Effect of Firm Understanding on Productivity of Expenditures*** on the Decreasing R&D on Maturing Technology Loop is similar to the nature of the impacts on the Switching Cost Reduction Loop. As can be seen in the following comparative plot, understanding of the voice of the customer in R&D ultimately results in a product that delivers greater benefit to the customer that in turn leads to increased adoption.

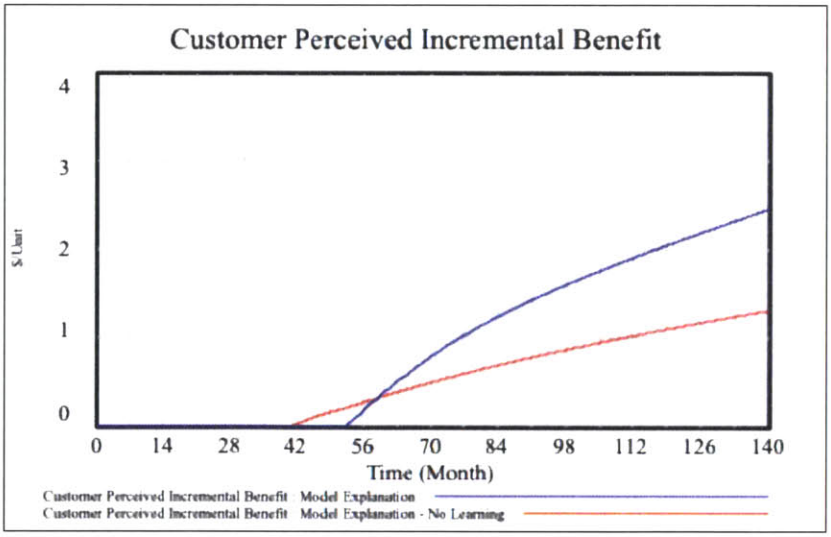

Figure 27 - Customer Perceived Incremental Benefit

The source behavior within the R&D cycle for this enhanced perception of benefit can be seen in the following comparative plots. Seeking the voice of the customer in product development initially diverts resources and results in a lower ***Productivity RD Expenditures*** and slightly diminished ***Increase in Technology***. However, once there is an accumulation of understanding of customer needs, the productivity of R&D expenditures rises sharply and ultimately is more sustainable than if there were no active learning from the customer base.

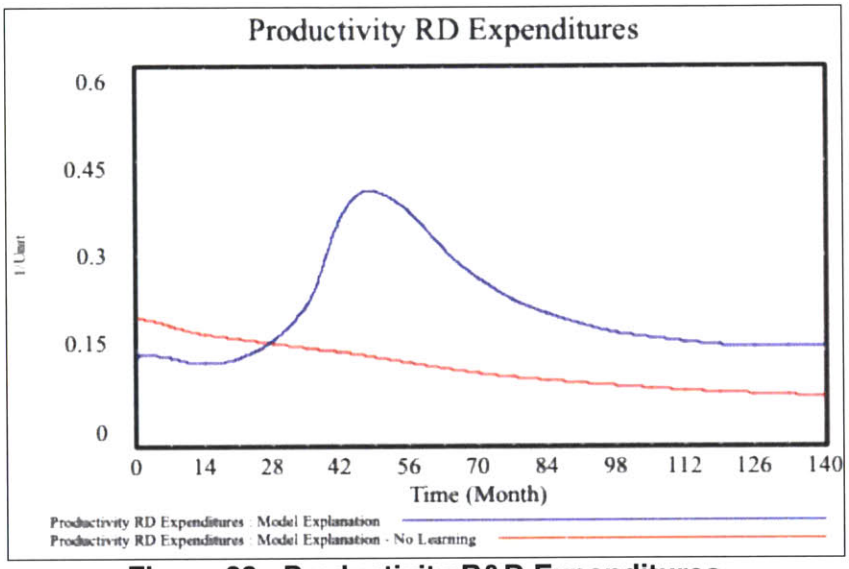

Figure 28 - Productivity R&D Expenditures

It can also be seen that while insight into the voice of the customer has a significant impact on customer perception of benefit, it does not have a long-term impact on the actual ***Increase in Technology***. This behavior demonstrates that the voice of the customer is useful to properly focus the efforts of R&D groups to maximize benefit of expenditures, but neither significantly alters the technical ability of the research group nor the performance boundaries of the technology incorporated in the product.

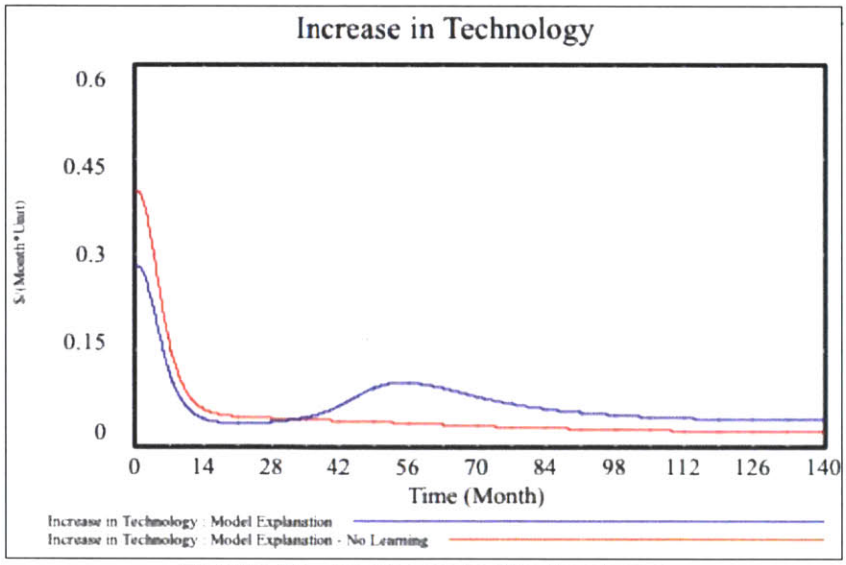

Figure 29 - Increase in Technology

4.4.8. Technology product launch strategy

There is a group of variables that exist in the model to simulate the technology firm's product prelease timings and strategy. The ***Product Launched*** stock serves as a master switch to trigger the following activities:

- Change ***RD Expenditures*** in the Decreasing R&D on Maturing Technology Loop from being a function of ***Prelaunch Product Development Expenditures*** to being a function of ***Postlaunch Product Development Expenditures***.
- Engage the Product Marketing loop by permitting the ***Target Marketing Effectiveness*** to be calculated based on the current ***Effect of Word of Mouth on Customer Perception*** and the firm's previously established ***Target Customer Perception***.
- Engage the Customer Adoption Loop by permitting the ***Adoption Rate*** to be calculated based on the current ***Population Willing to Switch*** to the new technology and the ***Time to Acquire*** the product.

4.4.9. Product Release Options

There are several possible product release strategies available to the technology firm, based on which variable is engaged to affect the ***Decision to Launch***:

- ***Blind Decision to Launch***, activated by ***Toggle for Product Launch*** **= 0**

Immediately release the produce once ***Firm Perceived Incremental Benefit to Customer*** is greater than zero, regardless of ***Average Switching Cost***.

- ***External Decision to Launch***, activated by ***Toggle for Product Launch*** = **1**
  Release the produce based on an established schedule, regardless of ***Incremental Benefit to Customer*** or ***Average Switching Cost***.
- ***Informed Decision to Launch***, activated by ***Toggle for Product Launch*** = **2**
  Release the product based on the ***Average Switching Cost***, the ***Firm Perceived Incremental Benefit to the Customer***, the ***Desired Initial Market Penetration***, the table function of ***Inverse Cumulative Standard Normal Distribution*** of product adopters, and the established ***Switching Cost Standard Deviation***.

4.4.10. Financial metrics

A key measure of the success of a released product to the management of a technology firm is the financial performance of the product. Investment choices, or ***Expenditures***, are input into the financial success metric of ***Accumulated Discounted Profits***. This is a simple measure of the relative success of the firm's investment choices. In chapter 6, we run different scenarios and evaluate their success using this metric.

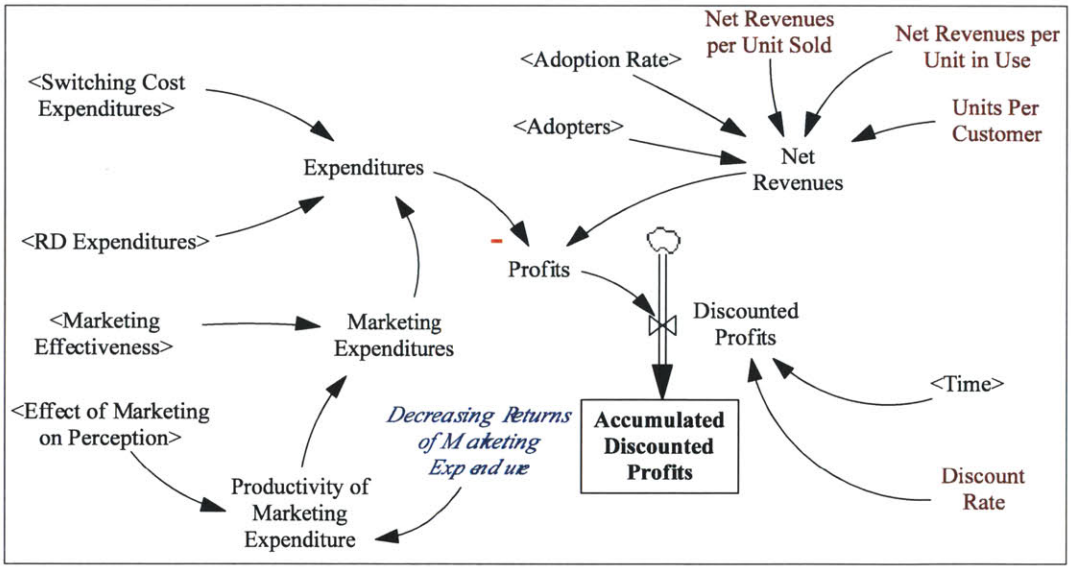

Figure 30 - Causal loop diagram of the financial success metric

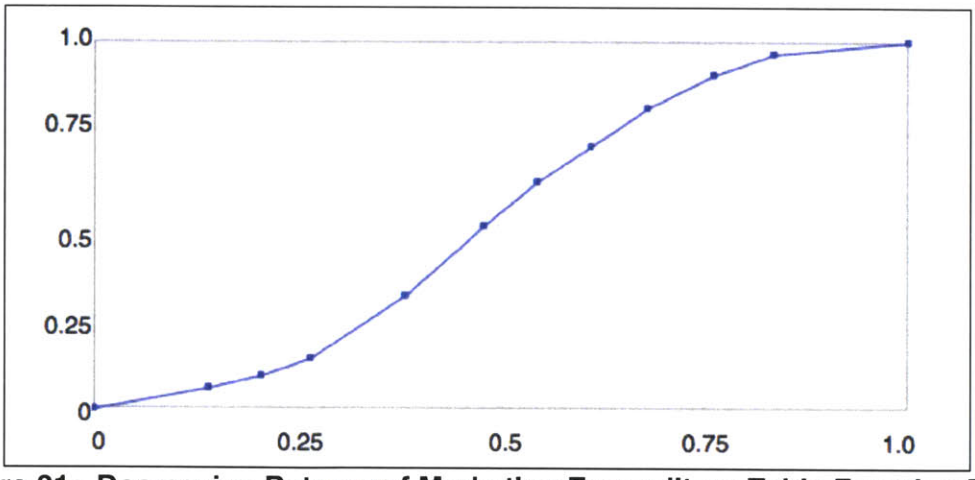

Figure 31 - Decreasing Returns of Marketing Expenditure Table Function Plot:
Effect of Marketing on Perception (X-Axis)
Productivity of Marketing Expenditures (Y-Axis)

We described in this section the basic behaviors generated by the system dynamics model. In the next sections 5 and 6, we describe the validation data from firm A and validate the model against actual product adoption data. We also analyze several scenarios to gain insights that we apply for Firm T's entry into cloud computing.

5. Model validation using business data

5.1. Overview of Firm A

Firm A is a global information services provider with two large divisions that are the result of a recent merger. One of Firm A's business units delivers online research tools for legal professionals. The product of this large business unit of firm A is an online research platform. We were given adoption data about two products called product A and product B that were introduced around the same time. Both products are embedded features on the legal online research platform. We also interviewed executives in charge of product research and development in order to understand the important adoption factors for both products. Interviews revealed attributes of Product A and B that aided the calibration of the system dynamics modeled described in chapter 0.

5.2. Product A – familiar technology and familiar market

Product A is built on a technology that is well understood by the firm. Product A is an external facing version of an internal development tool that was in extensive use by the R&D team. The purpose of Product A is to improve the content provided on the online search platform. The strategy behind the launch of product A was to take an internal solution and deliver it to the user of the online research platform. Product A consists of a recommendation engine for additional legal content and opinion. Interviews with the executive in charge of new product development helped apply both the familiarity matrix and the Gourville's framework. Product A is familiar. The underlying new technology had been extensively used internally to improve the performance of the parent online search platform. The market is also familiar: product A's value proposition is the same as the parent online search platform.

5.3. Product B – new, familiar technology and new, familiar market

Product B relied on the technology those less familiar to the firm. The assumption was that the user would greatly benefit from the ability to perform search on her internal documents in the same fashion that users search for content on the online research platform. Again an interview when the executive in charge of product development positioned product B on the familiarity matrix and Gourville's framework. Product B is new but familiar technology. Its functionality is different from the parent search platform therefore the market is new but familiar. Although product B is targeted at the same customer base, it delivers a functionality that is new and different. Product B was developed internally. The Familiarity matrix in section 2.2 shows that a better go-to-market strategy would be to consider an internal venture approach, an acquisition or licensing. Berry and Roberts describe that internal ventures, the ability *"to harness and nurture an entrepreneurial behavior within the corporation"* yield mixed records. Product B assumed that its value proposition was complementary to the one of the parent online search platform.

5.4. Description of adoption data

Firm A provided product adoption data for both products. The data consisted of monthly-adjusted revenue numbers as well as instances of usage in the case of product A. For Product A, the delivery model was changed mid-stream. The product management team received feedback from users that the ancillary model of pay-per-use was a cause of concern. The variable and unpredictable cost of usage of product A was unattractive to firm A's customers. Consequently, firm A switched the delivery model of Product A to a subscription model that provided predictable yearly expenses for its customers. After adjusting for price increases, we verified with Firm A's senior executives that revenue numbers where an adequate proxy for adoption of product A. We obtained a smaller range of data for product B. Interviews with senior executives confirmed that the missing data was in trend with the data received. In other words product B experienced a very low flat adoption rate.

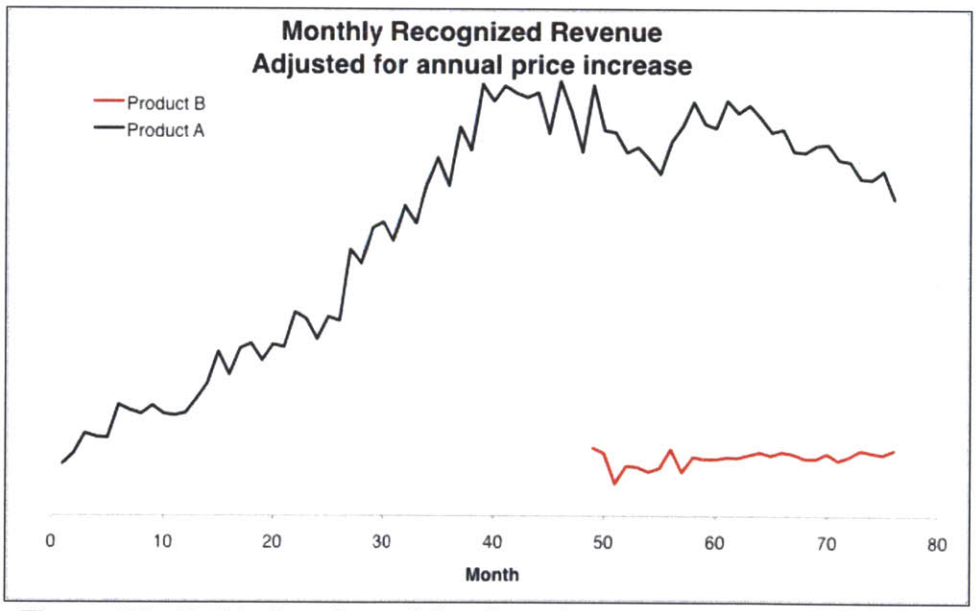

Figure 32 - Validation data: Adoption of products A and B in firm A

During our interview, we asked the senior executive in charge of product development to locate Product A and B on the Gourville framework shown on Figure 7. Product A was classified as an "Easy Sell" and product B as a "Long Haul".

Product A fits well in the customer experience of the customer as it is performing its primary task of legal search: there is very little behavior change required of the customer. The underlying technology was proven and used internally by Firm A. In contrast, Product B required a significant change of behavior from the customer as it attempted to replace an incumbent solution that exists outside of the Firm A's product suite. In addition, the underlying technology was not familiar to Firm A.

The Gourville framework described in the literature survey was sufficient to predict the relative success of Product A and failure of Product B. However, we want to study and understand the complex role of technology, customer experience and product launch strategy in order to help build a set of strategic recommendations for Firm T as it enters the new business area of cloud computing.

6. Scenario analysis

"There can be a very powerful synergy between scenario development and system dynamics modeling. Scenarios consider multiple futures and force unconventional thinking. (…) Scenario building requires managers to have a coherent view of their business. System dynamics models can help managers to acquire this view". (Weil 2007)

6.1. Base scenario – model validation

Firm A provided adoption data for two products in the form of recognized revenue. Recognized revenue scales with the number of users and is a good measure of adoption. The revenue data was adjusted for annual price increases. Product B did not get adopted and is a failure as measured by the stagnant and small revenue generated. Product A was a success. We note that there is a decline of revenue that coincides with the "Great Recession" starting in December 2007 (Rampell 2009). The recession affected all products and is exogenous to our model. We also can make the assumption that competition can be kept outside the boundaries of the model. For the period studied, the product was embedded on a platform that maintained consistent and dominant market share. In 2010 and onward, after the studied period, new entrants from other industries and small players are threatening the dominant position of the platform today. However, understanding the success

factors of Product A and the drivers behind the failure of Product B continue to be important as competition increases.

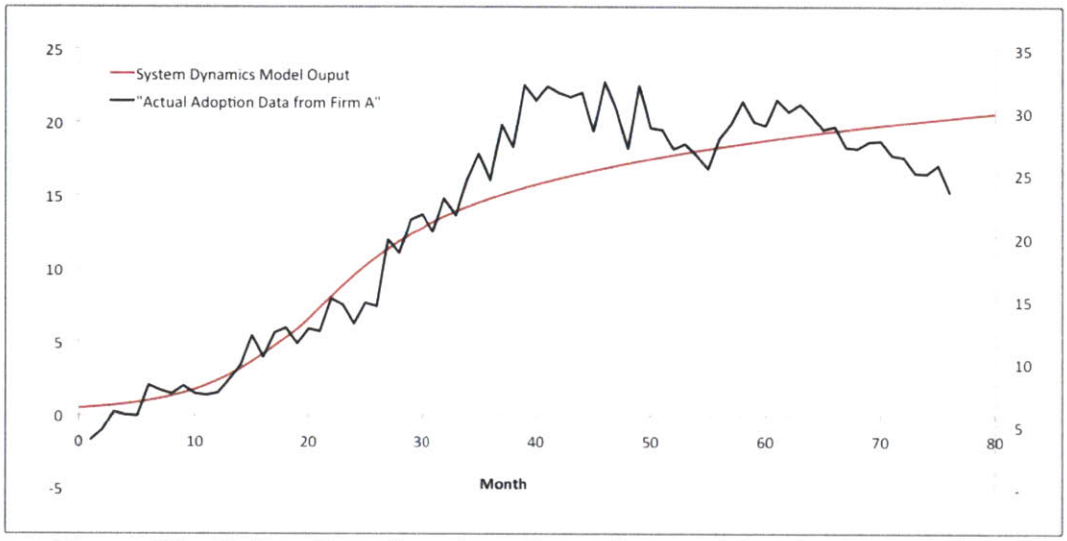

Figure 33 - Calibration of system dynamics model using Firm A data

Product B did not take into account the switching costs and therefore resulted in very low adoption. The model predicts low to no adoption for a given product if ***Average Learning Per Sale*** or the ***Switching Cost Expenditures*** are null as shown in Figure 34.

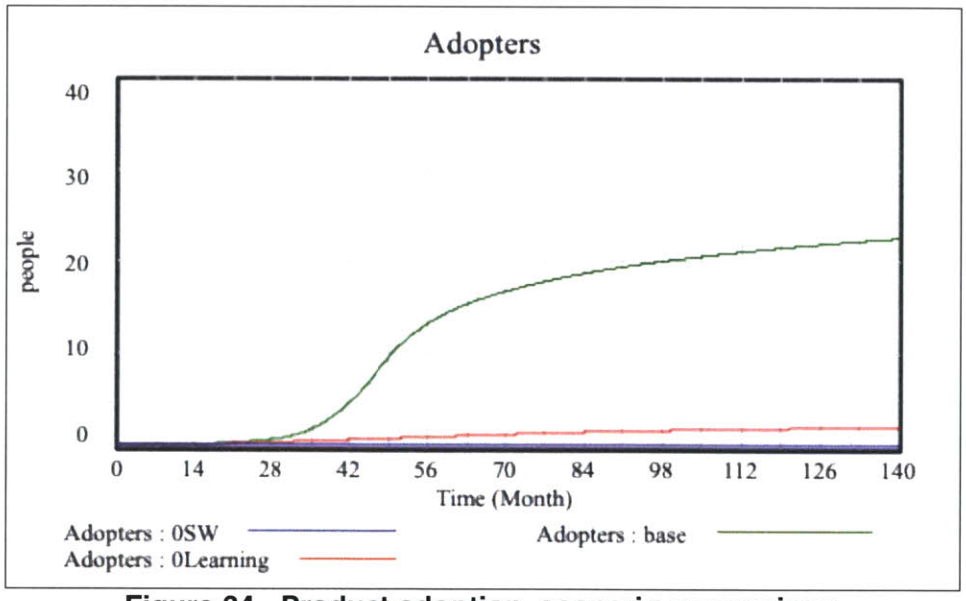

Figure 34 - Product adoption, scenario comparison

6.2. Alternate scenarios

In this section, we run different scenarios from the baseline for Product A to understand what factors contribute to adoption. For each scenario, we looked at the rate of adoption by plotting the stock ***Adopters*** and the financial outcome, ***Accumulated Discounted Profits*** at the end of the simulation period of 140 Months. The goal of scenarios is to experience the behavior of the model.

6.2.1. Scenario: Learning more from customers

The first scenario is one where we double the ***Average Learning Per Sale***.

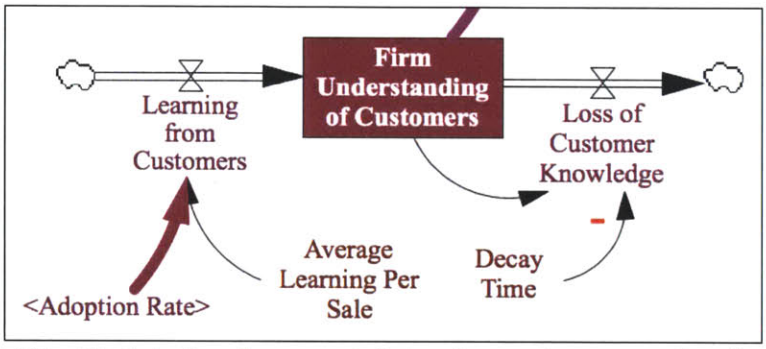

Figure 35 - Model structure pertaining to customer understanding

Increasing ***Average Learning Per Sale*** by a factor of 2 results in a 12% increase in ***Accumulated Discounted Profits***. It also increases the rate of adoption and drives adoption sooner as shown in Figure 36. This scenario illustrates the benefits of investing in the firm's ability to learn from customer and to disseminate the information efficiently inside the organization.

Our interview with Firm A's management revealed that there was a change of delivery model based on information collected from customers and feedback on why a pay-per use model was less favorable than a subscription based model. This scenario describes a case where additional insights might have been collected about the usage of Product A to increase the firm's ability to learn with each sale. Better business analytics enabled by richer customer data offers new ways to achieve increased learning from each sale. The ability to rapidly learn from customers and share the insights inside the firm is enabled by information technology (IT).

"IT is setting off a revolution in innovation on four dimensions simultaneously: measurement, experimentation, sharing and replication. Each of these is important in and of itself, but, more profoundly, they reinforce each other. They magnify the impact of each other" (Brynjolfsson 2010).

Learning from customers must be seen as integral and essential to the go-to-market strategy for information technology products.

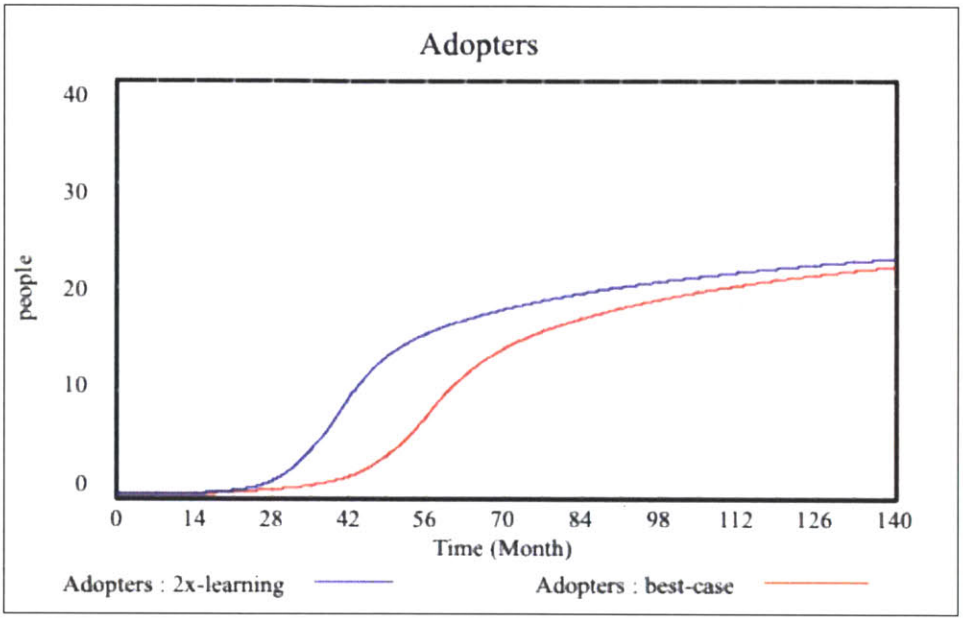

Figure 36 - Impact of better organization learning on product adoption

6.2.2. Scenario: Decreasing switching costs

In this scenario, we allocate an additional 0.5 million in ***Switching Cost Expenditures*** and reduced ***Prelaunch Product Development Expenditure Rate*** by the same amount. In this scenario, the firms focuses on the factors that contribute to customer experience that are not driven by technology or by the perception of technology that can be addressed by marketing or word of mouth. Reducing the switching costs has a significant positive effect on product adoption, as measured by a 27% increase in ***Accumulated Discounted Profits***. Investments towards reducing switching costs aim at meeting and anticipating the needs of the customer over time. "Switching costs shift competition away from what we normally think of as the default (a single consumer's needs in a single period) to something broader – a single

consumer's needs over time" (Farrell and Klemperer 2007). Attributes such as usability, simplicity of use, carefully designed and reliable customer service provide the assurance to the customer that the new product is worth incurring switching costs. The impact of re-allocating 0.5 million from research and development to the reduction of switching costs is positive because the product is adopted faster by a broader set of customers.

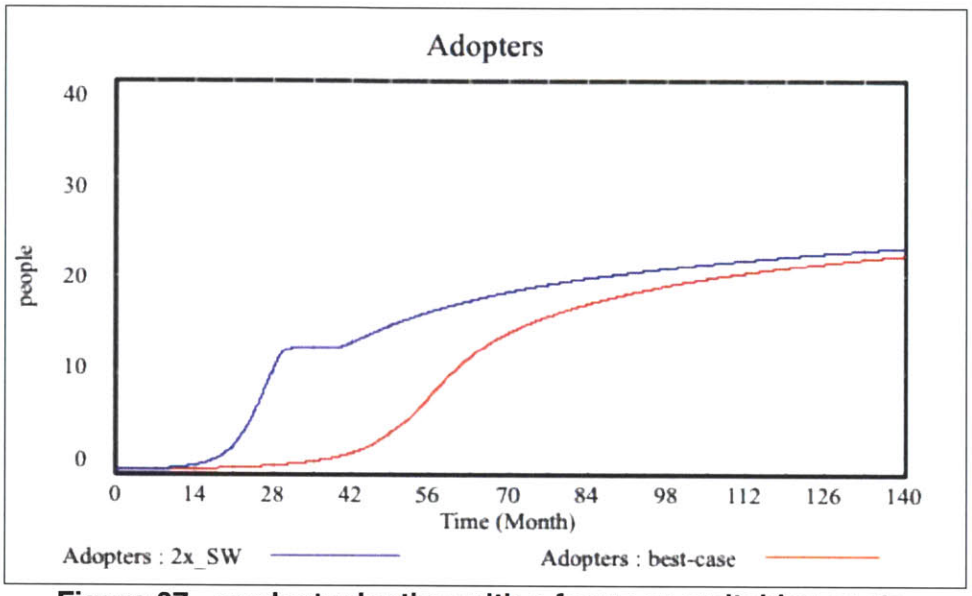

Figure 37 - product adoption with a focus on switching costs

Technology firms tend to underestimate these switching costs. Instead of product design and development lifecycle process, technology firms should adopt a customer experience design approach. There are many frameworks to do so, we particularly like the human-centered design approach developed by the design firm, IDEO shown on Figure 38 (IDEO 2010). The components of the human-centered design approach are desirability, feasibility and viability. Feasibility refers to what is technically and organizationally feasible. Viability refers to financial viability. Desirability - what customer desire - may seem more applicable in the consumer space but it is important design consideration in the enterprise or business-to-business space. Enterprise customers desire a trusted relationship with the enterprise product provider. They desire better business performance by adopting the enterprise product even though the definition of "better" is subjective and driven

by competitive forces and past experience. There are many non-technical and financial elements to a winning enterprise product design that fit in the category of desirability and ultimately differentiate a winning product from a failing one.

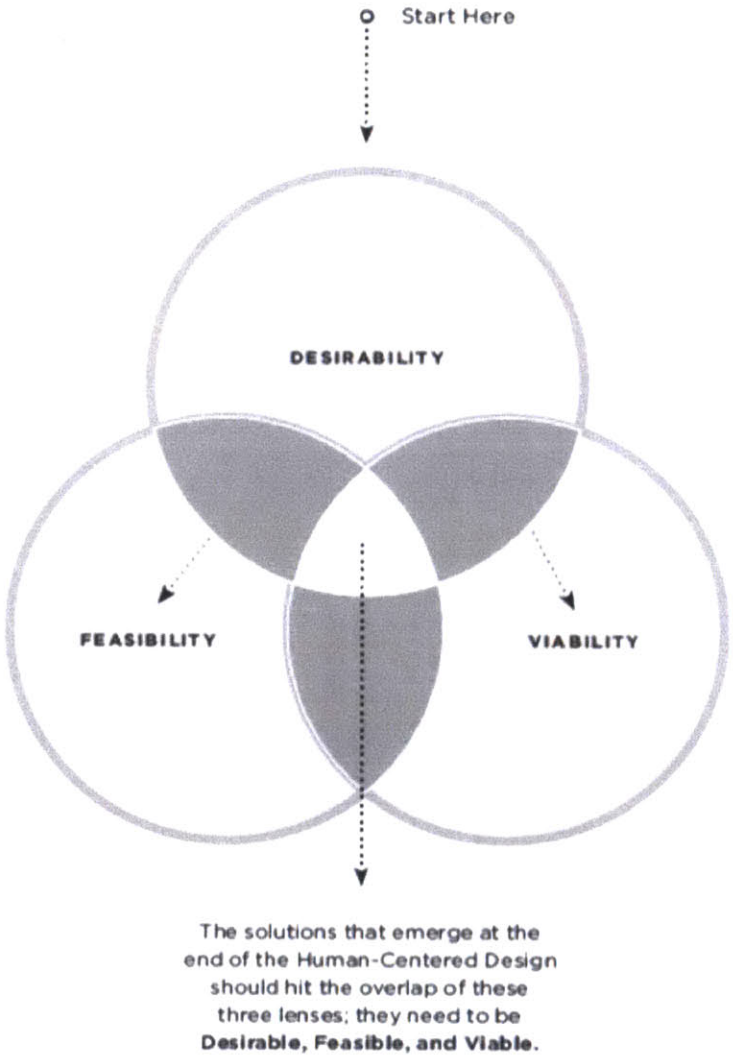

Figure 38 - IDEO's human-centered design model

The desirability lens is relevant for all markets including in the enterprise IT market. Cloud computing lead architects at firm T and a leading US telecom provider are confident that their public cloud computing services were secure and reliable. Yet interviews with potential enterprise customers confirmed that security and reliability were barriers to adoption for public cloud computing. There is a gap between the real

and perceived risks of the new technology from the enterprise customer's perspective. To succeed, desirability should be addressed as suggested by the IDEO model. A tacit requirement for the adoption of new technology is reducing switching costs that are neither financial nor solely addressed by technological improvement. For cloud computing, there are many switching costs that are perceived by customers and cannot be addressed by technological innovation alone.

6.2.3. Scenario: Building up capabilities prior to product launch

We ran a scenario where product launch was delayed by 24 months in order to build up the benefit of the new technology, develop capabilities to reduce switching costs and learn from the early sales. This scenario resulted in a 15% increase of ***Accumulated Discounted Profits***. There were more adopters sooner.

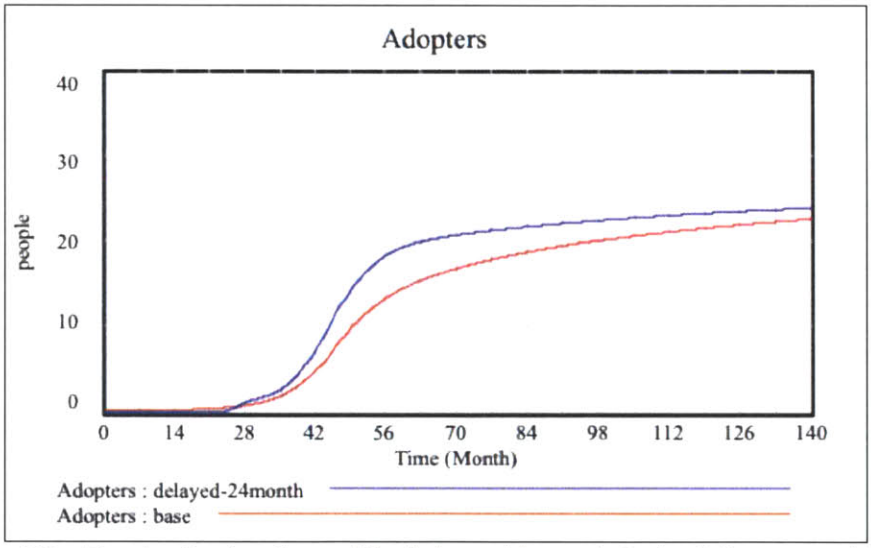

Figure 39 - Product adoption with delayed launch to build up capabilities

The ***Customer Perceived Incremental Benefit*** is significantly higher with the delayed product launch. A carefully planned albeit delayed product launch is preferred when the firm can build up the capabilities to design and deliver a better customer experience. An interesting example in the consumer space is the entry of Apple in the cloud computing business. As of April 2011, Apple was building large data centers to support the delivery of a new set of cloud computing products, including personal cloud storage solutions and a cloud-based online WebTV and

music service (Poeter 2011). Apple will be a late entrant in this space, yet it is expected that when Apple launches its cloud-based services it will be able to attract a large customer base. We argue that one of Apple's keys to success is that it continues to choose a go-to market strategy that favors getting customer experience right rather than getting to market first at all costs.

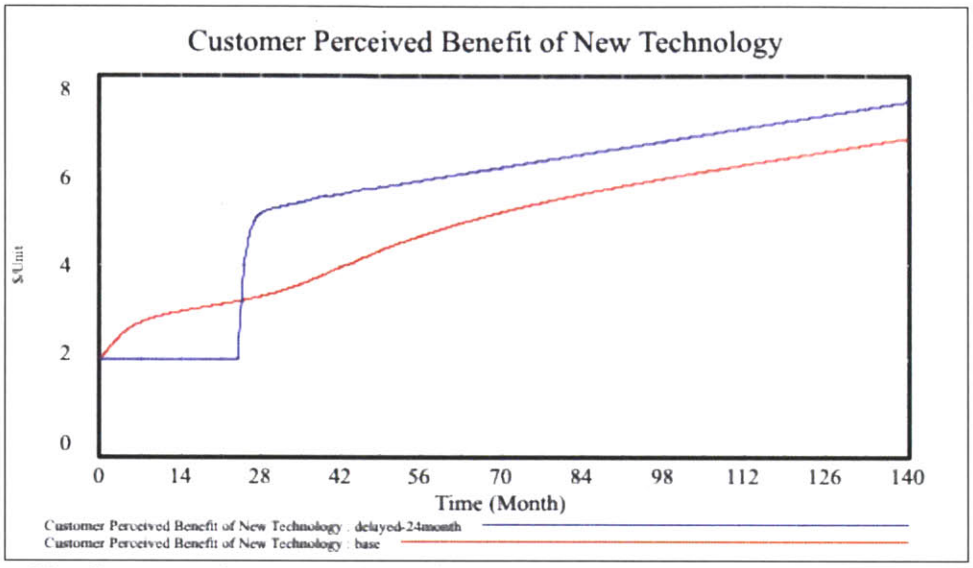

Figure 40 - Customer's perception of new technology as impacted by a delayed product launch

This research project started in 2009 and was completed in 2011. During this period, we collected opinions of senior executives from global telecom, information technology and consulting firms on cloud computing. We interviewed technology and innovation executives at conferences by Microsoft Innovation Outreach Program, MIT's Communications Future Program and MIT Center for Information System Research. We also interviewed executives at Firm A that are considering IaaS on their technology roadmaps both as vendor and consumer.

Enterprise customers understand and want to capture the value both in cost savings and opportunity for innovation that cloud computing promises to deliver. A constant theme through these two years is the appeal but significant barriers to adoption for enterprise-wide deployment of IaaS cloud computing. Data privacy is cited as one of the barriers to adoption for enterprise customers.

We describe in this section the implications of privacy for firm T as it enters into the cloud computing business. To address the concerns of enterprise customers, a

technology solution to privacy would be far from being sufficient and would continue to prevent the mainstream adoption of cloud computing by enterprise customers.

Our system dynamics modeling results suggest that two high leverages points around reduction of switching costs and organization learning need to be considered in addition to the delivery of an adequate technological solution to the data privacy problem. In the context of data privacy, switching costs might include the uncertainty of a rapidly changing global regulatory landscape, and the paradox of disclosure to end users on the topic of privacy -- that is by raising awareness about privacy in an effort to market it to your customers you trigger a wariness in your customers.

Today's consumers, especially younger consumers (the "Millenials"), seem willing to forego privacy in return for free/low cost products and services that are easier to use. However, following recent high profile missteps, there is an increasing awareness of products that capture and leverage an individual's online behavior. A rising tide of public awareness is driving companies', industry and government responses. However, business model experiments continue to further erode privacy while existing regulations and consumer education are lagging further and further behind.

"Consumerization" of IT blurs the boundaries between the consumer and the enterprise space. There are several drivers of consumerization: Millennials that enter the workforce and want to bring their consumer products into the workplace; better connectivity facilitating working from home; and, enterprise customers that are excited about taking advantage of low-cost, large scale consumer applications. However, counter to this shift, companies are required to respond to legislation and develop new policies to better protect the privacy of the individual and of their customers' data. As a consequence, companies that are excited about taking advantages of consumer applications that leverage behavior have increasing concerns about their privacy and security implications.

These concerns are focused around several areas: types of data and location, and data ownership and lifecycle. B2B customers cannot tolerate data location ambiguity. Cultural differences in privacy expectations and requirements have led to an extremely heterogeneous global regulatory landscape. Thus, privacy requirements in

contracts with global companies have become extremely complex. Lastly, behavioral data collected by consumer products has no defined owner and lifecycle and may be resold and aggregated in ways not foreseen by the user. These issues may prove to be an insurmountable barrier to adoption for consumer software for B2B use.

7. Cloud computing

7.1. Cloud computing overview

Cloud computing transforms the delivery of information technology into a subscription service. Instead of buying servers, installing software on them, and taking on the cost and risk of maintaining both of these, companies have access to a shared pool of computing resources over the Internet. Cloud computing is split into three layers (Mell and Grance 2009).

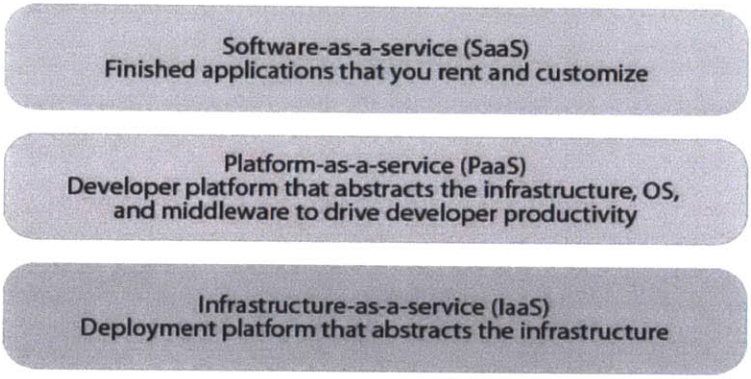

Figure 41 - Three type of cloud computing products (Source: Forrester Research)

As shown on Figure 43, IaaS will hit its peak early and then commoditize quickly (Ried and Kisker). The limited growth of public IaaS cloud can be explained in part by concerns about technical performance but primarily by the relatively high switching costs of enterprise customers. Enterprise customers cannot bear the risks of not owning their IT infrastructure while managing a complex global regulatory landscape.

Despite a growing interest from large enterprise, the adoption rate of public cloud solutions remains limited. The primary limiting factor is the lack of clarity around such topics as security, privacy, compliance, and accountability. Other factors include the

ability to adopt a new type of IT architecture and to migrate legacy products to products that can be run on a cloud infrastructure.

The decision to relinquish the control and visibility afforded by on-premise self-managed IT in order to adopt IaaS cloud computing must to go hand-in-hand with a major governance initiative by the early adopters: the majority of companies are waiting for some clarity to emerge around the notion of cloud governance. To address this significant switching cost, firm T is collaborating with key opinion leaders and cloud governance experts to lead the way in understanding and addressing governance issue. However, this pain point is recognized by most if not all cloud computing IaaS providers and does not constitute a significant differentiator.

The economics of IaaS cloud computing complicate further the decision to adopt public IaaS cloud: large enterprises are better off owning their IT infrastructure. Furthermore, the time scale of the cost savings has an impact on the cost benefits of IaaS. Figure 42 shows that hosting a website on the public cloud is not cost effective after 12 month.

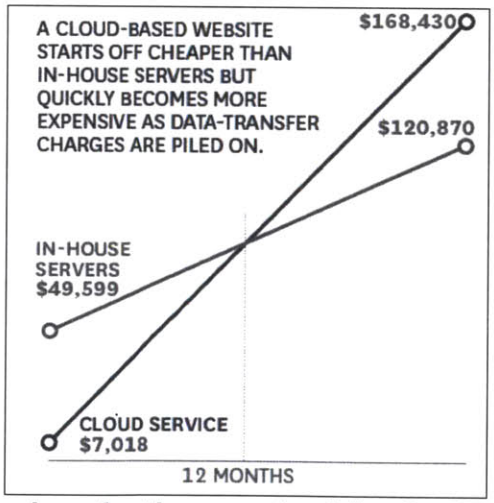

Figure 42 – Cost comparison for the use of public cloud vs. of in-house servers (Harvard Business Review 2010)

SaaS represents the largest and most sustainable growth opportunity. The SaaS market today represents the largest public cloud market by far, with $21.2 billion in total revenues in 2011 as shown in Figure 43. SaaS will grow significantly over the next five years driven by demand from companies from all sizes. Adoption of SaaS is

aided by the limitations of the incumbent ownership model of enterprise software. A pay-per-use model is more cost effective than deploying individual licenses that are difficult to upgrade, maintain and obsolete. Furthermore, SaaS providers can push updates to customers and therefore manage the quality of the product remotely.

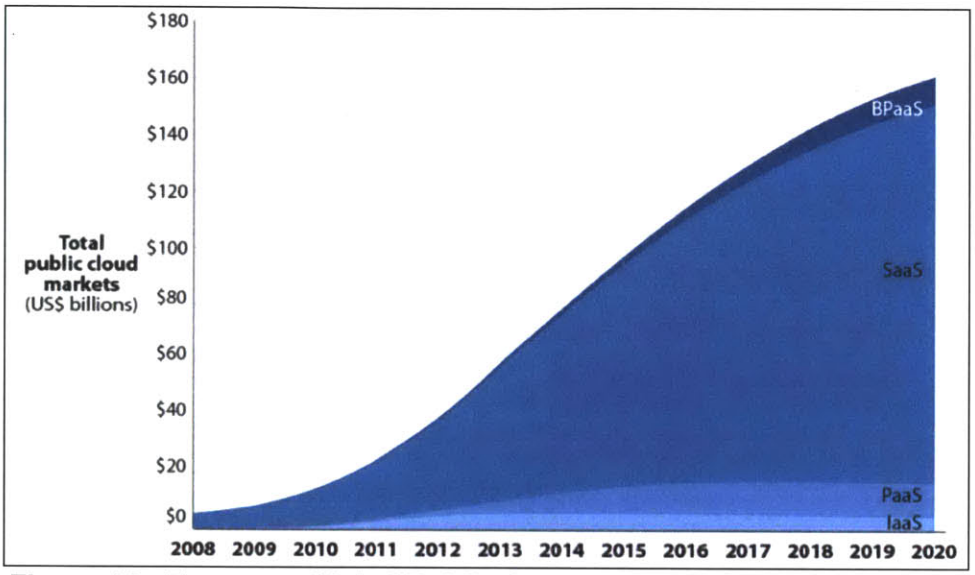

Figure 43 - Forecast: Global Public Cloud Market Size, 2011 To 2020 (Ried and Kisker)

7.2. The promise of cloud is met by unaddressed customer concerns

This research project started in 2009 and was completed in 2011. During this period, we collected opinions of senior executives about infrastructure-as-a-service (IaaS) cloud computing. These senior executives are from firms selling or considering purchasing IaaS. We even reviewed the position of firms that have IaaS on their technology roadmaps both as vendor and consumer. A constant theme is the barriers to adoption that continue to remain high in 2011. Security and privacy are often cited as the main barrier to adoption for enterprise customers. Enterprise customers understand and want to capture the value both in cost savings and opportunity for innovation that cloud computing promises to deliver. However, concerns around security and privacy are increasing and worsened by several factors.

Privacy is one of the barriers to adoption for cloud computing – the new business area considered for entry by firm T. A combination of primary and secondary research augmented the learning from the system dynamics modeling. We describe in this section the implications of privacy for firm T as it enters into the cloud computing business. To address the concerns of customers, a technology solution alone would be far from sufficient and would continue to hinder the mainstream adoption of cloud computing. The system dynamics modeling results suggest that two high leverages points around reduction of switching costs and organization learning need to be considered in addition to the delivery of a technological solution. In the context of data privacy, switching costs might include the uncertainty of a rapidly changing global regulatory landscape, and the paradox of disclosure to end users on the topic of privacy.

8. A case study for Firm T to enter cloud computing

8.1. Insights from the system dynamic model applied to Firm T

We reported in section 2.2 that firm T's leadership does not agree on its position on the familiarity matrix. This lack of consensus translates in a sub-optimal market entry strategy. The system dynamics model and scenario analysis in chapters 0, 5 and 6 provided important insights for firm T as it enters the cloud computing business. In this section, we shall use the short hand of cloud computing to describe infrastructure-as-a-service cloud computing. Our primary and secondary research revealed that firm T invested significantly in developing and demonstrating a better technical cloud computing solution.

While investments in R&D is necessary, the barriers to adoption for cloud computing need to be addressed with a balanced approach to investments in R&D, marketing and managing customer experience. Firm T's customers do not trust cloud computing and firm T as a preferred IT provider and not only a telecom provider. Therefore, firm T must invest in building the capabilities to reduce its customers current high switching costs. Firm T must improve customers' perception of cloud computing as a viable and readily deployable solution. Firm T need to design a cloud migration plan and service-level agreements that positions Firm T's as a trusted

partner. Firm T can leverage the use case of having completed a significant internal migration to cloud computing. To do so, firm T must be able to translate the internal migration use case into a compelling value proposition for its customers.

Another important insight from our model is the importance of learning from customers. All investments made by firm T to support its entry into the cloud computing business are more effective when firm T improves its ability to learn from customers. Trust and reputation are important dynamic capabilities in the cloud computing space. Understanding and addressing the customers' switching costs means that firm T aspires to transition from a product company to a customer experience company. In the remainder of this chapter, we deliver an example of how to start this transition.

8.2. The "learn more/serve better" model

In this chapter 8, we deliver a set of recommendations to the consumer division of firm T as part of a semester-long case study in the context of a MBA course "Economics of Information" in the fall of 2009. This case illustrates how Firm T can apply the "learn more/serve better" model (Weil and Endicott Weil 1999) to transition from a product company to a customer experience company.

Figure 44 – The learn more/serve better model

"Growing satisfaction and trust leads the customer to be more open regarding values and needs, and more willing to empower the service provider. The empowerment is critical" (Weil and Endicott Weil 1999)

We present here an opportunity for cross-selling when Firm T effectively manages and delivers good customer experience. This business case supports the thesis that the analogy of cloud computing to electricity is limited (Brynjolfsson, Hofmann et al.

2010). While computing is increasingly cheaper and the pay-per-use delivery model offers attractive cost-saving opportunities, adoption of cloud computing, specifically infrastructure-as-a-service must be viewed as an opportunity for innovation.

"The real strength of cloud computing is that it is a catalyst for more innovation. In fact, as cloud computing continues to become cheaper and more ubiquitous, the opportunities for combinatorial innovation will only grow" (Brynjolfsson, Hofmann et al. 2010).

We propose here a service innovation that is enabled by cloud computing and built on existing capabilities of Firm T. A cross-selling and bundling strategy can deepen firm T's relationship with its customers and mitigate the commoditization of its primary telecom product offering that experiences strong competition.

8.3. Bundling Cloud Computing and Broadband

To enter the cloud computing market, Firm T can bundle online backup and recovery services, an infrastructure cloud computing offering, with broadband for the Small and Medium Businesses (SMBs). Firm T already has a dominant position in broadband, data centers, and corporate network/software services throughout the United Kingdom. As Firm T searches for an entry point into cloud computing, it should leverage these existing assets and look for innovation in technology and pricing to sustain a leading position as a cloud service provider. SMBs in the UK are interested in a "one stop shop experience" (Microsoft 2009) for their IT needs and seek cost savings provided by cloud services.

Online backup and recovery represent an appealing market, and a way to introduce cloud services to SMBs. Since SMBs already trust Firm T to deliver broadband connectivity, trusting Firm T to deliver cloud-based services such as backup and recovery is a relatively small progression. A next step would be to augment the bundle to include software as a service and develop technological innovation to integrate cloud and communication services. In addition, the SMBs space can provide rapid feedback to help increase the ***Learning Per Sale*** thereby providing a good starting point for Firm T to develop the capacity to run business experiments that can increase its ability to design and deliver an improved customer experience.

"Cloud computing is on-demand access to virtualized IT resources that are housed outside of your own data center, shared by others, simple to use, paid for via subscription, and accessed over the Web" (Brynjolfsson, Hofmann et al. 2010)

Instead of buying servers, installing software on them, and taking on the cost and risk of maintaining both of these, companies have access to a shared pool of computing resources over the Internet. As discussed in Section 7, cloud computing is typically split into three layers. Software as a Service (SaaS) is the renting of finished applications over the Internet. Platform as a Service (PaaS) refers to cloud-based tools that facilitate building, deploying, and maintaining software in the cloud. Infrastructure as a Service (IaaS) is data center facilities for rent.

8.3.1. Infrastructure as a Service (IaaS)

Infrastructure as a Service (IaaS) is the delivery of computer infrastructure as a service. It is an evolution of web hosting and virtual private server offering. Clients can consume computing resources, such as storage and processing capacity, as a fully outsourced service. Virtualization allows for elastic allocation and provision of those resources over the network. In principle, IaaS provides a generic runtime environment with 'real' resources, not restricting the type of application. Hence user lock-in is limited. An example of an IaaS-type platform is Amazon Web Services (AWS).

8.3.2. Platform as a Service (PaaS)

Platform as a Service (PaaS) is the delivery of a computing platform and solution stack as a service. It moves the level of abstraction a layer higher as computing resources are not directly exposed. PaaS provides software systems typically including various developer tools. PaaS provides features such as application serving and database management. An example of an PaaS is Google App Engine.

8.3.3. Software as a Service (SaaS)

Software as a Service (SaaS) is a delivery model where applications are delivered to the end user over-the internet rather than as on-premise software. SaaS is the fastest growing segment of cloud computing as shown in Figure 43. Firm T does not

have capabilities in SaaS but can partner with SaaS vendors if it chooses to pursue a one-stop-shop strategy.

8.3.4. Value of cloud computing for firm T

Firm T's core industry, telecommunications, is characterized by pricing competition, government regulation, falling margins, and slowing revenue growth. As a result telecoms companies are all looking for sources of growth and higher margins. The cloud computing industry has appealed to large telecom service providers because of the similarities in the large capital expenditures and maintenance of infrastructure. The cloud computing industry has been growing rapidly as new customers warm to the idea of moving to the cloud, and as such the industry is becoming increasingly crowded with new competitors. Furthermore, as one industry analyst predicts, IaaS will be commoditized as the technology matures and adequate standards, service level agreements and governance emerge (Interview with analyst at Current Analysis).

Firm T launched an infrastructure cloud service as have other telecom companies worldwide as an approach to leverage its network and data centers assets. In addition, it has recently partnered with SaaS vendors (source: Firm T website). There is an internal concern that is shared with industry analysts that a pure infrastructure play does not provide a competitive advantage. Interview with analysts from Current Analysis and Gartner confirmed that commoditization is inevitable as the short-term competitive advantage is a result of the immaturity of cloud technology and governance. Long term there is a hypothesis that value is going to be captured by SaaS players. If this hypothesis is true, there is an imperative to be well positioned in the SaaS space. However, to leverage SaaS innovation and differentiate its cloud product from existing SaaS players, Firm T cannot compete on the same grounds.

We suggest that Firm T should focus on customer experience and map a journey towards a complete business solution (Integrated cloud and communication services) for the SMB customer. This case study describes the initial steps in this journey.

8.4. Options Considered as Market Entry Strategy

We recommend that Firm T bundle online backup and recovery services with broadband and target SMBs. This approach leverages Firm T's existing data centers, broadband lines, and deep market penetration, into cloud computing. SMBs need the value that Infrastructure as a Service (IaaS) provides, in the least intrusive/disruptive way.

We considered entering cloud computing by offering a Platform as a Service. This is an attractive market that is on the verge of changing the way software is written. There were a couple of issues that led us away from PaaS. First, there are three software giants already investing enormous amounts of money in PaaS: Amazon, Google, and Microsoft. These competitors alone may be enough to shy away from this option as they represent vast resources focused on providing PaaS solutions. They each see PaaS as core to their business, and will likely invest enough to drive anyone else out. Second, Firm T does not have software creation competency. Coming up with a PaaS solution would mean acquisitions, and then dependence on Firm T's ability to build a competency around PaaS. While this can be done, there are many companies that already have this competency. One interview with a US Telecom Cloud provider highlighted that there is no clear business model around PaaS and that entry into a specific PaaS market is highly dependent on the driving SaaS offering. Consequently, it appears that PaaS entry requires a SaaS partner.

Software as a Service (SaaS) was another option that was considered. SaaS is attractive because it has the highest margins of any other space within cloud computing. We think that Firm T should think about building internal competency in SaaS over the next decade, but we do not think that they should try to enter cloud computing here. Rather Firm T should look at SaaS as an opportunity for creating a complete solution as a service for the SMB market. By partnering with SaaS vendors and reselling SaaS as part of a bundle, Firm T can increase the stickiness of its IaaS and communication offering for the SMB market. Furthermore by partnering with SaaS vendors, it can develop options to buy into the innovation via acquisitions.

8.5. Customer target segment choice: Small Medium Businesses

From the perspective of the target market, SMBs were chosen as the focus over large corporations. This is because SMBs represent a significant growth opportunity. Cloud computing is always touted as a way for SMBs to compete with large corporations for customers. But for a few reasons, it hasn't penetrated SMBs as quickly as analysts had expected. They are concerned about security and privacy, and they don't have a lot of time to look into cloud computing. SMBs were chosen because the potential value they can gain and because Firm T already has strong relationships with a large portion of SMBs through its broadband and software reselling services. Under our recommendation to sell online backup services, Firm T sales representatives, who already have relationships with SMBs, would sell a service that is a very logical extension to broadband and resold software. By easing this customer segment into cloud computing services, Firm T can invest time and effort into learning more about the customer experience for this segment and parlay that into better service offerings.

8.5.1. Small and Medium Businesses (SMBs) are an attractive segment

"Market research firm IDC expects the overall IT market to grow by just 0.5 percent worldwide, while the SMB packaged software market is expected to grow by 6.7 percent, more than 10 times the rate of the overall IT market" (Microsoft 2009). In addition, SMBs currently represent 30 percent of Firm T's retail sales. Firm T knows this market well and has the channel expertise to upsell these customers.

8.5.2. SMBs Relying on Suppliers to Assist With Cost Reduction

The economic crisis magnified companies' interest in cost reductions. SMBs look to their suppliers to help reduce the cost of IT. In addition, SMBs are also interested in their IT partner in the following ways: providing a one-stop experience for hardware, software and services (15%), providing more remote management (15%) and providing greater integrated consulting services (13%) (Microsoft 2009). These findings are consistent with the growing interest in virtualization.

Changing Role	Overall	US	Canada	UK	France	Brazil
Customers look to us for assistance with cost reducti o	27.3%	26.6%	31.5%	23.3%	20.4%	38.1%
Demand for "one-stop" experience for hardware, soft ware and service	14.8%	13.5%	20.4%	26.0%	12.4%	10.6%
More remote management	14.4%	15.1%	20.4%	11.0%	16.8%	12.4%
Greater need for integrated consulti ng	13.1%	12.0%	5.6%	5.5%	21.9%	13.3%
Anti cipate less on premise work with ou customers	8.6%	16.2%	3.7%	12.3%	2.2%	3.5%
They will use us more for strategic planning	6.3%	4.7%	9.3%	4.1%	6.6%	8.9%
Higher need for fi nancing and licensin deals	5.3%	4.7%	5.6%	5.5%	1.5%	9.7%
Greater demand for hosted business applicati on	2.9%	1.6%	3.7%	4.1%	4.4%	–
No change	5.3%	2.6%	–	5.5%	11.0%	2.7%
Other	2.1%	3.1%	–	2.7%	2.9%	0.9%
No. of Respondents = ( )	(620)	(192)	(54)	(73)	(137)	(113)

Figure 45 - Changing Role of IT for SMBs (Microsoft 2009)

8.5.3. SMBs want a one-stop experience

In the UK, the demand for the "one stop" experience is the highest. This demand represents a good opportunity for a leading Telecom provider like Firm T to extend the "one stop" experience beyond IT needs and include telecommunications services in one package. In addition, their needs are well-matched by cloud offerings. These needs are generally related to connectivity, with nearly 40% of SMBs citing coordination with outside vendors, clients, and suppliers as a large IT challenge. These needs also include the challenge of matching applications between different workers, in an environment that may not be supported by IT professionals. With cloud offerings, all employees would have continuously updated versions of software, eliminating compatibility problems.

Finally, SMBs note that they struggle with version control for key documents. Cloud offerings could later be bundled with collaboration and web-based productivity tools to move from a system of e-mailing word processed documents from one hard drive to another to a wiki-based system in which teams work on one document in real-time.

SMBs are wary of cloud services, but stand to benefit greatly from their added value. There are many perceived risks with the adoption of cloud computing products:

- Security and privacy
- Reluctance of VARs and consultants serving SMB IT market to introduce cloud offerings
- Vendor risk and the proliferation of cloud computing vendors from established players from adjacent industries, such as Firm T, to new players such as Dropbox
- Technology obsolescence, compatibility and migration risks

8.5.4. Opportunity to deliver an improved customer experience

However, these concerns also represent opportunities for Firm T to differentiate its value proposition by recognizing and addressing the perceived barriers to adoption by the SMB customer.

Firm T delivers reliable Telecom services to SMBs and can emphasize its commitment to guarantee quality of service. Firm T has also developed pricing strategies for Telecom products that are familiar to its customers: Multiplay offers that combine phone, broadband and TV services are examples of bundling that can be adapted to the SMB market and to the delivery of cloud services.

Because the benefits of cloud services offered by a stable, well-know provider address the concerns noted by SMBs, Firm T has an opportunity to build on its asset base of infrastructure, brand name, and sales channel knowledge to increase its revenues from the SMB segment by selling cloud services.

8.6. Bundling

"Innovative packaging and marketing structures can stimulate demand. For example, bundling services (i.e. cross-selling) is a means through which integrated telecommunication companies can leverage their subscriber base and boost overall use" (IbisWorld Report, 2009)

For bundling to be a viable solution to a pricing problem, four conditions must be met:

1. The goods to be bundled must be complementary. That is, use of one must increase sales of the other. It is easy to see this relationship between broadband and, say, premium channels: without the former, one cannot access the latter. In turn, the presence of the latter makes the former more valuable. In this case, broadband use speaks to a business' reliance on accessing and using large quantities of data. Even non-technical businesses generate a great deal of IP in the form of proprietary manuals, partnership agreements, customer lists and analyses of those customers, and so on. More data means more need for storage and backup.
2. There must be significant transaction costs. For SMBs to buy most IT products, from PCs to software to services, transaction costs are high. Search costs for the best combination of price and quality are non-trivial, since even non-cloud software offerings are regularly packaged with services for install, data migration and upgrades. SMBs often do not have the IT savvy to choose easily, and they also have trouble policing the agreements to ensure that their resellers are providing, say, the compatibility promised between various productivity, accounting, voice mail, and network software.
3. There must be a low marginal cost to one or both bundled products. With broadband and storage, we meet this criterion easily.
4. The seller must have some market power. Firm T holds over a quarter of the broadband market in the UK and is often in negotiations with EU regulators about its pricing power. While the firm is no longer as monopolistic as it once was, it does have market power.

Given that Firm T has experience with bundling services, it is worth exploring the benefits of this approach beyond communications services. Firm T can push the demand curve outward and change its shape by aggregating the demands of different types of customers, some of whom prefer broadband and others who prefer storage and backup services. They could even displace other online storage in some markets, especially in the UK, where they have a significant broadband presence, since bundles create a winner-takes-all scenario when more of the goods and

services desired are packaged together. Finally, they can solidify their own position and perhaps drive out smaller competitors who do not offer the same bundle. As a market entry strategy, bundling is perfectly matched to Firm T's situation.

8.7. Metrics for Success

We would measure Firm T's success in this effort in a few different ways, generally relating to sales, revenue, and profit:

- Relative market share in on-line storage and backup market
- Rate of taking share from other cloud computing service providers
- Revenue from bundle vs. broadband on its own
- Profitability of bundle
- Cost of customer acquisition, to monitor whether a profitable bundle is still hurting the bottom line. This could be the case if SMBs are still skittish and require a very long sales cycle to be convinced to use IaaS.

8.8. Costs and Benefits of Bundling IaaS and Storage for SMBs

For Firm T the upfront costs for IaaS are sunk costs because they have already invested in the infrastructure. This allows Firm T more flexibility in meeting potential pricing pressures. The benefits of IaaS and storage are potentially quite large. With the market growing 10%-20% annually there are plenty of opportunities for capturing new customers. Additionally upfront investments allow Firm T the opportunity to eventually pursue moving to higher margin cloud services such as SaaS. This would afford further bundling options and would increase the switching costs for customers who would increasingly turn to Firm T for all of their IT needs. It is for these reasons that we believe that Firm T should aggressively pursue building its position in cloud computing by bundling IaaS and storage for small- and medium-sized businesses.

9. Recommendations

"Competitive advantage is no longer about the economics of applications, software or hardware. In the modern era, it is the economics of data and networks of trust that determine winners and losers." (Newman 2011)

9.1. Limitations of classic frameworks

In chapter 2, we presented several strategy frameworks that were incorporated into a system dynamic model. Classic frameworks such as Porter's five forces are static. They do not address the effects of "bounded rationality, imperfect information, and fragmentation of decision making" (Weil 2009). We describe here some of the limitations of the classic frameworks.

The digital economy represents an acceleration of the pace of competition and a static and linear view of competitive advantage is therefore limiting and inadequate for survival. Other frameworks identify the rise of competition from adjacent or radically different industries (Munir and Phillips 2002), (Teece, Pisano et al. 1997). By developing a dynamic firm-level model, we walked away from an industry level view of competition.

Gourville focuses on the firm and its customers. His framework captures perceptions biases of new products by customers and the firm. Gourville's framework does not address market heterogeneity as captured by the normal distribution of switching costs in our model, nor the positive effect on profits of effectively learning from customers over time as product adoption increases. Learning from customers is an important and effective mechanism for closing the perception gaps identified by Gourvillle. Building dynamic capabilities to conduct business experiments, continuously acquiring and refining better customer understanding, and disseminating learnings across the organization increases the firm's chance to overcome the "9x effect".

While each framework described in chapter 2 provides insight, separately they only partially address the important decisions of whether to launch and how to launch. We combined critical aspects of each of these frameworks into a more inclusive, cohesive and dynamic model.

9.2. Summary of finding from the model

A system dynamics model was described in chapter 0 and provided the basis for scenario building to understand high leverage points when introducing a new

information technology product to market. A firm has limited resources and must constantly ask itself where it makes the most sense to invest its next dollar. Our system dynamic model shows that the answer to this question changes over time based on previous investment decisions and that focusing exclusively on any one area leaves significant value on the table.

Technology firms have a strong bias towards over-estimating their market familiarity and towards over-estimating the benefit of the new technology. Enterprise customers will not widely adopt a public infrastructure-as-a-service cloud computing unless there is a compelling reason to make the switch – a 10 times better solution (Gourville 2006) and they can trust the technology and the technology provider. To succeed, firm T needs to go-to-market with a cloud solution that is not only technically performing but also matched to customers "desire" (IDEO 2010). Firm T needs to transition from a product company to a customer experience company. We identified that investing in improving customer experience is necessary to succeed for technology firms. Technologists tend to underestimate the implications of customers' switching costs and perception of the benefit of a new technology.

In chapter 3, we defined customer experience as the customer's perception of the benefit of the new technology and her average switching costs. Investments towards reducing switching costs aim at meeting and anticipating the needs of the customer over time. Such investments imply building new capabilities to reduce switching costs: new type of work force, new model of customer engagement and adaptive business models that leverage past business experiments.

9.3. Firm T's entry into cloud computing

In chapter 8, we explored a possible mechanism to deliver better customer experience to customers who are considering adopting cloud-computing solutions. The bundling strategy described in chapter 8 assumes that firm T has established trust and can successfully manage the customer experience. This strategy attempted to respond to the desire of SBM customers to have a one-stop shop experience for IT. This strategy also provides firm T an opportunity to learn from SMB customers and gradually build trust as a cloud computing and telecom provider. There are

important organizational learning opportunities with SMB customers that may be helpful in supporting firm T's enterprise division.

In the enterprise space, there are still significant technical barriers to adoption of cloud computing such as latency, limits of scale and security (Brynjolfsson, Hofmann et al. 2010). There are also non-technical barriers to adoption such as the need to control IT assets, to be compliant with rapidly evolving global regulations and with end-users requirements for data privacy.

To better understand what is an acceptable level of performance and the associated trade-offs, firm T should identify early adopting enterprise customers with whom to establish a learning partnership. Firm T should invest in understanding the perceived benefit of cloud computing from the customer's point of view and the real switching costs.

To be successful, firm T must invest in acquiring the capabilities to design and deliver a customer experience that meets the demand of enterprise customers by using early success and failures to learn and improve the offering. As such, focusing on small initiatives to gain market knowledge and understanding would offer firm T the ability to become familiar with the cloud computing space and to experiment to find the best offering.

10. Appendix: Documentation of the system dynamics model

10.1. System dynamics model – stock and flow diagrams

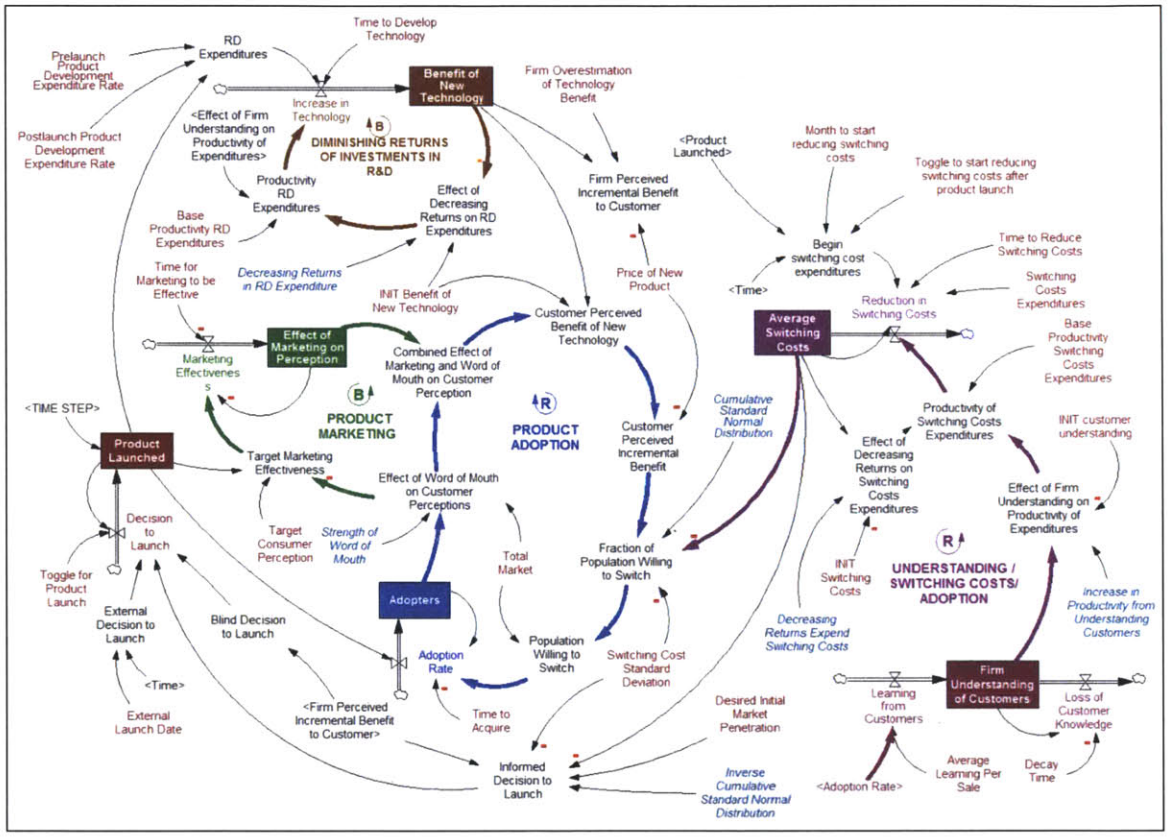

Figure 46 - Product Development, Marketing, Strategy, and Adoption Loops

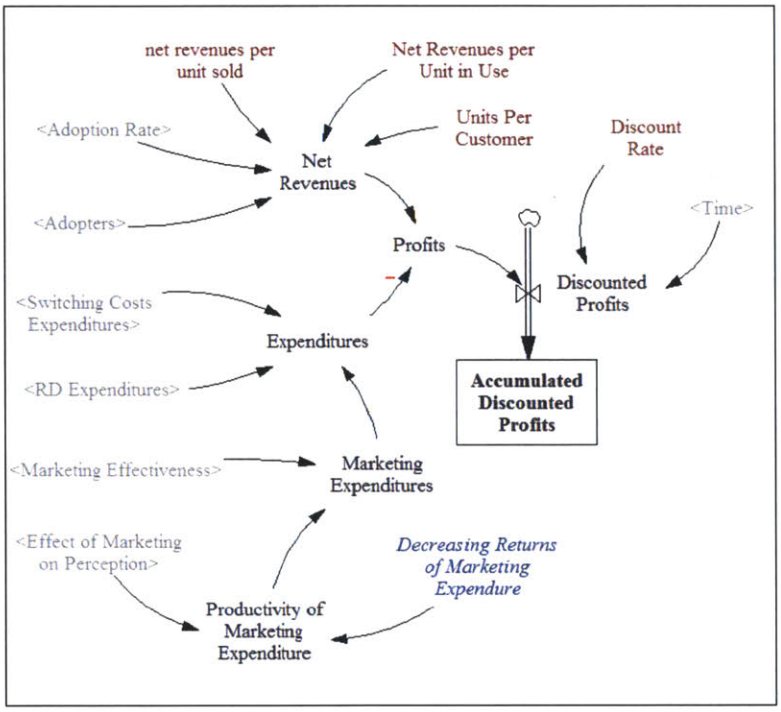

Figure 47 - System dynamics model - Financial metrics

10.2. Description of the elements of the system dynamic model

NAME	DESCRIPTION	EQUATION AND NOTES
STOCKS		
Accumulated Discounted Profits	Total discounted profits for the technology firm from the sales of a technology product	INTEG (Discounted Profits) Initial Value = 0
Adopters	The total quantity of users of a launched product.	INTEG (Adoption Rate) Initial Value = 0
Average Switching Cost	The required effort required by a consumer to adopt the new technology	INTEG (- Reduction in Switching Cost) Initial Value = INIT Switching Cost
Benefit of New Technology	The accumulated technical	INTEG (Increase in Technology)

	benefit of a new technology compared to incumbents	Initial Value = INIT Benefit of New Technology
Effect of Marketing on Perception	The accumulated ability of the firm's marketing activity to influence customer perception	INTEG (Increase in Marketing Effectiveness) Initial Value = 0
Firm Understanding of Customers	The firm's accumulated organizational knowledge of the drivers of customer adoption.	Learning from Customers - Loss of Customer Knowledge Initial Value = INIT Customer Understanding
Product Launched	Binary trigger indicating the release of a new technology product to the market	Decision to Launch / TIME STEP Initial Value = 0

NAME	**DESCRIPTION**	**EQUATION AND NOTES**
FLOWS		
Adoption Rate	The rate at which customers acquire the new technology product.	MAX (0, Prod Launched * ((Population Willing to Switch - Adopters) / Time to Acquire))
Decision to Launch	Rate at which the Product is released to the Market	IF THEN ELSE (Prod Launched = 0, IF THEN ELSE (Toggle for product launch = 1, External decision to launch , IF THEN ELSE (Toggle for product launch = 2, informed decision to launch , blind decision to launch)) , 0)
Discounted Profits	Rate of accumulation of	EXP (- Discount Rate * Time) * Profits

	discounted profits	
Marketing Effectiveness	Rate at which marketing activities add to an effect on customer perception	(Target Marketing Effectiveness - Effect of Marketing on Perception) / Time for Marketing to be Effective
Increase in Technology	Rate at which R&D activities add to the benefits of a new technology	DELAY3 (RD Expenditures * Productivity RD Expenditures , Time to Develop Technology)
Learning from Customers	Rate at which the firm's product development team learns from their customers	Average Learning Per Sale * Adoption Rate
Loss of Customer Knowledge	Rate at which the firm's knowledge of customer needs is lost	Firm Understanding of Customers / Decay Time
Reduction in Switching Cost	Rate at which the Average Switching Cost for a new technology product is reduced	IF THEN ELSE (Average Switching Cost > 0, IF THEN ELSE (Begin switching cost expenditures = 1, DELAY3 (Switching Cost Expenditures * Productivity of Switching Cost Expenditures , Time to Reduce Switching Costs) , 0) , 0)

NAME	DESCRIPTION	EQUATION AND NOTES
ENDOGENOUS VARIABLES		
Begin Switching Cost Expenditures	Trigger to determine timing to begin reduction of new technology product switching costs	IF THEN ELSE (Toggle to start reducing switching cost after product launch = 1, IF THEN ELSE (Product Launched = 1, 1, 0) , IF THEN ELSE (Time >= Month to start reducing switching cost , 1, 0))
Blind Decision to Launch	Trigger to dictate product launch once the firm's perceives a benefit of the technology to the customer	IF THEN ELSE (Firm Perceived Incremental Benefit to Customer > 0, 1, 0)
Combined Effect of Marketing and Word of Mouth on Consumer Perception	Addition of the effectiveness of the firm's marketing campaigns and viral word of mouth marketing among customers.	MAX (0, MIN (1, Effect of Word of Mouth on Customer Perceptions + Effect of Marketing on Perception))
Customer Perceived Benefit of New Technology	The customer's perception of the gross benefit of the new technology compared to its incumbents.	INIT Benefit of New Technology + (Benefit of New Technology - INIT Benefit of New Technology) * Combined Effect of Marketing and Word of Mouth on Customer Perception
Customer Perceived Incremental Benefit	The customer's perception of the net benefit of the new technology compared to its incumbents.	MAX (Customer Perceived Benefit of New Technology - Price of New Product , 0)
Effect of Decreasing Returns on RD Expenditures	Net benefit of R&D efforts to future R&D efforts	Decreasing Returns in RD Expenditure (Benefit of New Technology / INIT Benefit of New Technology)

Effect of Firm Understanding on Productivity of Expenditures	Increase in firm productivity from its understanding of customer needs	Increase in Productivity from Understanding Customers (Firm Understanding of Customers / INIT customer understanding)
Effect of Returns on Switching Cost Expenditures	Impact of the current average switching cost on the productivity of switching cost expenditures	IF THEN ELSE (INIT Switching Cost = 0, 1, Decreasing Returns Expend Switching Costs (Average Switching Cost / INIT Switching Cost))
Effect of Word of Mouth on Customer Perceptions	The strength of word of mouth based on market penetration	Strength of Word of Mouth (Adopters / Total Market)
Expenditures	Total firm product development and marketing expenditures	Switching Cost Expenditures + Marketing Expenditures + RD Expenditures
External Decision to Launch	Toggle switch for product launch based on set time	IF THEN ELSE (Time >= External Launch Date , 1, 0)

NAME	DESCRIPTION	EQUATION AND NOTES
ENDOGENOUS VARIABLES (CONTINUED)		
Firm Perceived Incremental Benefit to Customer	Firm-centric view of the technology product benefit to the customer	Benefit of New Technology * Firm Overestimation of Technology Benefit - Price of New Product
Fraction of Population Willing to Switch	Percentage of total market who would accept the current benefits and switching costs of a new technology product	Cumulative Standard Normal Distribution ((Customer Perceived Incremental Benefit - Average Switching Cost) / Switching Cost Standard Deviation)
Informed Decision to Launch	Toggle switch for product launch based on the firm's perception of benefit to the customer, switching cost, and the customer adoption statistical distribution	IF THEN ELSE ((Firm Perceived Incremental Benefit to Customer - Switching Cost Standard Deviation * Inverse Cumulative Standard Normal Distribution (Desired Initial Market Penetration) - Average Switching Cost) > 0, 1, 0)
Marketing Expenditures	Firm's rate of expenditure towards product marketing	MAX (0, IF THEN ELSE (Productivity of Marketing Expenditure > 0.1, Marketing Effectiveness / Productivity of Marketing Expenditure , 0))
Net Revenues	Firm's net revenues for the technology product	Adoption Rate * Net Revenues per Unit Sold * Units Per Customer + Adopters * Net Revenues per Unit in Use * Units Per Customer
Population Willing to Switch	Total population willing to adopt the technology product	Total Market * Fraction of Population Willing to Switch
Productivity of Marketing		Decreasing Returns of Marketing Expendure (Effect of Marketing on

Expenditure	Perception)
Productivity of Switching Cost Expenditures	SMOOTH (Base Productivity Switching Cost Expenditures * Effect of Returns on Switching Cost Expenditures * Effect of Firm Understanding on Productivity of Expenditures , 3)
Productivity RD Expenditures	SMOOTH (Base Productivity RD Expenditures * Effect of Decreasing Returns on RD Expenditures * Effect of Firm Understanding on Productivity of Expenditures , 3)
Profits	Net Revenues - Expenditures
RD Expenditures	IF THEN ELSE (Product Launched = 0, Prelaunch Product Development Expenditures , Postlaunch Product Development Expenditures)
Target Marketing Effectiveness	IF THEN ELSE (Product Launched = 1, MAX (0, Target Customer Perception - Effect of Word of Mouth on Customer Perceptions) , 0)

NAME	**DESCRIPTION**
EXOGENOUS VARIABLES	
Average Learning per Sale	
Base Productivity RD Expenditures	
Base Productivity Switching Cost Expenditures	

Decay Time	
Desired Initial Market Penetration	
Discount Rate	
External Launch Date	
Firm Overestimation of Technology Benefit	A multiplier representing estimation of relative benefit of new technology compared to incumbents.
INIT Benefit of New Technology	
INIT Customer Understanding	
INIT Switching Cost	
Month to Start Reducing Switching Cost	
Net Revenues per Unit in Use	
Net Revenues per Unit Sold	
Prelaunch Product Development Expenditures	
Postlaunch Product Development Expenditures	
Price of New Product	The assigned unit price of the new technology product to the customer.
Switching Cost Expenditures	
Switching Cost Standard Deviation	This variable shows how far from the norm are the ealry adopters and the laggards.
Target Customer Perception	Value between 0-1. The target for marketing.
Time for Marketing to be Effective	Time for marketing campaign to effect customer perception
Time to Acquire	Time for a willing customer to adopt a product

Time to Develop Technology	Time to advance technology after resources expended
Time to Reduce Switching Costs	Time to reduce switching costs after resources expended
Toggle for Product Launch	Binary switch to indicate product launch
Toggle to Start Reducing Switching Cost After Product Launch	This variable enabl
Total Market	This is the size of the target market for the new product

TABLE FUNCTIONS

Cumulative Standard Normal Distribution	Statistical adopter distribution
Decreasing Returns in RD Expenditure	Benefit of R&D expenditure based on ratio of current and initial technology benefits
Decreasing Returns of Marketing Expenditure	
Increase in Productivity from Understanding Customers	Qualitatively describes the relationship between firm development productivity with the increase in understanding of consumers.
Inverse Cumulative Standard Normal Distribution	This function is needed to reflect the normal distribution of risk aversion in customers when considering adopting a new product
Strength of Word of Mouth	Qualitatively describes the relationship between market penetration and the impact of word of mouth marketing

10.3. Equations for the causal loop diagram shown on Figure 46

```
Adopters = INTEG( Adoption Rate , 0)
      Units: people
```

```
      in millions of people

Adoption Rate=
      MAX ( 0, Product Launched * ( ( Population Willing to Switch -
Adopters )
/ Time to Acquire ) )
Units: people/Month

Average Learning Per Sale=
      0.2
Units: 1/$

Average Switching Costs= INTEG (
       - Reduction in Switching Costs,
             INIT Switching Costs)
Units: $/Unit

Base Productivity RD Expenditures=
      0.2
Units: 1/Unit

Base Productivity Switching Costs Expenditures=
      0.2
Units: 1/Unit

Begin switching cost expenditures = IF THEN ELSE ( Toggle to start
reducing switching costs after product launch
 = 1, IF THEN ELSE ( Product Launched = 1, 1, 0) , IF THEN ELSE ( Time
>= Month to start reducing switching costs
 , 1, 0) )
Units: Dmnl
This variable defines when the swithiching costs are incurred

Benefit of New Technology= INTEG (
       Increase in Technology,
             INIT Benefit of New Technology)
Units: $/Unit

Blind Decision to Launch=
```

IF THEN ELSE (Firm Perceived Incremental Benefit to Customer > 0, 1, 0)
Units: Dmnl

Combined Effect of Marketing and Word of Mouth on Customer Perception=
MAX (0, MIN (1, Effect of Word of Mouth on Customer Perceptions + Effect of Marketing on Perception
))
Units: Dmnl

Cumulative Standard Normal Distribution(
[(-4,0)-(4,1)],(-4,0),(-3,0.001),(-2.9,0.002),(-2.8,0.003),(-2.7,0.003),(-2.6,0.005),(-2.5,0.006),(-2.4,0.008),(-2.3,0.011),(-2.2,0.014),(-2.1,0.018)
,(-2,0.023),(-1.9,0.029),(-1.8,0.036),(-1.7,0.045),(-1.6,0.055),(-1.5,0.067
),(-1.4,0.081),(-1.3,0.097),(-1.2,0.115),(-1.1,0.136),(-1,0.159),(-0.9,0.184
),(-0.8,0.212),(-0.7,0.242),(-0.6,0.274),(-0.5,0.309),(-0.4,0.345),(-0.3,0.382
),(-0.2,0.421),(-0.0916498,0.461905),(0,0.5),(0.1,0.54),(0.2,0.579),(0.3,0.618
),(0.4,0.655),(0.5,0.691),(0.6,0.726),(0.7,0.758),(0.8,0.788),(0.9,0.816),(1,0.841),(1.1,0.864),(1.2,0.885),(1.3,0.903),(1.4,0.919),(1.5,0.933),(1.6,0.945
),(1.7,0.955),(1.8,0.964),(1.9,0.971),(2,0.977),(2.1,0.982),(2.2,0.986),(2.3
,0.989),(2.4,0.992),(2.5,0.994),(2.6,0.995),(2.7,0.997),(2.8,0.997),(2.9,0.998
),(3,0.999),(4,1))
Units: Dmnl
Switching costs are assumed heterogeneous. There is a normal distribution of switching costs for customers.

Customer Perceived Benefit of New Technology=
INIT Benefit of New Technology + (Benefit of New Technology - INIT Benefit of New Technology

) * Combined Effect of Marketing and Word of Mouth on Customer Perception
Units: $/Unit

Customer Perceived Incremental Benefit=
MAX (Customer Perceived Benefit of New Technology - Price of New Product , 0)
Units: $/Unit
Decay Time= 50
Units: Month

Decision to Launch=
IF THEN ELSE (Product Launched = 0, IF THEN ELSE (Toggle for Product Launch
= 1, External Decision to Launch , IF THEN ELSE (Toggle for Product Launch
= 2, Informed Decision to Launch , Blind Decision to Launch)) , 0)
Units: Dmnl

Decreasing Returns Expend Switching Costs(
[(0,0)-
(1,1)],(0,0),(0.107943,0.047619),(0.236253,0.142857),(0.360489,0.361905),(0.443992,0.585714),(0.521385,0.723809),(0.633401,0.842857),(0.820774,0.933333
),(1,1))
Units: 1/Unit
Taken form DEVLPPDY

Decreasing Returns in RD Expenditure(
[(1,0)-
(5,1)],(1,1),(1.5,0.97),(2,0.92),(2.5,0.84),(3,0.72),(3.5,0.54),(4,0.42),(4.5,0.34),(5,0.3))
Units: 1/Unit
Taken form DEVLPPDY

Desired Initial Market Penetration=
0.25
Units: Dmnl
This variable represents the initial target market penetration

```
Effect of Decreasing Returns on RD Expenditures=
      Decreasing Returns in RD Expenditure ( Benefit of New Technology
/ INIT Benefit of New Technology
 )
Units: Dmnl

Effect of Decreasing Returns on Switching Costs Expenditures=
      IF THEN ELSE ( INIT Switching Costs = 0, 1, Decreasing Returns
Expend Switching Costs
 ( Average Switching Costs / INIT Switching Costs ) )
Units: Dmnl

Effect of Firm Understanding on Productivity of Expenditures=
      Increase in Productivity from Understanding Customers ( Firm
Understanding of Customers
 / INIT customer understanding )
Units: Dmnl

Effect of Marketing on Perception= INTEG (
       Marketing Effectiveness,
             0)
Units: Dmnl

Effect of Word of Mouth on Customer Perceptions=
      Strength of Word of Mouth ( Adopters / Total Market )
Units: Dmnl
between 0 and 1

External Decision to Launch=
      IF THEN ELSE ( Time >= External Launch Date , 1, 0)
Units: Dmnl

External Launch Date=
      6
Units: Month
Month product gets launched no matter what, if external launch is
toggled
```

```
Firm Overestimation of Technology Benefit= 3
Units: Dmnl
Multiplier that firm applies without knowing (1= no overestimation, 3=
firm thinks bN is 3 times actual value)

Firm Perceived Incremental Benefit to Customer=
      Benefit of New Technology * Firm Overestimation of Technology
Benefit - Price of New Product
Units: $/Unit

Firm Understanding of Customers= INTEG (
       Learning from Customers - Loss of Customer Knowledge,
             INIT customer understanding)

Fraction of Population Willing to Switch=
      Cumulative Standard Normal Distribution ( ( Customer Perceived
Incremental Benefit
 - Average Switching Costs ) / Switching Cost Standard Deviation )
Units: Dmnl

Increase in Productivity from Understanding Customers(
      [(0,0)-
(10,4)],(0,0),(0.631365,0.4),(1.3442,0.990476),(2.01629,1.50476),(2.464
36
,2.01905),(2.91242,2.30476),(3.5,2.5),(4,2.55),(4.5,2.58),(5,2.6),(10,2
.6))
Units: **undefined**

Increase in Technology=
      DELAY3 ( RD Expenditures * Productivity RD Expenditures , Time to
Develop Technology
 )
Units: $/Unit/Month
in millions $/month

Informed Decision to Launch=
      IF THEN ELSE ( ( Firm Perceived Incremental Benefit to Customer -
Switching Cost Standard Deviation
```

```
 * Inverse Cumulative Standard Normal Distribution ( Desired Initial
Market Penetration
 ) - Average Switching Costs ) > 0, 1, 0)
Units: Dmnl

INIT Benefit of New Technology=
      2
Units: $/Unit

INIT customer understanding = 0.05
Units: **undefined**

INIT Switching Costs=
      6
Units: $/Unit

Inverse Cumulative Standard Normal Distribution(
      [(0,-4)-(1,4)],(0,-3),(0.006,-2.5),(0.007,-2.45),(0.008,-
2.4),(0.009,-2.35
),(0.011,-2.3),(0.012,-2.25),(0.014,-2.2),(0.016,-2.15),(0.018,-
2.1),(0.02,
-2.05),(0.023,-2),(0.026,-1.95),(0.029,-1.9),(0.032,-1.85),(0.036,-
1.8),(0.04
,-1.75),(0.045,-1.7),(0.049,-1.65),(0.067,-1.5),(0.074,-1.45),(0.081,-
1.4),
(0.089,-1.35),(0.097,-1.3),(0.106,-1.25),(0.115,-1.2),(0.125,-
1.15),(0.136,
-1.1),(0.147,-1.05),(0.159,-1),(0.171,-0.95),(0.184,-0.9),(0.198,-
0.85),(0.212
,-0.8),(0.227,-0.75),(0.242,-0.7),(0.258,-0.65),(0.274,-0.6),(0.291,-
0.55),
(0.309,-0.5),(0.326,-0.45),(0.345,-0.4),(0.363,-0.35),(0.382,-
0.3),(0.401,-
0.25),(0.421,-0.2),(0.44,-0.15),(0.46,-0.1),(0.48,-
0.05),(0.5,0),(0.52,0.05
),(0.54,0.1),(0.56,0.15),(0.579,0.2),(0.599,0.25),(0.618,0.3),(0.637,0.
35),
(0.655,0.4),(0.674,0.45),(0.691,0.5),(0.709,0.55),(0.726,0.6),(0.742,0.
65),
```

(0.758,0.7),(0.773,0.75),(0.788,0.8),(0.802,0.85),(0.816,0.9),(0.829,0.95),
(0.841,1),(0.853,1.05),(0.864,1.1),(0.875,1.15),(0.885,1.2),(0.894,1.25),(0.903
,1.3),(0.911,1.35),(0.919,1.4),(0.926,1.45),(0.933,1.5),(0.953157,1.6381),(
0.96945,1.82857),(0.983707,2.01905),(0.99389,2.28571),(1,3))
Units: Dmnl
This a mathematical function (inverse cumulative) required to calculate the informed decision to launch. This variable is needed because the switching costs are assumed hetetogeneous. There is a normal distribution of switching costs for customers.

Learning from Customers=
    Average Learning Per Sale * Adoption Rate
Units: 1/Month

Loss of Customer Knowledge=
    Firm Understanding of Customers / Decay Time
Units: **undefined**

Marketing Effectiveness=
    (Target Marketing Effectiveness - Effect of Marketing on Perception) / Time for Marketing to be Effective
Units: Dmnl/Month

Month to start reducing switching costs=
    0
Units: Month
0 = start right away, 100 = never reduce switching costs, can
        also set to something in between. (Note: only active if
        switching costs product launch toggle is not active)

Population Willing to Switch=
    Total Market * Fraction of Population Willing to Switch
Units: people

Postlaunch Product Development Expenditure Rate=
    0.25

```
Units: $/Month
in millions $/month

Prelaunch Product Development Expenditure Rate=
      1
Units: $/Month
in millions $/month

Price of New Product=
      4
Units: $/Unit

Product Launched= INTEG (
       Decision to Launch / TIME STEP,
            0)
Units: Dmnl

Productivity of Switching Costs Expenditures=
      SMOOTH ( Base Productivity Switching Costs Expenditures * Effect
of Decreasing Returns on Switching Costs Expenditures
 * Effect of Firm Understanding on Productivity of Expenditures , 3)
Units: 1/Unit

Productivity RD Expenditures=
      SMOOTH ( Base Productivity RD Expenditures * Effect of Decreasing
Returns on RD Expenditures
 * Effect of Firm Understanding on Productivity of Expenditures , 3)
Units: 1/Unit

RD Expenditures=
      IF  THEN  ELSE  (  Product  Launched  =  0,  Prelaunch  Product
Development Expenditure Rate
 , Postlaunch Product Development Expenditure Rate )
Units: $/Month
in milliions $/month This variable describes the R$D expenditures

Reduction in Switching Costs=
      IF THEN ELSE ( Average Switching Costs > 0, IF THEN ELSE ( Begin
switching cost expenditures
```

= 1, DELAY3 (Switching Costs Expenditures * Productivity of Switching Costs Expenditures
, Time to Reduce Switching Costs) , 0) , 0)
Units: $/Unit/Month

Strength of Word of Mouth(
[(0,0)-(1,0.3)],(0,0),(0.0794297,0.0514286),(0.195519,0.11),(0.315682,0.134286),(0.464358,0.164286),(0.627291,0.178571),(0.841141,0.191429),(1,0.2))
Units: Dmnl

Switching Cost Standard Deviation=
2
Units: $/Unit
This variable shows how far from the norm are the ealry adopters
and the laggards.

Switching Costs Expenditures=
0.5
Units: $/Month

Target Consumer Perception=
0.5
Units: Dmnl
Value between 0 and 1

Target Marketing Effectiveness=
IF THEN ELSE (Product Launched = 1, MAX (0, Target Consumer Perception -
Effect of Word of Mouth on Customer Perceptions) , 0)
Units: Dmnl

Time for Marketing to be Effective=
1
Units: months

TIME STEP = 0.125
Units: Month [0,?]
The time step for the simulation.

Time to Acquire=

1

Units: months

Time to Develop Technology=

6

Units: months

Time to Reduce Switching Costs=

6

Units: months

Toggle for Product Launch=

0

Units: Dmnl

0 = blind, 1 = external, 2 = informed

Toggle to start reducing switching costs after product launch=

1

Units: Dmnl

1 = active (yes)

Total Market = 25

Units: people

in millions of people

10.4. Equations for the causal loop diagram shown on Figure 47

```
Accumulated Discounted Profits = INTEG( Discounted Profits , 0)
      Units: $

Adopters = INTEG( Adoption Rate , 0)
Units: people
in millions of people

Adoption Rate=
      MAX ( 0, Product Launched * ( ( Population Willing to Switch -
Adopters )
/ Time to Acquire ) )
Units: people/Month

Decreasing Returns of Marketing Expendure(
      [(0,0)-
(1,1)],(0,0),(0.142566,0.052381),(0.207739,0.0857143),(0.268839,0.13809
5
),(0.386965,0.304762),(0.482688,0.5),(0.545825,0.614286),(0.610998,0.70
9524
),(0.682281,0.814286),(0.761711,0.904762),(0.835031,0.961905),(1,1))
Units: 1/Unit

Discount Rate=
      0.01
Units: Dmnl

Discounted Profits=
      EXP ( - Discount Rate * Time ) * Profits
Units: $/Month

Effect of Marketing on Perception= INTEG (
       Marketing Effectiveness,
             0)
Units: Dmnl
```

```
Expenditures = Switching Costs Expenditures + Marketing Expenditures +
RD Expenditures
Units: $/Month

Marketing Effectiveness=
      ( Target Marketing Effectiveness - Effect of Marketing on
Perception ) / Time for Marketing to be Effective
Units: Dmnl/Month

Marketing Expenditures=
      MAX ( 0, IF THEN ELSE ( Productivity of Marketing Expenditure >
0.1, Marketing Effectiveness
 / Productivity of Marketing Expenditure , 0) )
Units: $/Month

Net Revenues=
      Adoption Rate * net revenues per unit sold * Units Per Customer +
Adopters
  * Net Revenues per Unit in Use * Units Per Customer
Units: $/Month
in millions $/month

Net Revenues per Unit in Use=
      1
Units: $/Unit

net revenues per unit sold = 10
Units: $/Unit

Productivity of Marketing Expenditure=
      Decreasing Returns of Marketing Expendure ( Effect of Marketing
on Perception
 )
Units: 1/Unit

Profits=
      Net Revenues - Expenditures
Units: $/Month
```

RD Expenditures=IF THEN ELSE (Product Launched = 0, Prelaunch Product Development Expenditure Rate, Postlaunch Product Development Expenditure Rate)
Units: $/Month
in millions $/month This variable describes the R$D expenditures

Switching Costs Expenditures= 0.5
Units: $/Month
Units Per Customer=1
Units: units/person

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