AN EMPIRICAL EXAMINATION OF THE ROLE OF CHARACTERISTICS OF THE

FORMAT, STANDARD SETTING ALLIANCE AND ALLIANCE PARTNERS IN

THE MARKET ACCEPTANCE OF FORMATS

A Dissertation

by

SUJAN MATHEW DAN

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2008

Major Subject: Marketing

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August 2008

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ABSTRACT

An Empirical Examination of the Role of Characteristics of the Format, Standard Setting

Alliance and Alliance Partners in the Market Acceptance of Formats. (August 2008)

Sujan Mathew Dan, B.Tech., Kerala University; M.S, Texas A&M University

Co-Chairs of Advisory Committee: Dr. Alina Sorescu
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New product introductions rely on technologies that are often subject to strongly

contested standards wars. In an attempt to ensure that the technical *formats* that their

products are built upon, are the ones that gain widespread market acceptance and thereby

emerge as industry standards, firms often engage in alliances to develop and/or market

these technical formats. This research examines the relationships between the

characteristics of *standard setting alliances, those of the alliance partners, the technical

formats* and the *market acceptance* of the formats. In doing so, I seek to complement

prior research by developing and empirically testing a theoretical framework of these

relationships. While a few studies (Axelrod et al. 1995; Chiao, Lerner and Tirole 2007)

have examined how firms form and organize standard setting alliances, the relationship

between the characteristics of such alliances and their success (i.e., the market's

acceptance of the technical format supported by the alliance) is an under-researched

subject.

A format that is widely accepted by the market (adopted in more products and

adopted by more firms) is in turn more likely to emerge as a standard. Using a unique

data set of formats and standard setting alliances in the consumer electronics industry, assembled from multiple sources, I examine this link between standard setting alliances and format characteristics, and the market's acceptance of the format.

Results indicate that the relationship between the size of a standard setting alliance (number of partners in alliance) and the market acceptance of a format is inverted U-shaped. This suggests that a larger membership in the development alliance does not always imply that the alliance activities will lead to market acceptance of the format. I find that alliances with a greater proportion of generalists are shown to be capable of developing formats that find greater acceptance in the market. Marketing intensity in the years prior to forming the alliance is found to be important. The results also suggest that the broader the applicability of a technical format across industries, the greater its market acceptance. Interestingly though, the hypothesis that formalized alliances lead to greater market acceptance of the format was not supported by the data.

I conclude with a discussion of the potential contributions and implications of the findings for marketing practice and future research.

DEDICATION

To my parents Mathew and Sherly Dan

ACKNOWLEDGEMENTS

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CHAPTER I

INTRODUCTION

In many product categories, the presence of network externalities requires that the technical specifications of the core technologies that products rely upon are standardized. A standardized technology implies that products from different manufacturers, and very often, competitors, are able to seamlessly integrate with one another, thereby increasing the value offered to both the firms participating in the network and to the end customers. In such markets, prior to a specification being settled upon, very often, there is competition between the specifications that the competing firms or alliances of firms have developed.

Which technical specifications are to be adhered to by producers is determined either by market forces, or by alliances established with the purpose of developing and establishing a standard in a given technical domain (Axelrod et al. 1995; Shapiro and Varian 1999). Specifically, in many instances, the increasing emphasis on compatibility and inter-operability of multiple technologies within a product and between products leads to firms forming alliances which have come to be known as standard setting alliances (These have also been referred to as consortia and committees in economics). That is, alliances formed with the purpose of developing and establishing industry standards.

This dissertation follows the style of *Journal of Marketing*.

Such alliances, which I will refer to as standard setting alliances (Axelrod et al. 1995), are formed with the purpose of developing technical specifications referred to as *formats*, promoting them within the industry and eventually establishing them as the commonly accepted set of technical specifications referred to as *standards*.

Consider, for instance, the competition between the Betamax format introduced by Sony in 1975 and the VHS format introduced by JVC in 1976 in the market for video cassette players. The success of the winning format - VHS, can be attributed, at least in part, to the alliances that Matsushita formed with other Japanese producers of video cassette players. Correspondingly, despite Sony managing to convince RCA to stop development of a similar technology, it's reluctance to license its technology to other manufacturers helped JVC and its parent Matsushita to gain market acceptance for its format (Cusumano, Mylonadis and Rosenbloom 1992).

Thirty years later, a similar battle was waged between the HD-DVD and Blu-ray formats, until Blu-ray pulled ahead in the race and became the de facto standard. This time however, the rivalry was between two standard setting alliances, namely the DVD Forum and the Blu-Ray Disc Association. Another recent example is the competition between various DVD formats in the mid-nineties where Sony and Philips teamed up with downstream content providers such as Time Warner and competitors like Toshiba to develop and promote the new DVD technology (Shapiro and Varian 1999). While the high definition DVD war is better known because it has received a lot of recent press coverage, many other such standard wars between standard setting alliances are common across product categories.

A plausible explanation for this marked shift from competition between firms to competition between alliances of firms could be that when firms involved in the development of a technology are at par in terms of resources and capabilities, and when the quality and performance of the technologies developed by these firms are comparable, markets may be indifferent to a choice of technology. In such cases, where network effects are strong, industry alliances are formed with the goal of garnering support from various downstream and upstream players in the market.

The question of which format is likely to emerge as a standard in a standards war is obviously an interesting one, both for firms within an industry and for the end consumers. Despite the important role of standard setting alliances in the standard setting process and the vast amount of literature on standards, there has however been very little empirical research in marketing, economics and management science that addresses the issue of what kind of standard setting alliances and formats are more likely to develop and promote a standard that attracts other industry players, complementors, competitors and a sizable customer base to gain their acceptance and to eventually command a larger portion of the market share in order to establish the format as the industry standard (Chiao, Lerner and Tirole 2007).

Most research that has addressed optimal methods of developing and promoting a format to establish it as a standard has primarily looked at this relationship either using case studies or using theoretical lenses. While a subset of these papers have looked at the strategies that standard setting alliances utilize to achieve their goals (e.g., Weiss and Sirbu 1990; Chiao, Lerner and Tirole 2007), other than theoretical work by Axelrod et

al. 1995, we know little about how a firm decides on what standard setting alliance to join. The questions that address the strategic choices faced by firms, namely the those of what firms to attract into an alliance, what kinds of formats to promote and what kind of alliances to join, have therefore by and large gone unaddressed. The primary goal of this dissertation is to address this gap. A more detailed discussion of prior work is presented in Chapter II.

The primary reason that the aforementioned gap exists within the marketing, management science and economics literature is the lack of available data, and the lack of clarity with regards to alliance participation. It has however been shown that when multiple incompatible technologies compete in network markets, the initial characteristics of the network can be predictive of the outcome[1] (e.g. Farrell and Saloner 1985; Katz and Shapiro 1986; Farrell and Saloner1988). The initial characteristics of standard setting alliances are well documented and observable. Given that, these initial characteristics of the network can predict the outcome, and that these characteristics are observable, this dissertation focuses primarily on the initial characteristics of the alliance and the format in predicting the market outcome in the form of acceptance by the market.

To summarize, the primary goal of this dissertation is to gain an understanding of the role of the initial characteristics of the alliance and of the firms involved in the alliance, and the format in the acceptance of the format by the market. Specifically, it addresses the following issues*:*

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[1] Outcome of a network has been equated to sales, growth of direct and indirect network size etc. of users and a system of compatible and often complementary products.

The association between

1) *The initial characteristics of the standard setting alliance and the market acceptance of the format.*

2) *The characteristics of the partners in the initial alliance and the market acceptance of the format., And*

3) *The characteristics of format and its market acceptance.*

I utilize network theory and the resource based view, to argue that contrary to Axelrod et al (1995), the participation of a larger number of firms in the initial alliance exhibits decreasing returns to participation in standard setting alliances. I also seek to clarify relationships that have mixed, or even contradictory conclusions in previous research, such as the effect of age of a technology on its success and that of the effect of formalized alliances on alliance performance. Also, while the impact of the initial characteristics of the network on the outcome of the network has been theoretically demonstrated using normative models, this dissertation, to my knowledge, is the first to provide some supporting empirical evidence.

By using a unique dataset of formats, and measure of the market's acceptance of the format, this dissertation contributes to the rich stream of research on standards and standard setting alliances. While the marketing has a rich tradition of studying new product alliances (e.g. Wuyts, Stremersch and Dutta 2004; Rindfleisch and Moorman 2001), it has not extensively studied multi-firm alliances or alliances in the context of standard setting. This dissertation looks at both these substantive areas.

The next chapter discusses the background to the problem in greater detail, presents the conceptual definitions and a theoretical framework that describes the effect of the variables of interest on the market acceptance of a format. Following this, I present the hypotheses and conceptual support for these, describe the data and model used in the study, and present the results. I conclude with a discussion of the implications of the findings of the study for marketing practice and future research.

CHAPTER II

BACKGROUND, DEFINITIONS AND LITERATURE OVERVIEW

BACKGROUND AND DEFINITIONS

Formats and Standards

While the concept of standards has been around since Biblical times, where the lack of an established language standard led to the disruption of the construction of the tower of Babel (Shapiro 2001), their relevance in the marketplace and our everyday lives has undergone quite a bit of evolution. The numerous standards that have influenced our existence range from the U.S Constitution's requirements for an established system of weights and measures, the U.S Navy's requirements for standardized diameters for bolts, nuts, and screw threads, but only at Navy yards, to the case of varying railroad widths or gauges in the early 19th century. History shows that the lack of standards could even lead to tragic consequences, as was the case with the Baltimore fire in 1904, when firefighters called in from a neighboring city were unable to use their equipment on the Baltimore fire hydrants because of the differing diameters of the fire hoses (Nesmith 1985).

As firms move to an environment where the importance of information technology, electronics and other networked industries grow, we have also concurrently witnessed the emergence of an alternate type of standard. Such standards are prevalent in product categories where compatibility and interoperability are critical to both products and their complements. For instance, fax machines can connect to one another because they obey a common protocol, computers can connect to one another because they

operate by rules set by standardized hardware and software. At a larger scale, email is made possible by virtue of numerous computers utilizing various pre-determined technical specifications, known as formats and obeying established rules and policies (Shapiro 2001).

Technical specifications that refer to a given technology, referred to as formats are evaluated (often in competition with other specifications) by both the market and the institutions and firms operating in the industry. The focus of this dissertation is on formats of this nature. Departing somewhat from prior research, I note that prior to the emergence of a single industry standard, competition occurs between formats, the outcome of which is the establishment of a standard. While prior literature on standards (e.g. Farrell and Saloner 1986; Katz and Shapiro 1986; Axelrod et al. 1995; Farrell and Saloner 2001) has not made this distinction, this differentiation is important for the purposes of this dissertation.

When formats compete in markets where there are increasing returns to the number and size of the firms that adopt the same core product and process design features (Axelrod et al. 1995), and where compatibility with other formats is an important requirement, either the market or the firms participating in the market decide upon a standard which emerges as the winner from among the formats under consideration (Farrell and Saloner 1988; Shapiro and Varian 1999). In competitive settings where the components of a product are made by different manufacturers, firms developing and selling complementary components are just as much relevant to a firm's choice of competitive strategy, as are the firm's competitors, suppliers and customers

(Katz and Shapiro 1994; Shapiro and Varian 1999)[2]. It must however also be noted here that a winning standard may not always emerge from either of the two processes described, or in certain product categories the market may make it possible for multiple standards to co-exist. In other words, in such instances, more than one format can exist simultaneously in the market. Therefore, rather than observe the emergence of a single industry standard, it is appropriate to look at the formats that are able to command a larger share of the market.

Based on the preceding discussion, I define a **format** as *a (set of) technical specification(s) for a core product component that allows the product to connect or communicate with other products or systems*. Multiple formats may exist in markets prior to the emergence of a specification that is accepted by the market. A **standard** is *a format that has gained acceptance in a market, either through adoption by consumers or through approval by a body of experts*.

It is also important to separate this work from prior related conceptualizations (e.g., Anderson and Tushman 1990; Besen and Farrell 1994; Katz and Shapiro 1986; Schilling 1998) which have used the terms 'formats' and the ensuing 'standard' interchangeably with the term 'dominant design'. This research follows the terminology outlined in Srinivasan, Lilien and Rangaswamy (2006), who state that standards (and preceding formats) are distinctly different from dominant designs (e.g. Abernathy and Utterback 1978; Suarez and Utterback 1995). First, dominant designs can encompass multiple formats, which can co-exist in the market without one of them emerging as a

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[2] This has also, in some cases been termed as systems competition.

standard. Second, while standards emerge as an outcome of standard setting activities as well as market forces, dominant designs emerge as an outcome of market forces only. It must however be noted that in many cases, the terms dominant design and standards can be used interchangeably. For example, in the much publicized high definition DVD standards battle, both Blu-Ray and HD-DVD competed to become the dominant design. However, each of them is capable of playing multiple formats ranging from the CD-ROM, CD-R formats, Mini Disc, DVD-R formats, DVD+R formats in addition to the Blu ray specific formats (BD-R and BD-RE) and the corresponding HD DVD (HD DVD-R and HD DVD-RAM).

The earlier discussion on systems competition, in light of the compatibility and interoperability requirements highlights the importance of collaborative relationships. Such an approach implies that firms must focus not only on competition and end users, but also on collaborators. The Literature on network markets suggests that in markets with strong network effects, first-mover advantages do not necessarily have to be decisive, and victory in such markets often requires entering alliances with other firms to strengthen the networks (Shapiro and Varian 1999). In markets with strong network externalities, consumers place a high value on the compatibility of products and technologies. Given that there are benefits to being the commonly accepted specification in the market, standardization becomes all the more important to firms, and it is in a firm's best interest to actively be involved in developing and/or promoting a format by entering into licensing agreements with the alliance that controls the format.

Standard Setting Alliances

Standards may emerge as an outcome of a *De Jure* mode of standardization, where either a privately controlled standardizing body or a regulatory body decides what the standard should be (Farrell and Saloner 1986). In the absence of a De Jure standardization process, the standard is determined by means of a *De Facto* process, wherein the market determines the standard. Participation in De Jure processes can be either by promoting one's own format or joining an alliance to promote the preferred standard. From a manufacturer's perspective, the drawback of the De Facto mode of standardization is that the firms involved have little control over the market's choice of standards. The De Facto standard could however be one that is not compatible with the firm's technology, and hence may put the firm at a competitive disadvantage by locking it out of the market (Schilling 1998).

Unofficial, fast-acting standard setting and promotional private standard setting alliances that participate in De jure processes are a more recent phenomenon beginning in the late 1980s (Weiss and Cargill 1982). These private alliances were preceded by more formal standard setting organizations such as ANSI (American National Standards Institute), ETSI (European Telecommunications Standards Institute) and the IEEE (Institute of Electrical and Electronics Engineers). In the late 1980s though, firms increasingly began to view the standard setting organizations as slow to act on fast emerging technologies, and not equitably representing the interests of all firms (consortiuminfo.org 2007).

The consequence of the slowing down of the standardization process and the growing understanding that firms could use the right collaborative relationships, promotions and the market to arrive at a favorable outcome for themselves was that a number of private standard setting alliances were formed to create a standard to address a single commercial need. The primary purpose of these alliances was to agree upon, develop and promote a technical standard and put together a large installed base of producers, complement firms and users (David and Greenstein 1990; Axelrod et al. 1995). Participating in such alliances or assembling allies, could at one time almost be certain to lead to an established standard. For example, the VHS format video cassette player was able to gain market acceptance due to Matsushita Corp.'s willingness to license its technology to other Japanese firms and indirectly partnering with video stores.

The changing nature of the standard setting process and particularly the increasing emphasis on standard setting alliances has been attributed, primarily to two factors. *First*, while several firms may possess most of the technical and market capabilities that are needed to set the standard individually, no single firm may possess the capability to build a large enough network of users to ensure the format's market acceptance (Farrell and Saloner 1986). Besen and Johnson (1986) attribute this failure to the heterogeneous preferences of other firms and users within the industry, and the firm's limited knowledge of these preferences. This in turn, causes firms to look towards alliances or other firms to assist in building up a large network. *Second*, the absence of a clearly dominant player, and the presence of several strong firms, may cause smaller firms to offer their support to as many competing alliances as possible (Saloner 1990).

The alliance that develops the format may also offer licenses at low or zero costs to encourage adopter firms to adopt the particular format (Farrell and Gallini 1988). These, in turn, have led to multiple formats that perform the same task to emerge and compete in certain industries. Therefore, even in the presence of a De Jure standard setting process, the market continues to play some role in choosing among formats, accepting the format and eventually establishing a standard.

The conceptualization of a format in this dissertation, takes these into account, and implies that *a standard, if it emerges from the competition, is an outcome of both De Facto and De Jure processes*. In the absence of a clear standard such as in the case of VHS and Beta, more than one format can exist side by side; oftentimes serving similar market segments such as was the case with the Blu-ray and HD-DVD formats. In such cases, the degree to which a given format is accepted or adopted by firms in an industry, and the number of products in which a given format is utilized serves as a better measure of success.

Standard setting alliances are therefore essentially multi-firm partnerships formed with either 1) the purpose of developing and supporting a technical format in the marketplace, such as the Kodak, Intel and Adobe alliance to develop the Kodak Picture CD, or 2) the purpose of supporting more than one format through time, and hence setting multiple standards such as the CF card and memory stick which were developed by the compact flash association. Therefore, standard setting alliances can be anything from an informal partnership of firms to a more structurally organized body built to perform regular standard setting and format promoting tasks, and involved in a range of

activities, including sharing information, engaging in active product design, negotiating compromises, testing for compliance, performance (Farrell and Saloner 1988) and even branding.

Standard setting alliances tend to be dynamic organizations whose membership may change over time. The initial members of the standard setting alliance tend to be active participants in the day to day functioning of the alliance and remain involved in the development, design and improvement processes. Over the course of time, other members, often referred to as adopters[3] are added to the alliance. These firms are less active members of the alliance but they receive license rights over the format's technical specifications which permit the use of the format in their products (consortiuminfo.org 2007). The initial alliance members, therefore primarily play the role of a) promoting the creation of new markets, or bringing new technology into an existing market, such as high definition televisions and b) spreading costs of R&D across the partners.

As discussed earlier, the scope of this research is restricted to the initial alliance members, which are the promoters that founded a standard setting alliance with the stated purpose of developing and promoting a given format. These firms are more likely to be the main decision makers in the alliance, and also to be more closely involved in the development and promotion of the format.

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[3] The adopter firms are occasionally invited to join the governing body (such as the 20 member strong steering committee in the DVD Forum, not all of whom were part of the developers) and may have a role in some of the standard setting alliance's major decisions. Adopters are essentially firms that join the alliance in order to be able to influence the future of the format, receive early knowledge about future developments, and have the opportunity to interact with industry leaders (consortiuminfo.org).

LITERATURE OVERVIEW

Prior work that has specifically examined the standard setting alliances includes analytical (e.g. Axelrod et al. 1995; Economides and Skrzypacz 2003; Farrell and Saloner 1988; Lerner and Tirole 2004), conceptual (e.g. Weiss and Cargill 1992; Funk and Methe 2001) and descriptive papers (e.g. David and Shurmer 1996; Dranove and Gandal 2004; Garud, Jain and Kumaraswamy 2002). However, with few exceptions such as the work of Chiao, Lerner and Tirole (2007), which uses a combination of analytical and empirical methods, there is a dearth of theoretically grounded empirical research that examines the outcome of standard setting alliances.

Axelrod et al. (1995) develop an analytical model for how firms form alliances to develop and sponsor technical standards, but do not account for the success of the standard. Further, their framework is based on the assumptions that the utility for the firm joining a particular standard setting alliance increases with the size of the alliance and decreases with the presence of rivals in the alliance. I do not impose such restrictions in this research. Chiao, Lerner and Tirole (2007), empirically examined the workings of the standard setting organizations, from a mix of both the traditional view-point of formal Standard Setting Organizations[4] such as the ANSI and private standard setting organizations. While they examine policies governing disclosure and licensing of intellectual properties of these organizations, I look at the market outcome of standard setting alliances, independently organized by firms.

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[4] Traditional standard setting organizations are fast being replaced by private standard setting organizations as the default mode of standardization (consortium info.org 2007; Axelrod et.al 1995).

To my knowledge, this research is the first attempt at trying to understand the impact of the initial characteristics of standard setting alliances, members and of the format on the market outcome of a format. Table 2.1 presents a more detailed review of prior work examining the relationship between alliances and standards, and Table 2.2 positions this research in relation to other related work.

In Chapter III, I present the conceptual model, hypotheses and supporting arguments.

TABLE 2.1

Relationship between Consortia/Alliances and Format Success/Standards: A Review of Representative Literature

Paper	Issue(s) studied	Data & Methodology	Major Findings and Limitations
Rosenkopf, Metiu and George (2001)	How do interactions between mid-level managers in technical committees facilitate subsequent alliance formation?	Cellular Industry: Communications Standards Review (Trade pub) and SDC, LEXIS/NEXIS and Compustat Random effects negative binomial regression.	The effect of joint technical committee (TC) participation on alliance formation decreases as firms have more prior alliances, suggesting that TCs provide a more critical avenue for knowledge exchange when firms do not have the luxury of exchanging information through contractual linkages. Correspondingly, Joint CTO (Cooperative Technical Organizations) participation increases alliance formation at a diminishing rate.
Axelrod, Mitchell, Thomas, Bennett and Bruderer (1995)	How business firms form alliances to develop and sponsor technical standards?	Analytical	Predicted alliance configurations are only for a Nash equilibrium. No single firm has an incentive to switch to another alliance. Assumes that the utility of a firm joining a particular standard setting alliance increases with the size of the alliance and decreases with the presence of rivals in the alliance. Limited to nine firms in the UNIX industry
Farrell and Saloner (1988)	Examines three common methods for achieving coordination: 1) explicit communication and negotiation before irrevocable choices are made, 2) no explicit communication and succeeds if one agent chooses first and the others follow (simple form of market leadership/bandwagon), 3) a hybrid allowing both communication and unilateral preemptive actions.	Analytical	Although the committee is slower, it outperforms the market mechanism. The unilateral and committee mechanisms were analyzed together and subsequent analyses of the hybrid mechanism shows that unilateral actions improve the committee system.

TABLE 2.1 (Continued)

Paper	Issue(s) studied	Data & Methodology	Major Findings and Limitations
Chiao, Lerner & Tirole (2007)	Investigates the relationship between SSO (Standard Setting Organization) characteristics and their policies governing disclosure and licensing of intellectual properties (patents).	Game theory, ordered logit regression sample- consortiuminfo.org, and other lists (see paper pg 15)	Negative relationship between SSO orientation to technology sponsors and concession level required by the sponsor and positive relationship between sponsor 'friendliness' of the selected SSO and quality standard.
Keil (2002)	Analyses the strategic logic of standardization alliances	Case study	In establishing a standard, there is a tradeoff between speed of standards development and standard penetration in the marketplace. Increased size of SIGs (Special Interest Groups) slowed the process
Lemley (2002)	Standardization and assignment of IP rights	Case studies and survey of standard setting rules and bylaws.	Members of standard setting organizations (SSO) contract to bargain from an inefficiently powerful set of property rules to a regime where intellectual property (IP) rights are removed or are licensed in advance on standardized firms, SSO IP rules are hence a partial market solution to excessive IP protection

TABLE 2.2

Positioning of Research Reported in Relation to Prior Research

Article	*Key predictor variable (where applicable)*	*Outcome variable (where applicable)*	*Alliance outcomes examined*	*Format characteristics examined*	*Market outcome examined*	*Methodology*
Rosenkopf et al. (2001)	Technical committee participation	Alliance formation	X	X	NA	Empirical
Farrell and Saloner (1988	Speed, efficacy and payoffs of choosing standards	Best form of choosing a standard	X	X	NA	Theoretical/ Analytical
Chiao et al. (2006)	Standard setting organization characteristics	Policies governing disclosure and licensing of IP	X	X	NA	Analytical/ Empirical
Lemley (2002)	NA	NA	IP rights assignment	X	X	Observational/ Case Studies
Axelrod et al. (1995)	Alliance size and competitor involvement	Alliance configurations	X	X	NA	Theoretical/ Analytical
Keil (2002), Funk and Methe (2001) etc.	NA	NA	Emergence of a standard	X	X	Case Study (sample=1)
This study	Alliance, partner and format characteristics	Market acceptance of a format	✓	✓	✓	Empirical

CHAPTER III

CONCEPTUAL FRAMEWORK AND HYPOTHESES

Figure 3.1 presents a conceptual model delineating the relationship between standard setting alliance, partner and format characteristics and the market acceptance of format.

FIGURE 3.1
Relationship between Characteristics of the Format, Standard Setting Alliance and Alliance Partners and the Markets Acceptance of the Format[5]

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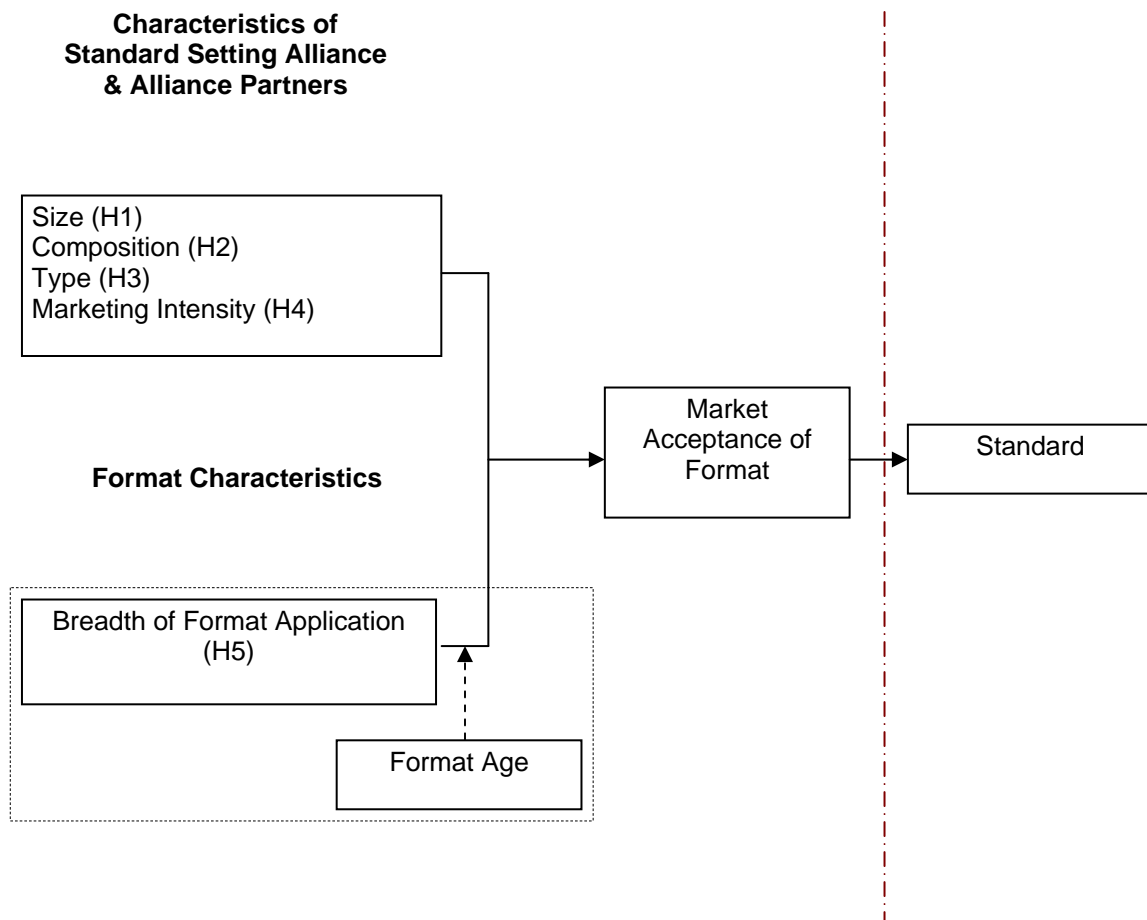
[5] While the emergence of a single standard is indicated for the purpose of a more complete conceptual model, the outcome variable in this research is restricted to the market acceptance of the format.

SIZE OF THE STANDARD SETTING ALLIANCE

Prior research has shown that firms enter into alliances with the aim of minimizing transaction costs, cope with environmental uncertainty and reduce dependence on resources outside their control (Das and Teng 2000). The eventual performance of such alliances is however conditional upon choosing appropriate partners, alliance design, and being able to adapt the nature of the alliance to achieve the desired end results (Ireland, Hitt and Vaidyanath 2002), such as develop proprietary software, manage decisions on licensing to adopters, manage improvements in the format, etc.

In addition to financial gains, the purpose of entering a standard setting alliance, is to take into account the direct and indirect network externalities that arise as a result of being part of the right network, and to combine the resources of the partners (Das and Teng 1998), and to combine them in a manner such that the resources brought in to the alliance are complementary to one another (Parkhe 1991). Direct network externalities are the externalities that occur "through a direct physical effect of the number of purchasers (or users) on the quality of the product." Indirect network externalities "involve instances that lack that direct physical effect; for example, software being more plentiful and lower in price as the number of computer users increases" (Liebowitz and Margolis 1994).

Having a large network of users and firms producing complementary goods is crucial for creating sufficient network externalities that enable a technology to succeed. Having too few members in the alliance is therefore indicative that the format may not

be able to gather hard to access resources and complementarities and take advantage of the network externalities required to get the technology off the ground. While some formats have been developed and promoted by smaller alliances, and in some instances, by even a single firm[6], the downside to having too few members in an alliance is that the format runs in to the danger of not getting sufficient resources and or the support of a network to popularize it in the market (Axelrod et al. 1995).

Standard setting alliances can vary from a dyad to partnerships involving more than two partners. The primary goal of the standard setting alliance is to develop and subsequently commercialize a given format, thereby often calling for resources that are varied ranging from technological to market resources. Das and Teng (2000a) have argued that alliances are "optimal resource configuration tools" and that sustained resource heterogeneity arising from a diversity of partners is a source of competitive advantage. By this argument, as more members join the alliance, unique resources and/or capabilities are being brought in, and each member participates and makes unique contributions in either the upstream (developmental stages) and/or the downstream (commercialization) of the format.

Prior research has identified that technology, marketing skills (knowledge of local markets in the case of international alliances), management competence (Chi 1994) and financial, physical and managerial resources (Das and Teng 1998) are the commonly identified sets of resources that firms bring to an alliance. Though it is recognized that strategic alliances are a 'balance between cooperation and competition' (Luo,

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[6] Farrell and Saloner (1986) show that only dominant firms, which exert substantial market power, are able to single handedly and successfully develop and commercialize a technology.

Rindfleisch and Tse 2007; Luo, Slotegraaf and Pan 2006; Das and Teng 2000b), in cases where competitors are involved in an alliance, the corresponding resources possessed by the competitors are likely to overlap (especially since R&D and market access are critical roles performed by standard setting alliances).

Rindfleisch and Moorman (2001), have also shown that horizontal alliances (alliances between competitors), have lower levels of relational embeddedness (reciprocity and closeness among alliance participants) and higher levels of knowledge redundancy (degree of overlap in the knowledge base between alliance members). Hence, both from the resource based view perspective and from the strength of ties perspective, I argue that beyond a certain point, resource heterogeneity can be difficult to sustain when more competitors begin to join the alliance, particularly at the development phase.

Further, the role and importance of trust impacting firm performance (e.g. Aulakh, Kotabe and Sahay 1996; Mohr and Spekman 1994), and control (e.g. Parkhe 1993; Dyer 1997) are well documented. Alliances between competitors are shown to be especially plagued by a lack of trust between partners (Khanna, Gulati and Nohria 1998) and hence result in coordination issues. This consequently raises the risk of voluntary information disclosure or involuntary knowledge dissemination through informal networks of employees (von Hippel 1987), which gets magnified with more partners being involved in the alliance, all vying for control of the spoils of the outcome. Besen and Johnson (1986) have shown that when there is a lack of coordination between firms and users, as argued above, market adoption of technologies suffers. Luo, Rindfleisch

and Tse (2007) also argue that a larger number of competitor alliances may also negatively affect firm performance by enhancing a competitor's ability to copy its partner firm's technological capability and marketing tactics.

Therefore, there is quite a bit of evidence that as competitors get involved in alliances, performance is negatively affected. This is also argued for by Brock (1975) who finds that competitive rivalry between firms negatively affects standardization in the computer industry.

In sum, beyond certain number of alliance partners, I propose that the standard setting alliance is likely to exhibit diminishing returns. Hence, the following hypothesis:

H1: The relationship between the number of participants in the initial standard setting alliance supporting and promoting the format and market acceptance of the format will be inverted U-shaped.

COMPOSITION OF THE STANDARD SETTING ALLIANCE

Prior research has shown that both the number and type of products and/or the resources used by a firm has an impact on a firm's profits and/or survival in the industry. Teece (1982) argues that firms leverage valuable resources (which they use to enter new markets), across multiple markets to gain scale and scope economies. Organizational ecologists also argue along similar lines that firms with a broader scope are able to adjust better to changing environmental conditions (e.g. Hannan and Freeman 1977; Sorenson et al. 2006). Hannan and Freeman (1977) placed firms along a continuum, with their position determined by the combinations of resource types and levels in which the firm

can survive. This position was termed as the organizational niche, and along the continuum, firms can be classified as specialists or generalists. Specialists are firms that can survive within a limited range of resources, whereas generalist firms have the ability to gather a wider range of resources, and survive in a variety of environments (Sorenson et al. 2006). Operationally, specialists and generalists have been differentiated based on the breadth of the markets in which they operate (Freeman and Hannan 1983; Sorenson et al. 2006).

In the context of product strategy, the position along the specialist-generalist continuum (referred to also as scope) has been shown to have influence on both firm performance and strategy. For example, Robinson and Fornell (1985) and Kekre and Srinivasan (1990), show that broader product lines lead to significant market share benefits and increases firm profitability. In addition, Schmalensee (1978) shows that firms with broader product lines can erect entry barriers to new market entrants; and Bernheim and Whinston (1990) demonstrate that multiple products reduce competition through mutual forbearance in multiple markets, and numerous studies have provided evidence for mutual forbearance when firms compete in multiple markets (Jayachandran, Gimeno and Varadarajan 1999). Sorenson (2000) demonstrates that the number of products offered by a firm has a negative and significant effect on market exit.

In the context of this dissertation I follow the new product and product portfolio literature and I define generalist firms as those involved in the development and commercialization of multiple formats or a broader format line, as evidenced by their participation in multiple standard setting alliances. Specialists, on the other hand, are

involved in the development and commercialization of one or at most few formats or a narrow format line, as evidenced by their involvement in fewer standard setting alliances.

I argue that alliances with a greater proportion of generalists (as compared to alliances with a greater proportion of specialists), by virtue of having a higher proportion of firms involved in the development of multiple formats, have access to more unique resources and capabilities from their various partners, and are able to use their broad alliance involvement to increase market share and mutual forbearance. Such alliances will have in effect also have a greater ability to push for compatibility and interoperability of other formats that they have been involved in, or are involved in. In other words, such alliances are able to leverage their involvement and experience in other alliances to develop formats that are more likely to be accepted by the market. I therefore expect that as evidenced by literature on product breadth, alliances with a greater proportion of generalists are likely to find greater acceptance in the market.

However, previous literature has produced divergent streams of thought relating to product breadth and focus. Lancaster (1990), in a review of the literature on optimum product variety (a term he equates to "models" in the consumer durables market), in which he examined multi product firms argued that firms' choice of product variety is influenced by a) the existence of inter-product economies on the production side, b) potential for increasing demand by offering greater variety and c) the use of product variety for strategic purposes. While the second point does not apply directly to this

situation, the first and third points have direct bearing on my argument that formats developed and promoted by generalist alliances are likely to be successful.

First, the argument about inter-product economies suggests that when there are economies to be gained from being involved in a network, firms are able to learn from one alliance and use this knowledge across other alliances they are involved in or in other formats. Also, being involved in the development of multiple formats enables firms to be influential in determining the characteristics of other technologies they are involved in, there by contributing to positive indirect externalities.

Second, the market that formats operate in is a networked one. Network theory literature (e.g., Katz and Shapiro 1986; Farrell and Saloner 1986) suggests that there are strategic benefits to being part of a larger network. In networked markets, the long run success of the firm is determined by the network size (Schilling 2002) and resource access (Besen and Farrell 1994). Generalist firms and alliances are far more likely to have access to more varied resources, and also to provide the much needed connectivity that is essential to the development and success of formats. Hence, I argue that being a generalist in network markets presents greater and more unique advantages in terms of inter-product (format) economies and ensuring interoperability between formats and products, the importance of which has already been discussed. Hence, the following hypothesis:

H2: Formats developed and promoted by a standard setting alliance with a greater proportion of generalists will gain greater market acceptance compared to

formats developed and promoted by a standard setting alliance with a greater

proportion of specialists.

STANDARD SETTING ALLIANCE TYPE

A major outcome of the movement from official standard setting organizations such as IEEE, ETSI and ANSI to private standard setting alliances such as the compact flash association and the DVD forum was that the alliance did not need to be a permanent part of the firms involved in the development of the format. Two broad categories of standard setting alliances can be identified.

First, some formats tend to be developed within formalized alliances, whose stated and formally recorded purpose is to develop and establish multiple standards collaboratively or to promote formats developed by individual members over a period of time. These alliances have a formalized structure and a committee that oversees the workings of the alliance, and make decisions on such topics such as formats to be supported and alliance membership. These alliances have a much broader focus in terms of what they wish to achieve and tend to exist for longer periods, and have also been referred to as *ecosystem SSOs* (standard setting organizations) (consortiuminfo.org 2007).

Other formats are developed in informal alliances whose purpose is to develop a single format and possibly establish it as an industry standard. These alliances tend to be short-lived and their purpose tends to be very narrow. Such alliances are often times formed in order to enable a new market to address an isolated functional need in a

product category. They are also formed when immediate action is required for developing or making improvements to a format. Occasionally, such alliances may remain active for longer periods of time when the original intent for forming the alliance was to limit the participation to a few firms; but in such situations, the alliance is limited to making improvements in the existing technical specifications. I refer to the former type of alliance as a *formal standard setting alliance*, and to the latter as an *informal standard setting alliance*.

The existence of a formalized alliance structures has been found to better capture and apply know-how (Sivadas and Dwyer 2001; Kale, Dyer and Singh 2002). In addition, relative to an informal and transactional system for access to resources, an alliance based system enables a firm to minimize relational and performance risks (Das and Teng 1998), reduce transaction costs and better manage the transfer of resources, especially when they are diverse and complementary in nature.

Makhija and Ganesh (1997) also note that formal control systems can exist within alliances that allow predictable, regular and involved explicit information transfers. In the absence of formalized controls in an alliance or when the controls are informal, information transfer tends to be uncertain, ambiguous and embedded within a particular firm, owing to a multitude of factors that could range from lack of trust to transfer knowledge and skills between firms (e.g. Das and Teng 1998; Inkpen and Currall 1998), control issues (Blodgett 1992), or a lack of attachment between partners especially in newer alliances (Seabright, Levinthal and Fichman 1992).

Given that alliances are usually entered in to with the objectives of accessing a common and otherwise inaccessible resource pool among others, I argue that having a formal alliance structure enables firms to better perform these activities that are crucial to new product development, minus the risks of transferring proprietary knowledge and instabilities associated with bargaining power in alliances (Inkpen 2001), especially when they are asymmetric in nature. Hence, the following hypothesis:

H3: Formats developed and promoted by a formal standard setting alliance will gain greater market acceptance compared to formats developed and promoted by an informal standard setting alliance.

MARKETING INTENSITY

Marketing intensity of the standard setting alliance refers to the average marketing expenditure of the members as a proportion of their assets.

Dutta, Narasimhan and Rajiv (1999), examining marketing capability in high-technology markets, state that firm performance in such markets has generally been attributed to external market factors such as its ability to ward off competitors. In addition, innovative performance has been attributed to the R&D and manufacturing investments, inter industry appropriability and opportunity conditions. They subsequently argue for and demonstrate that marketing capability is in fact necessary in high-technology markets. While the unit of analysis in the Dutta et al. study is the firm, I look at the importance of marketing at the alliance level, and at the early stage of the alliance.

A characteristic of network markets is that they are "winner take all" markets (Srinivasan, Lilien and Rangaswamy 2006; Schilling 2002) where the market support garnered at the early stages of competition can be critical in choosing the winner (Besen and Farrell 1994; Srinivasan et al. 2006), which in this case is a format accepted by the market, as an outcome of the combination of market and organizational forces. Thus, in such markets, the ability of the initial members in an alliance dedicated to the development and the promotion of a format is of great importance to the eventual success of a format and its ultimate emergence as a standard.

In technology intensive markets, innovative firms which have developed a new technology are likely to look for ways to promote it and help it take-off in the market (Dutta and Weiss 1997). Having a system of supporting products and supporters is therefore just as important as the role and quality of the format (Katz and Shapiro 1994; Shapiro and Varian 1999) in its market acceptance. This is evidenced in alliances such as the HomeGrid Forum where innovative but smaller firms such as Infineon seeking the support of larger firms such as Texas Instruments, Panasonic and Intel to help promote their technology. Similarly, when Sony participates in a standard setting alliance with SanDisk to develop a memory format to be included in its products, advertisements for the product include mentions to the format as well, thereby providing more legitimacy in the market.

This therefore implies that in addition to the technical resources to develop the product, firms involved in standard setting alliances also seek access to substantial and varied market based resources in order to ensure successful commercialization of the

developed format. Alliance with stronger marketing capabilities is better able to identify customer segments and product categories that require certain types of technologies, and hence develop better technologies and formats that more specifically address these. Therefore, such firms are able to develop formats that have greater potential in the market, and are therefore able to better differentiate themselves on the dimensions of direct and indirect network externalities, which have been argued for in earlier sections.

Schilling (2002) and Katz and Shapiro (1994), for instance, describe the role of advertising and other marketing activities in improving customer expectations and preventing technologies from failing. Chakravarti and Xie (2006), taking a behavioral approach, provide further evidence of the role of marketing and more specifically advertising in determining the outcome of standards wars. They provide evidence for the benefits of comparative advertising as opposed to absolute advertising. These once again point to the importance of marketing capabilities in establishing a standard.

Dutta and Weiss (1997) also argue that the transfer of tacit knowledge is less likely in marketing partnerships than in joint ventures or licensing agreements. Hence, technologically innovative firms will tend to have a higher number of marketing agreements, since they may be able to protect their knowledge from competitors in the alliance. While Dutta and Weiss do not find support for this proposition, I argue that, in the case of early stage alliances, the support of firms with significant marketing and advertising expenditures is critical to the success of a format. I argue that innovative firms are likely to seek out firms that have marketing capabilities in an effort to earn the acceptance of the market. In the case of early stage standard setting alliances, it is

therefore not just the initial set of developers, but also adopters who are interested in accessing a wider user network. A wider user network would be in turn associated with a firm with strong marketing capabilities.

Firms that have spent sufficient resources in marketing and advertising activities may find it easier to build a larger network of both partners and users. When the format first emerges, potential adopters will have little information on its quality and the likelihood that it will gain wide market acceptance. Hence, potential adopters are likely to make decisions about the format they may consider licensing based on characteristics of the initial set of firms and the likely size of the user network, which research has shown is often used as a proxy for quality (Gatignon and Robertson 1985; Hellofs and Jacobson 1999). Promoters, on the other hand, hope for irreversible bandwagon effects (Wade 1995) to set in at some point wherein more adopters would join the alliance, thus encouraging more customers and supporters to join the network. For example, in June 2007, when the Wibree forum[7], a newly formed alliance led by Nokia opted to merge with the Bluetooth SIG (www.bluetooth.com), the Wibree forum in essence accessed an installed user base and an 8000 member strong network of manufacturers.

These arguments point to the possibility that in markets for technologies, market resources could be an important factor in determining their success, especially in determining early success. Hence, I argue that *in the early stage of the standard setting alliance*, while R&D intensity of promoter firms is important, the market resources it

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[7] Wibree is a new interoperable radio technology for small devices. It can be built into products such as watches, wireless keyboards, gaming and sports sensors, which can then connect to host devices such as mobile phones and personal computers. The forum classifies is as the missing link between small devices and mobile devices/ personal computers. (http://www.wibree.com/ 2007).

manages to assemble and hence the support it manages to garner both in terms of a user network and complements may be more important than R&D capabilities in determining the ultimate success of the format and to get the bandwagon effects to set in. Hence, the following hypothesis:

H4: Formats developed and promoted by a standard setting alliance with greater marketing intensity will gain greater market acceptance.

BREADTH OF FORMAT APPLICATION

Formats are evaluated not just on their quality, but also on their breadth of applicability in the market and in other product categories. Breadth of format application refers to the number of product categories that a format is implemented in. For instance, consider the necessity for data transfer between products. While both USB and Firewire formats transfer data, the USB found more applicability in different product categories. The Firewire has become extremely popular in digital video cameras, primarily because of the high rates of data transfer it is capable of. Alternatively, the USB has become popular because of its breadth of applicability and the number of products that over the years since introduction have adopted it over the Firewire format.

The strategic consequences of having a large and stable installed user base of consumers and firms that implement the format in their product are well researched in the literature (e.g. Frels, Shervani and Srivastava 2003; Katz and Shapiro 1986). Anecdotal and empirical evidence suggest that the size of the installed customer base is a key success factor in markets with network externalities. For example, the Windows

operating system (Microsoft), personal computer architecture (IBM), VHS video cassette player (Matsushita), and Palm operating system (3Com) were successful because of their ability to expand the size of their respective networks much faster than their closest rivals [Macintosh (Apple Computers), Betamax video cassette player (Sony) and Windows CE (Microsoft), respectively]. Given the winner takes all nature of electronics markets where network effects are prevalent, an early lead in convincing manufacturers to adopt a particular format ensures a long term competitive advantage (Arthur 1989). As more product manufacturers adopt and implement the format, it serves as a surrogate variable for product quality (Gatignon and Robertson 1985; Hellofs and Jacobson 1999).

Certain formats, by virtue of their applicability, are used in more than one product category. As certain formats that exhibit the characteristics necessary for broader application get implemented in multiple product categories, the format contributes to the indirect externalities (Katz and Shapiro, 1985 and 1986) of each of those products. Indirect network externalities involve instances that lack direct physical effect, such as when complementary products become more available as users of the primary product increase (Liebowitz and Margolis 1994).

For late movers, in addition to early movers having captured a larger installed base (Arthur 1989), there is also the switching cost or the added cost of making accommodations for alternate formats. However, there is sufficient evidence to show that inferior technologies are replaced by newer, more superior technology. Hence, the following hypothesis:

H5: The greater the breadth of format application across product categories, the greater the market acceptance of the format.

As the time since a format has been available (format age) increases, there is a greater possibility of it being used in more products and having built a larger installed base (Wade, Greenstein and Barth 2006). This could be either because it has been developed by manufacturers that are active in a particular product category (e.g. media formats developed by Sony to be implemented in products such as digital cameras and video cameras), or because they have been endorsed by national or regional bodies (e.g. television broadcast formats such as the NTSC and PAL systems). Such products, therefore, quite possibly, also have externalities that reduce the rate at which their installed base declines after sales have ceased (Wade, Greenstein and Barth 2006). These arguments present a case for older technologies finding a stronger installed base in the product category.

Another stream of literature on product sales argues that with time, firms tend to fall behind in terms of technological sophistication, and correspondingly, the sales of the older products fall behind, leaving only the technologically innovative products (Requena-Silvente and Walker 2005; Bayus 1998, Stavins 1996) or products offered by firms with strong brands and large market share (de Figueiredo and Kyle 2006) to survive. Alternatively, firms switch to newer technology to ensure the survival of their products. This argues for the strong possibility that older technology may be replaced by newer technology in products.

In light of the above, since arguments in support of a positive association and a negative association between format age and market acceptance of the format are equivocal, I treat this as an empirical issue of interest, but do not hypothesize a specific relationship.

CHAPTER IV

METHODOLOGY

DATA

Empirical Context

The empirical context for this study is the consumer electronics industry. Researchers in marketing have studied this industry in the context of diffusion (e.g. Goldenberg, Libai and Muller 2002; Bayus 1993) and channel management (e.g. Frazier and Lassar 1996). The consumer electronics association (CEA) has estimated the total sales of consumer electronics to top $158.4 billion by 2008, a growth of over 60% since 2000. The consumer electronics industry, characterized by a high rate of growth and continuous streams of innovation, provides an appropriate empirical context given the large number of standard setting alliances.

Sampling Procedure

The population of interest is all the formats in the consumer electronics industry. Based on the definitions of formats and standards used in this paper, the sample was narrowed to only formats that exhibited the characteristics of exhibiting connectivity or communication with other systems or products. The product categories available on the review pages of CNET.com, a consumer electronics review source, were examined and the following eight product categories were initially chosen for inclusion in the study: camcorders, cell phones, digital cameras, DVD players, PDAs, GPS systems, Digital TV

and wireless systems (wireless routers and cards). However, four of these product

categories were dropped following a number of missing values being observed and the

reviews being incomplete. The categories eventually included in the analysis were

PDA's, digital cameras, camcorders and cell phones.

A PhP[8] script was developed to collect data from the product review pages on

CNET.com. The data collected included manufacturer, part number, first review date

(used as a proxy for the introduction date), high and low prices and the formats utilized

in the products. For the products listed on CNET which did not have review dates we

retrieved these dates from epinions.com, a website which aggregates electronics reviews

from various sources. Table 4.1, provides a summary of the penetration and installed

base of these categories (Consumer Electronics Association).

TABLE 4.1

Penetration and Installed Base for Product Categories Analyzed

Product	Penetration	Installed base (million)
Cell phone	78%	181.8
Camcorder	43%	52.5
Digital camera	57%	88.6%
PDA	15%	21.6%

For the products that had incomplete data on CNET, I sought to retrieve the

missing data from individual product homepages or from specialized review sources

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[8] Recursive acronym for PhP hypertext processor.

such as *Digital Photography Review* for digital cameras. Data on the firms that developed a format and the alliance participants was collected from *Factiva business news and information*. Searches were first conducted for the format and if known at the time, the name of the alliance. The results were examined for date of publication and for the firms involved in the development. The results were triangulated after a set of cross checks with other results for consistency in the content and to arrive at the final list of original developers. To ensure accuracy the dates of publication were examined to ensure that they were within a week (at most) of each other. Whenever available, the homepage of the standard setting alliance was used to confirm the list of original participants in the development alliance. Some formats had to be dropped from the analysis either because they could not be accurately tracked to their developers or because information was unavailable.

Firm level data on the firms involved in the alliance were collected primarily from Standard & Poor's COMPUSTAT database and supplemented with data from the Thomson Financial DATASTREAM database. For foreign firms (not traded in the U.S), this data was collected exclusively from DATASTREAM, and the values converted to U.S Dollars using the averaged exchange rates for the year of alliance announcement.

The product data (1399 observations) was aggregated at the product-year level to be used in the analyses, which yielded 464 observations at the category-format-year level from 69 unique formats across the four product categories. Fourteen of these formats were developed by alliances consisting of privately held firms or research agencies, on which firm level data was unavailable. These observations were therefore

dropped. The final sample consists of 364 observations at the category-format-year level on 55 unique formats. Table 4.2 presents a summary of the data.

TABLE 4.2

Data Summary

| Product category | Split of Products in the Product Data | | | Summarized at the category-format- year level |
	No. of Products	No. of Formats	Year Span	No. of observations
Digital camera	588	23	1999-2006	117
Cell phone	490	21	2001-2006	77
Camcorder	225	31	2001-2006	112
PDA	96	19	2001-2006	58
Total	1399			364

MODEL

Model Specification

In order to appropriately measure the market's acceptance of a technical format, one would ideally need data with a panel structure, wherein the dependent variables measuring market acceptance (market share) of a format are calculated across product categories and years. The benefit of developing such a panel structure where formats were observed across multiple years is that it allows controlling for format specific heterogeneity (Baltagi 2005; Prabhu, Chandy and Ellis 2005).The data used in this research allows for such a panel structure, albeit unbalanced.

As suggested by Wooldridge (2002), I perform a Hausman test to choose between random and fixed effects models. To run the test, I estimate both the fixed effects and random effects models and compare the saved coefficients from each to test that the random effects estimators are no different from the consistent fixed effects estimators. Based on the test, I continue with a random effects model.

I consider the possibility that formats that are developed by a larger alliance and/or utilized in a greater breadth of products are likely to survive longer. In a combination of these possibilities one could argue that a larger alliance is likely to keep developing the format technology, and hence result in a format that lasts longer. Therefore, as recommended by (Wooldridge 2002), I perform a Hausman test (Hausman 1978) to test for the endogeneity of the variable "format age." I first run a reduced form model with all exogenous variables on format age. The residuals from this are saved, subsequently included in the main equation with market acceptance as the dependent variable, and significance of the residual tested. This indicated that the variable "format age" is endogenous and is treated as such.

Next, I consider any potential for autocorrelation in my data. The Baltagi-Wu statistic (Baltagi and Wu 1999) has been shown to be better in cases on unequally spaced panel data, such as the case in my dataset as compared to the more traditional Bhargava et al modified Durbin-Watson statistic. Though exact critical values are not available in the literature (Kogel 2004), a Baltagi-Wu statistic of 1.93 indicates that autocorrelation is likely not a disruptive factor in the estimation of the model.

The presence of an endogenous covariate in the regression calls for an instrumental variable that is exogenous to the equation (uncorrelated with the error term) and is partially correlated with the endogenous variable (Wooldridge 2002), and a theoretically logical substitute for the variable in question. Given that appropriate instrumental variables are notoriously difficult to obtain, and given the limited number of appropriate candidates available that are excluded from my model[9], I use the Hausman-Taylor model that derives an asymptotically efficient instrumental variable estimator (Hausman and Taylor 1981). Using this model, also allows the latent individual effect to be correlated with both the time variant and invariant variables. OLS and GLS estimates are biased and inconsistent under such circumstances.

Consider a random effects model of the form

$$Y_{it} = \beta_1 X_{1it} + \beta_2 X_{2it} + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \mu_i + \varepsilon_{it} \qquad (1)$$

Where

'i' refers to the format and 't' to the time,

X_{1it} are exogenous, time varying variables,

X_{2it} are endogenous, time varying variables,

Z_{1i} are exogenous time invariant variables,

Z_{2i} are endogenous time invariant variables,

μ_i is the unobserved panel level random effect,

ε_{it} idiosyncratic error, and

X_{2it} and Z_{2i} may be correlated with μ_i

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[9] Appropriateness of IV's was tested using Hausman specification test (Hausman 1978).

Since X_{2it} and Z_{2i} may be correlated with μ_i, the simple random effects estimators are unlikely to be consistent for the parameters of the model. The fixed effects estimator would on the other hand, in removing μ_i also remove Z_{1i} and Z_{2i}.

Equation (1) is GLS transformed to give the Hausman-Taylor equivalent, represented below:

$$\widehat{Y}_{it} = \beta_1 \widehat{X}_{1it} + \beta_2 \widehat{X}_{2it} + \partial_1 \widehat{Z}_{1i} + \partial_2 \widehat{Z}_{2i} + \widehat{\mu}_i + \widehat{\varepsilon}_{it} \tag{2}$$

With $\widetilde{X}_{1it}, \widetilde{X}_{2it}, \bar{X}_{1i}, \bar{X}_{2i}$ and Z_{1i} as instruments, where

$\widetilde{X}_{1it}$ and $\widetilde{X}_{2it}$ are the within transforms of X_{1it} and X_{2it} respectively, and

$\bar{X}_{1i}$ and $\bar{X}_{2i}$ are the within panel means of X_{1it} and X_{2it} respectively

Hence, the Hausman-Taylor equivalent is represented below:

$$\widehat{MA}_{it} = \beta_1 \widehat{Size}_i + \beta_2 \widehat{Size}_i^2 + \beta_3 Composition_i + \beta_4 \widehat{MI}_i + \beta_6 \widehat{Breadth}_{it} + \beta_7 \widehat{Age}_{it} +$$
$$\beta_8 Breadth * \widehat{Age}_{it} + \beta_9 \widehat{Allsize}_{it} + \beta_{10} RD \widehat{\exp}_{it} + \beta_{11} \widehat{Compete}_{it} + \beta_{12} \widehat{SGA}_{it} + \widehat{\mu}_i + \widehat{\varepsilon}_{it}$$

$$\tag{3}$$

MEASURES

Dependent Variable

Market Acceptance (MA$_{it}$):

> *Measure 1*- The success of a format and the possibility of it becoming a standard are dependent on the number of products that actually implement it. The first of two measures of success of a format is an indicator of its acceptance in the market. Data was collected on the number of occurrences of the format and the

total number of products reported within the category. Market acceptance measure 1 is denoted by $MA1_{it}$, and is a measure of the percentage of products in a product category in a year, that includes or uses the format

$$MA1_{it} = \frac{\sum F_{it}}{\sum P_t}$$

Where

F_{it}= *No. of times a unique format 'i' is observed in time period 't'*

P_t= *Total No.* of products observed in time period 't'

Measure 2- An alternative indicator of success used in the analysis is the percentage of unique firms that adopt a format to include in their products. The dataset contains data on the number of unique firms which include the format in their products and the number of firms manufacturing digital cameras in a given year. *MA2$_{it}$* is a measure of the percentage of products in a product category in a year that includes or uses the format

$$MA2_{it} = \frac{\sum f_{it}}{\sum M_t}$$

Where

f = No. of *unique firms* which include the format '*i*' in their product in time period '*t*'

M = *Total No.* of firms manufacturing a product in time period '*t*'

Independent Variables

Format Age (Age$_{it}$): Measures the difference between the date of launch of a particular model within a given product category and the date of introduction of the format. If a format appears in a product, the very year it was launched, the age variable will take a value of zero. Product launch dates are available between 1999 and 2007, but since only 15 days of data were collected from 2007, the year 2007 was dropped from the scope of preliminary analysis.

Standard Setting Alliance Type (Type$_i$): The type of a standard setting alliance is determined by the nature of the alliance; specifically, whether it is developed with the purpose of developing multiple formats or significant improvements such as the Bluetooth forum. Standard setting alliances of this nature have formal governing bodies, commonly referred to as committees that govern their functioning. In addition to alliances that were clearly identified as being informal based on criteria described below, formats developed by single firms were treated as informal alliances. This was based on evidence from the popular press indicating that even though the format was developed by a single firm, there often are firms that support this alliance early on its life.

A formalized alliance would be characterized by announcements and reports similar to:

> Hewlett-Packard Co and five other companies involved in CD-Recordable/ReWritable technology have announced DVD+RW --a new recordable format. ……Hewlett Packard, Philips Electronics N.V., Sony Corp, Mitsubishi Chemical Corp, Ricoh Co Ltd and Yamaha Corp have now

submitted the open format specification to the ECMA international standards body for review and adoption.

-Telecomworldwire, 5th September 1997

The DVD+RW alliance is considered a formal standard setting alliance in the dataset, in light of the following

1) The alliance is mentioned in press reports or press releases from one of the partner firms.

2) Some firms have been identified as being alliance leaders.

3) As a group, continues to be active in developing newer versions of the format and new formats, as evidenced by press reports.

4) Press reports also discuss increasing membership to the alliance.

Correspondingly, the DVD+RW alliance has continuously been involved in formats development and standard setting activities, maintains a website discussing the various formats it is involved with, and matters of interest to it's members.

The DVD+RW Alliance is a voluntary group of industry-leading personal computing manufacturers, optical storage and electronics manufacturers including Dell, Hewlett-Packard Company, MCC/Verbatim, Philips Electronics, Ricoh Company Ltd., Sony Corporation, Thomson multimedia and Yamaha Corporation. The group seeks to develop and promote a universally compatible, rewritable DVD format to enable true convergence between personal computing and consumer electronics products.

-The DVD+RW alliance

On the contrary, formats launched by an informal alliance, are characterized by announcements and reports similar to:

Epson America Inc. today unveiled its revolutionary PRINT Image matching technology that ensures digital cameras and printers work together perfectly to produce photographs that print truer-to-life than ever before. Several leading digital camera manufacturers — Casio Computer Co. Ltd., Konica Corporation, Kyocera Corporation, Minolta Co. Ltd., Olympus Optical Co. Ltd., Ricoh Company Ltd., Sony Corporation and Toshiba Corporation — will incorporate PRINT Image matching technology in their upcoming digital camera models. Epson will include PRINT Image matching in all future photo printers.

-Epson Press Release, 2001

Such alliances are not characterized by

1) An announcement reported in popular and/or trade press, or by any of the individual firms involved.

2) No alliance leaders have been identified.

3) No further reports, beyond the announcement of the format, are available, or of the firms actively developing new versions of the format.

4) Other than reports of firms adopting the format (including the format in their products), there are no reports of firms partnering with the initial developer.

Alliance Size (Size$_i$): Size indicates the number of firms involved in the alliance at the time the development of the format was announced.

(Alliance Size)**2 (Size^2_i): The square of the above variable to test the non linearity.

Alliance Composition (Composition$_i$): The data describes the firms participating in the alliance and the corresponding format category. For each alliance in the database, this measures the proportion of firms that are active in three or more unique format categories (Excluding outliers, the mean number of alliances a firm participates in is three). Firms active in more than three formats are classified as generalists and standard setting alliances that have a higher proportion of firms participating in multiple format categories are classified as generalist standard setting alliances. Firms that are active in a single category are classified as specialists and alliances that have a higher proportion of firms participating in single a format category are classified as specialist standard setting alliances.

Marketing Intensity (MI$_i$): Measured by selling and general administrative expenses of the members of the alliance in the year preceding the announcement of the alliance as a percentage of assets. Prior researchers (Mizik and Robertson 2003) have used advertising expenses to measure a firms' focus on value appropriation, and state "One key component of value appropriation capability that is of particular concern to marketing managers relates to the effects of advertising." However, the data on advertising for the year prior to the alliance announcement is sparse. Therefore, I use a measure that is correlated with advertising expenses, namely selling and general administrative expenses. The SGA, when reported separately on COMPUSTAT includes advertising expenses and marketing expenses[10].

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[10] COMPUSTAT Data Definitions Part II, (LI-Z) (pp.642-643).

Format Breadth (Breadth$_{it}$): The breadth of application of a format is captured by the number of product categories it appears in. This is primarily a measure of the possible applications of a format.

Controls

Alliance Size (Allsize$_{it}$): Measured as number of employees for all the firms involved in the alliance in the year preceding the alliance announcement.

Selling and General Administrative Expenses (1999-2006) (SGA$_{it}$): Measured as the sum of selling and general administrative expenses of the firms in the alliance as a percentage of current assets in the years the format was observed (1999-2006).

Research and Development Expenses (RDexp$_{it}$): In examining the marketing capability of a firm, R&D expenses and as a consequence, its focus on value creation (Mizik and Robertson 2003) is controlled for. R&D expenses are calculated as the sum of R&D expenses for the alliance members as a percentage of current assets in the two years prior to the announcement of the alliance.

Competition Measures (Compete$_{it}$):

Total Products in a Category in a Year (Prodcatyr$_{it}$) - No. of products per category per year observed (as inferred from the number of products listed by Cnet.com).

No. of Firms Manufacturing a Product in a Given Year (Firmsman$_{it}$) - Count of unique firms that manufacture the product in a given year.

Table 4.3 summarizes the conceptualization of each variable, corresponding

measure and also presents the source of data.

TABLE 4.3

Summary of Measures and Data Sources

Conceptual Variable	Measured Variable	Data Source
Dependent Variable		
Market acceptance (Market share)	1. Percentage of products in a category at time t that implement the format 2. Percentage of firms which include the format in their product at time t.	CNet.com
Independent Variables		
Size of Standard Setting Alliance (H1)	No. of firms in the alliance at the time of formation/announcement	1. Factiva 2. Lexis-Nexis
Alliance Composition (H2)	Proportion of generalists in the alliance at the time of formation/announcement	1. Factiva 2. Lexis-Nexis 3. Format , Alliance and Firm homepages
Alliance type (H3)	Formal or informal alliance	1. Factiva 2. Lexis-Nexis 3. Format , Alliance and Firm homepages
Marketing Intensity (H4)	1. Sum of SGA/Assets for all firms in the alliance1 year prior to formation/announcement 2. Sum of SGA/Assets for all firms in the alliance 2 year prior to formation/announcement	1. COMPUSTAT 2. DATASTREAM
Breadth of Format Application (H5)	No. of product categories in which the format is used.	Cnet.com
Format Age	Year of announcement of a product (using the given format) – Date of Alliance announcement.	1. Factiva 2. Lexis-Nexis 3. CNet.com

TABLE 4.3 (Continued)

Conceptual Variable	Measured Variable	Data Source
Control variables		
Firm & Alliance Size	1. No. of employees in the alliance 1 year prior to formation/announcement 2. No. of employees in the alliance 2 years prior to formation/announcement	1. COMPUSTAT 2. DATASTREAM
Competition within a product category	1. No. of products per category. 2. No. of firms manufacturing the format.	Cnet.com
Selling and general administrative expenses over the period of observation	Sum of SGA/Assets from 1999-2006 for all firms in the alliance.	1. COMPUSTAT 2. DATASTREAM
Research and Development Expenses	Sum of R&D expenses/ Assets for all the firms in the alliance 2 years prior to the announcement	1. COMPUSTAT 2. DATASTREAM

CHAPTER V

RESULTS

Table 5.1 presents the correlation matrix for the data. Table 5.2 presents the

results from the estimated models. Model 1 uses the percentage of products in a category

in a year including the format, as the measure of market acceptance. Model 2 uses the

percentage of unique firms which include the format in their product, as the measure of

market acceptance.

Hypothesis 1 argues that the relationship between the number of members in the

initial alliance and the market acceptance of the format is 'U' shaped. This hypothesis is

supported by both models, as indicated by the positive and significant value of the linear

term and negative and significant value of the quadratic term. An increase in the number

of firms backing a format (size of an alliance) is associated with an increase in the

market acceptance of the format up to a point, beyond which, market acceptance shows a

decline with the size of the alliance. This result is contrary to the   Axelrod et al. (1995).

Their model, based on the assumption that that the utility of firms joining a particular

standard setting alliance increases with the size of the alliance was successful in

predicting alliance membership, thereby giving support to the afore mentioned

assumption. The results presented here are consistently strong across models and across

various combinations of independent variables. I do not predict an optimal number of

members, since different alliances are likely to perform well at varying levels of

membership and under varying circumstances.

TABLE 5.1

Correlations

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. MA1	1																	
2. MA2	.914	1																
3. Composition	-.076	-.063	1															
4. Age	.220	.228	.094	1														
5. Type	.113	.116	.152	.021	1													
6. Size	.271	.284	-.361	-.069	.220	1												
7. (Size)**2	.197	.211	-.340	-.061	.116	.960	1											
8. Firmsman	-.183	-.146	-.047	.086	-.061	-.098	-.098	1										
9. Prodcatyr	-.138	-.050	-.023	.097	-.052	-.055	-.060	.790	1									
10. Breadth	.311	.272	-.143	-.05	.213	.237	.131	-.033	-.033	1								
11. Breadth*age	.327	.318	-.001	.785	.173	.129	.063	.035	.056	.473	1							
12. AllSize1	-.015	.004	.286	-.261	.147	.259	.220	-.107	-.053	.307	-.037	1						
13. AllSize2	-.031	-.012	.300	-.269	.134	.216	.185	-.096	-.048	.285	-.066	.996	1					
14. MI2	-.068	-.041	-.088	.433	-.185	-.222	-.226	.003	.013	-.120	.278	-.345	-.355	1				
15. RDexp2	.007	.009	.126	.456	-.141	-.237	-.248	.010	.015	-.163	.274	-.249	-.26	.784	1			
16. MI1	.099	-.065	-.264	.241	.053	-.070	-.102	.082	.072	-.094	.111	-.386	-.381	.659	.477	1		
17. RDexp1	-.086	-.067	-.123	.181	.168	.003	-.061	.071	.074	-.055	.109	-.239	-.239	.400	.548	.830	1	
18. SGA	-.211	-.218	.233	-.295	-.284	-.058	-.040	-.080	-.039	.002	-.210	.399	.399	-.234	-.181	-.413	-.326	1

TABLE 5.2

Market Acceptance: Effect of Alliance, Partner and Format Characteristics

Dependent measures	Model 1	Model 2
	Market Acceptance 1	Market Acceptance 2
Variables of Interest		
(No. of members)	19.408***	27.186***
(No. of members)**2	-1.290***	-2.013***
Alliance Composition	46.756***	58.617***
Alliance Type	-4.902	-6.117
Marketing Intensity (SGA)– 1 year prior	212.338***	195.695**
Marketing Intensity (SGA) – 2 years prior	-130.306**	-118.481*
Format Breadth	10.090**	11.620**
Age	-.018	1.673*
Format Breadth*Age	.311	-.087
Controls		
SGA expenses over the period of observation (1999-2006)	5.874	22.484
Employees – 1 year prior (Alliance Size)	.931*	1.116*
Employees – 2 years prior (Alliance Size)	-1.112*	-1.291*
R&D Intensity – 1 year prior	-686.743**	-693.906*
R&D Intensity – 2 years prior	525.170**	571.016*
No. of Firms Manufacturing a product in a given year	-.379	———
Total products in a category in a year	———	.028**
N	334	339

* Significant at .1 level
** Significant at .05 level
***Significant at .01 level

Hypothesis 2 argues that a format developed by alliances with a greater

proportion of generalist firms will lead to greater market acceptance. This hypothesis is

supported and the result is consistent with prior research on product line breadth (e.g.

Robinson and Fornell 1985; Kekre and Srinivasan 1990), which has shown a positive

relationship between product line breadth and market share.

Hypothesis 3 suggests that formats developed by formalized alliances will be

more successful. While prior research has demonstrated that formalized alliances tend to

perform better, the results from my data do not lend support for this hypothesis. The

coefficient estimate, while negative in all models, is not significant. Nonetheless, this

presents an interesting result because the lack of an effect in either direction could be

because of the fact that formats developed by alliances without a formalized structure

may still be able to develop formats that fill a niche, and thereby find firms willing to

adopt it. On the other hand, it could also be that one or more firms involved in the

alliance are dominant in certain product categories and have sufficient market share in

the product category that their introducing the format in their product can generate

preliminary sales to generate initial externalities that convince other firms to adopt and

develop related products. Cases in point are firms such as Microsoft and Apple, which

owing to their size and influence in the industry have been tremendously successful in

launching new formats in the market despite not being involved in alliances. Effects to

this extent have been proven by Farrell and Saloner (1986), who show that dominant

firms have been single handedly capable of developing and commercializing successful

formats. I find some support for this possibility by the significant effect of the alliance

size variable.

Most of the literature that has studied formal and informal alliances, and

discussed earlier, have looked at the role of formality from the perspectives of learning,

risk and trust. While I use the existing literature to argue for the positive effect of formal alliances on market acceptance, to my best knowledge, there has been no literature that directly examines market based outcomes. The findings of this paper may not be therefore contradictory to prior research. I do however recognize that there are possibly more complex interrelationships between variables. The coefficients discussed are therefore possibly marginal effects that do not flow through other variables not considered here. Makhija and Ganesh (1997) for instance control for power asymmetry and partner need, which I do not account for. There could undoubtedly be relationships between the formality of alliance and power asymmetry, which goes un-captured.

Hypothesis 4 argues that formats developed and promoted by alliances with greater marketing intensity will gain greater market acceptance. Marketing intensity was significant in both models 1 and 2. Marketing intensity was measured for both 1 year and 2 years prior to the formation of the alliance, indicating that past marketing intensity is an important criterion for alliance members. Correspondingly, R&D intensity for 1 and 2 years prior to the announcement of the alliance is significant.

However the marketing intensity during the period of observation measured as selling and general administrative expenses proves to be not significant. This suggests that while marketing intensity is related to greater market acceptance in the early stages of the alliance, and firms spend more on marketing and commercializing the format, once the format gets established, marketing intensity is not a significant predictor of greater market acceptance. This could be due to the fact that in the early stages, firms look towards alliances that have the ability to take a format toward a tipping point or

firms that are able to sell products using the format. Beyond this initial stage, direct and indirect network externalities take over, and are of greater importance in predicting format success.

To gain a better understanding of the role of marketing intensity in the market acceptance of a format, I proceed to run a post hoc analysis comparing marketing intensity against R&D intensity in the early stages of the alliance. To this extent, I follow Mizik and Jacobson (2003), and measure the strategic emphasis of the firms, strategic emphasis being measured as

SE_{it} = (SGA Expenditures-R&D Expenditures)/Assets

Mizik and Jacobson (2003) use advertising expenses, rather than SGA expenses, but since, as discussed earlier, data on advertising expenses, was sparse and since SGA is correlated with advertising expenses, I use SGA to compute the strategic emphasis of the alliance developing format '*i*' in time period '*t*'.

The results indicated that when MA1 (the percentage of products using a format) was used as the dependent variable, marketing and R&D intensity were substituted by the strategic emphasis variable, strategic emphasis of a firm one year prior to the formation of the alliance, was positive and significant. The strategic emphasis variable is not significant in two years prior to the alliance formation. This is interesting because, it provides some indication as to the role of a strategic emphasis on marketing, one year prior to the alliance formation. Since this is a post hoc analysis, and the results hold only in one of the two models, the results are not discussed in greater detail.

Hypothesis 5 states that a format with greater breadth of application is likely to lead to greater market acceptance. I find support for this argument. However, as discussed in Chapter III, the question of whether products that survive in the market for longer periods of time, are likely to be adopted more widely and hence find greater acceptance in the market has often been contested in the literature. This is the case since it has also been argued in literature that as products exist in the market, newer technologies, and products are likely to replace the older ones. I therefore test the effect of both format age and the interaction between format age and format breadth, both of which I find to be not significant. This implies that format age, or the time for which the format has been available on the market is not a predictor of the breadth of applicability, and therefore of market acceptance.

CHAPTER VI

CONCLUSION: IMPLICATIONS, LIMITATIONS AND

FUTURE RESEARCH DIRECTIONS

IMPLICATIONS

While much of the past work on standard setting alliances has been theoretical,

the unique nature of the data used in this research allows empirical examination of the

success of formats and its relationship to the initial supporters. While there is a general

understanding of the role of the traditional standard setting organization (IEEE, IEEECS,

ISO, ITU etc.) in standard setting, and while we know the reasons for the shift to

standard setting alliances, we know much less about the characteristics of the alliances

and the participants in these alliances that are conducive to the successful development

of the format. Against this backdrop, the primary theoretical contribution of this research

is that it addresses this research void and enhances our understanding of the relationship

between standard setting alliances and the success of a format in the market.

The theoretical framework used in this dissertation relies, to a large extent, on the

network theory literature, which suggests that the initial conditions of any network

market are critical to the success of the product. The context of this research allows me

to test some of the initial conditions of a network (such as the effects of network size,

composition, type and marketing and R&D assets) on its future success. There have been

numerous calls from various quarters for more research on the evolution of technologies

(e.g. the Mack Center for Technology Innovation at Wharton and Tellis 2008). This research addresses this call.

Further, while much of marketing, management and economics literature has focused on the dyadic form of alliances, multi-firm alliances are an under researched topic. I address these gaps by building on extant research in the new product alliance and networks literature by observing the market outcomes over a time for a unique form of alliances.

For managers, this research first addresses the fundamental issue of alliance choice in format development. The results give some guidelines as to what types of standard setting alliances to support in the early stages and what characteristics to look for in the format. The results offer suggestions for the type of development stage alliances that firms can possibly join. While after development, a larger and growing standard setting alliance is better for the growth and spread of the format owing to network effects, there is uncertainty regarding the question of whether a small or a large alliance is better during the development stage. In addition, the results suggest that even for firms that operate in a limited number of industries, focusing on formats that may have applications in other industries could be potentially beneficial in terms of success of the format.

LIMITATIONS

Standard setting alliances, format development and standard setting are detailed processes with numerous intricate details that determine their success. This research

addresses but only a few of these. Empirical testing of a more comprehensive model is constrained by non availability data on multiple formats and their corresponding alliances.

Consideration of a larger set of variables such as the investments that individual firms make in the alliance, their role in the alliance, and the terms of the alliance, such as the intellectual property rights (Lemley 2002) can further enhance our understanding of the underlying processes. The outcome of standard setting processes is determined to a large extend, by the licensing practices of the firms that control the format. These practices are not accounted for here and hence a limitation. Some of the results, as discussed could therefore be marginal, in the fact that there may be more complex interrelationships between variables that are as yet unaccounted for in the model.

In addition, a more comprehensive database of formats per product model would greatly improve the quality of the results. Such a database can however be put together only by using more sophisticated programs designed to assemble data from a wider variety of sources.

FUTURE RESEARCH DIRECTIONS

Future research would ideally be able to move beyond observing the initial stage of the alliances, and observe different stages of the alliances. While such data on dyads in the pharmaceutical-biotech industries is available from commercial sources, different stages in larger alliances are either not reported or tracking them over time is a tedious and time intensive task. In addition, future research could also examine whether and how

firms assess prospects in standards markets. This would have direct implications for the choice of partners and alliances.

Another limitation of this research is that due to the non availability of data, the dataset used in the analysis is unbalanced. A more complete data set that covers all the years in question for all formats can present a balanced panel yielding better estimates. While such a dataset can be assembled, it would, as previously discussed, require the use of more sophisticated programming techniques and greater computing power.

Finally, this research focuses only on the formats developed within the consumer electronics industry. While the consumer electronics industry was chosen in light of both the prevalence of standard setting alliances and extensive standardization activities, standard setting is also prevalent in industries as diverse as aeronautics, construction, e-commerce, real estate and telecom. Future research could therefore potentially be extended to include these other industries.

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