Good Design Is Good Business: International Evidence for the Contribution of Product Design to Firm's Financial Performance

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Abstract:

Despite the wide recognition of the belief that "*good design is good business*", our academic research in design management largely lags behind the practice. This paper intended to offer useful complements to prior studies in the field by overcoming three theoretical and methodological shortcomings. It started with a historical review of the evolution of 'design' in business context during the last two centuries and explained what product design is in the 21st century. Six hypotheses were formulated on the relationship between product design and company performance and the moderating effects of industry. The hypotheses were then tested by six latent class regression models with a sample of 577 design award-winning firms and of 524 other randomly selected firms from 34 countries and 46 industries. The findings provided compelling evidence from all over the world that product design consistently contributed to firm's financial performance. However, the effect of product design varied with countries and industries.

Key Words:

Product design, design award, financial performance, latent class analysis.

1. Introduction

Today, there is a growing belief that "*good design is good business*" (Tom Watson Jr., former head of IBM). High-quality design is a powerful strategic tool that companies can use to gain a sustainable competitive advantage, to create corporate distinctiveness in an otherwise product- and image-surfeited marketplace, to give personality for a new product so that it can stand out from the crowd, and to reinvigorate product interest for matured products (Kotler and Rath, 1984). Studies of Dutch Design Institute (1994) and the Economist (1995) indicate that design budgets among American and European companies are increasing 8 to 20% a year. Chinese, Taiwanese, Korean, and Hong Kong companies and their governments are also committing huge resources to design in order to build global brands (Nussbaum, 2006). Companies are competing less and less on price but more and more on differentiation, relevance, and value to the consumer. One of the most famous design stories is Apple computer, whose hip-looking iMac not only boosted its market share and profits, but also started a trend toward style and fashion in personal computer (Reinhardt, 1999; Sage et al., 1998).

However, despite the wide recognition of the importance of product design, our academic research largely lags behind the practice. As Gemser and Leenders (2001) point out, "research on industrial (or product) design in general and on the relationship between industrial design and company performance in particular, is extremely light (Bloch, 1995; Potter et al., 1991; Roerdinkholder, 1995; Roy and Potter, 1993; Ulrich and Pearson, 1998). At best, the few studies which have been conducted in this area identify possible contributions of industrial design and/or offer anecdotal evidence on the positive effect of industrial design on company performance" (pp.28-29). Hertenstein et al (2005) also state that few studies have attempted to quantify the contribution of good industrial design to improved company performance, leaving managers with the intuitive senses that good industrial design is profitable, based primarily on anecdotal evidence (p4.).

There are four prior studies that begun to address this gap by providing the most direct evidence to date of the impact of design activities on firm's performance. In 1992 the British Design Innovation Group conducted two interesting surveys in the UK, comparing the performance of the award-winning firms (n=8 and n=6 respectively) with that of a random selection of 'typical' firms competing in the same industries. In both studies it is found that firms with 'good design' credentials perform significantly better (see Walsh et al., 1992). Likewise, the 'Groupe Bernard Juilhet' (1995) in France compared the financial performance of a group of firms investing regularly in design

(n=70) with a group of firms not investing in design (n=30), using figures found in annual reports of 1991 to 1993. They find that the financial performance of the firms investing regularly in design is better, especially in terms of average turnover, export sales, net yield and net results per employee.

Gemser and Leenders (2001) suggest that the impact of industrial design on company performance is not unconditionally positive but rather may depend on factors such as industry evolution and industrial design strategy. By comparing 23 firms investing considerably in industrial design with 24 firms investing little to industrial design, they find that the extent to which firms integrate industrial design in new product development projects has a significant and positive influence on company performance, in particular when the strategy of investing in industrial design is relatively new for the industry involved.

The study of Hertenstein, Platt and Veryzer (2005) has made a big step-forward on this issue. A panel of 138 design experts is first asked to rank the industrial design effectiveness of public traded firms. Based on the rankings, firms within each nine industry are then divided into high design effectiveness group and low design effectiveness group (n=29 and n=39 respectively). Finally, they compare a serial of traditional financial ratios between these two groups and find that firms rated as having "good" design are stronger on all measures except growth rates.

Although prior studies have contributed to the overall advancement of research and provided interesting results, there is room for improvement. First of all, no consensus has been reached about what design is in business context and what the role is that designers play in new product development (NPD) process. Some people regard design as decoration and designers only focus on the aesthetics of products. Some consider that design activity addresses not only the appearance of product but also its features, materials, functions and usability and designers are supporters of their marketing and engineering colleagues (e.g., Cagan and Vogel, 2002; Veryzer, 2005). Recently, some professionals and scholars suggest design being a function that can help conceptualize products early in development; designers are leveraging their position and broad-based skills to take a leadership role in the management of product development efforts (e.g., Siegel, 1995; Turner, 2000; Von Stamm, 2003). This apparent lack of uniformity in the definition of 'product design' impedes the progress of reaching a general agreement on how to assess the effectiveness of design activity, and then the evidence on the positive impact of product design on company performance becomes anecdotal. Second, there are some methodological drawbacks in the previous studies. Their sample sizes are too small

and concentrated on certain countries (i.e. Netherlands, France, the U.K. and the USA), so that their conclusions have limited generalizability, calling for further investigation on this crucial relationship. Finally, prior studies have not clearly addressed the firm heterogeneity and the contextual influence on product design's contribution. Although many managers recognize the importance of product design as necessary for being competitive, they often struggle to effectively manage their design activities for lack of practice guides.

This paper intends to offer useful complements to prior studies in the field by overcoming the above three shortcomings. It starts with a historical review of the evolution of 'design' in business context during the last two centuries and explains what product design is in the 21st century. Then, we will formulate hypotheses on the relationship between product design and company performance and the moderating effects of industry. We will test my hypotheses by six latent class regression models with a sample of 577 design award-winning companies and of 524 other randomly selected companies within the same industries and countries.

2. Theoretical Framework

2.1. What is product design in the 21st century?

There is often bewilderment surrounding the word "design" with parts of speech (i.e., noun and verb) revealing very different meanings. It is even worse, if one considers the different professional meaning of "design", for example, architectural design, jewellery design, graphic design, hair design, and even wedding or funeral design. The term of "product design" is unexceptional. It has been defined in various ways from different perspectives. Heskett (2001) suggests that much of this confusion has its origins in the diverse forms in which product design has evolved at different times. To give an unambiguous definition of design, it is useful to review the evolution of design in business, which can be divided into five periods:

Design for form. From the 18th to the late 19th century, working as draftsmen, designers merely translated academic artists' concept sketches for furnishings, fittings, and decorations for production specifications. The proliferation of forms that resulted increasingly meant a separation of decorative concerns from function (Heskett, 2001).

Design for production. With the growth of the capitalist industry and the expansion of the

marketplace, machines were intensively used, which led to a fragmentation of design and fabrication activities. Under the pressure of reducing cost, the form of industrial product must be simple, followed function and cohered with the aim of mass-production (Qdesign, 2000).

Design for sales. In the years after World War I, competition became more and more fierce, and mass advertising was used to persuade consumers to buy products which hinged upon visual imagery. All these required constant change in product appearance to stimulate market sales (Heskett, 2001).

Design for user. Since 1960s, after being attracted by the external design, consumers found many products unsatisfactory in use. That forced the role of industrial designers to change accordingly, so that they covered not only the issues of fabrication and aesthetics, but also human engineering, ergonomics and a little of market research (Qdesign, 2000). In 1980s and 1990s, the "*user-centered design*" paradigm has emerged, which encompassed both the cognitive aspects of using and interacting with product and the emotional aspects—how people feel about using it (March, 1994). Designers also began to integrate into team-based or parallel product development processes. "Design" in product development context is composed of *industrial design* which focuses on user-product interfaces, ergonomics, materials and aesthetics issues, and *engineering design* which focuses on the technologies, functions and production.

Design for Life. In the 21st century, business circumstance characterizing fierce competition and high-velocity change has led to increased emphasis on understanding the needs of consumer. Yet, the transfer of consumer and market knowledge from marketers to designers still proves to be problematic (Perks et al, 2005), because industrial designers are traditionally trained to be sensitive, intuitive, spatial, physical, visual, emotional artists that favor right-brain thinking (Kover, 1995; Leonard-Barton and Rayport, 1997; Molotch, 2003); while engineering designers often place over emphasis on technical criteria alone. Business analysis seems to be too deterministic for most designers because they prefer individuality of expression, vitality, human elements and technical sophistication in design. When designers are compelled to express performance parameters in marketing terms, where they have no knowledge and experience to understand, the design-marketing conflicts emerge and designers get frustrated with the other NPD team members (Perks et al., 2005). Moreover, designers are often suspicious of market research because ‘‘market research isolates a product from the context of its purchase or use and cannot predict how it might catch on with time and exposure. Designers think they are the ones who project forward in terms of market preferences,

whereas market research documents preferences in the present.'' (Molotch, 2003 p. 46).

On the other hand, the functional department structure may cause some designers to prefer to remain pure to their function with "not-invented here" attitude and neglect the other issues such as costs of production, manufacturing process and selling. The prevailing cross-functional team structure may not perfectly solve this problem. It has been shown in literature as "good concept but poor implementation" (Henke et al., 1993). For instance, in one empirical study, Song (1991) found the achieved integration level was only about half of the desired state. Divergent perspectives of different roles in timescales, style of working and objectives often result in perceived goal incongruity, which impairs all components of cross-functional integration and requires management intervention for resolution of conflicts (Xie et al., 2003). There is common tension "between personnel responsible for basic R&D and those such as industrial design and marketing personnel who are responsible for aspects related more toward the finished product and the consumers who will use it" (Oliver, 2002).

To resolve the above problems, it is advocated that the design function should adopt a more prominent position in the management of product development efforts and participate in all stages of new product's lifecycle (Turner, 2000; Von Stamm, 2003; Perks et al., 2005). At the development stage of NPD, embracing traditional marketing tasks and the other functions enables designers to effectively understand the customers without distorting market information and create successful products (Leonard-Barton and Rayport, 1997; Von Stamm, 2003). Bailetti et al (1991) and Veryzer et al (2005) also indicate that working in the front lines, designers can glean useful insights firsthand, spark initial ideas or refine design concept, increase their productivity and creativity, foster their deeper appreciation of user needs, and truly understand what delivers value to customers, which will significantly impact on the eventual success of the final product.

Throughout the manufacturing phase of NPD, designer participation can help solve production process problems and drive a large part of cost reduction potential, increasing overall profitability (Loch et al, 1996). It has been widely reported that 75-90% of product costs are determined when product design is finished (Berliner and Brimson, 1988; Shields and Young, 1991). Many CEOs accentuate the importance of design for manufacturing, the estimation of costs during design process (*design to cost*), and the use of CAD and PDM tools to reduce manufacturing tooling time and product costs (Dickson et al, 1995).

Even during the product launch stage, designers are supposed to play a vital role. Having the best awareness of new product features, designers should participate in the

consideration that how to effectively deploy marketing and selling operations in order to influence consumer's attitudes. For example, in the case studies of Perks et al. (2005), they found that designers could arm key sales people with information and induce buy-in and motvation to sell the product. The sales people directly got designers' support in communicating cirtical design and technical product features to retailer buyers. designer's participation in the commercialization period can also help them discover the deficiencies of current product, better understand consumer's needs, and conceive the next generation.

In addition, designer being leader in the cross-functional NPD team can improve cross-functional integration, unit team members' goals, harness cross-functionality, fight organizational inertia, rally management support, and lead the project to make for a great story. As discussed above, product design in the 21st century is no longer viewed as being only about the look and feel of product or as supporting function of engineering and marketing. Indeed, product design activities encompass the entire product lifecycle, from the idea generation, research & development, implementation, to product disposal and the birth of next generation. The involvement of designer in all stages of product lifecycle enables the designer to view NPD from multiple perspectives (Fujimoto, 1991). His/her interests are the broadest within the team, aligned with all the other members. Once a designer is assigned to be responsible to initiate, organize and operate the entire NPD project, he/she will be highly committed and fully capable to unify the competence of marketing & Sales, R&D, and production functions under the venture of new products. Actually, many leading companies such as DaimlerChrysler, Sony, and so on, have established their own 'Design Centers' to organize the whole new product development programs. Samsung even has created the post of Chief Design Officer so that the designers can come up with entirely new product categories (Business Week, 2004). The head of most design functions in many companies usually reports to the vice president level or above, indicating that design play a key role in a firm's strategy implication by interpreting strategic concepts and shaping them into products (Hertensten and Platt, 2000).

Therefore, under today's circumstance that the design paradigm has shifted from cosmetic design to holistic design, we adapted the view of Crawford and Di Benedetto (2003) to define product design as *the synthesis of technology and human needs into marketable and manufacturing products dedicated to the mutual benefit of both user and manufacturer*. It is multi-faceted concept, implying that in the 21st century, product design (and designers) should lead the NPD project, embrace marketing prowess,

technological sophistication and engineering capabilities, develop new products based on consumer's needs, and create "win-win" values for both users and firms.

2.2 Contribution of product design to financial performance

Once the definition of product design is clear, we can discuss how product design impacts firm's financial performance. Prior studies provide strong evidence suggesting that customer reactions and preferences to new products can be affected by the visual aspect of product design, for example, the form of a product (Sewall, 1978; Berkowitz, 1987), logo (Henderson and Cote, 1998), package (Schoormans and Robben, 1997), and aesthetics (Yamamoto and Lambert, 1994). The functional aspects of product as well as the influence of user-centered design principals on consumer's responses also have been investigated and documented. Card et al (1983) and Shneiderman (1998) find that the nature of functionality is a critical determinant of consumer's perceived risk. Designers should avoid adding too many functions into a product, making it not be perceived as being easy to try or as having advantages easily recognized and explained to others. Finely set product assortments can also affect consumer's perceived sentiments on the differences amongst products (Simonson, 1999). Further, standardization design on utilization interface and techniques significantly increase network externalities (Sahay and Riley, 2003) as well as consumer's confidence and reduce their switching costs (Dhebar, 1995), which make consumers feel beneficial to purchase such products. All of the studies discussed above consist with the finding that consumers assign greater value (i.e. price) to well-designed products (Veryzer, 1993). Hence, as Hertenstein et al. (2005) show, product design can improve the sales dimension of financial performance by increasing volume or selling price:

H1: the more effective product design, the better sales performance.

Product design can also improve the cost dimension of financial results. Advanced design methods such as computer-aided design, rapid prototyping and visual testing can well understand consumer needs, accelerate development process, ameliorate product design quality while minimizing redesign efforts and ultimately reduce development costs, (Drozdeno and Weinstein, 1986; Dahan and Srinivasan, 2000). Besides, well-designed products can economize marketing costs. Borja de Mozota (1990) provides evidence that companies who invest in industrial design tend to launch more profitable products indicating ‘‘profit increase is achieved not only by expanding sales or by a drop

in manufacturing costs, but also by a drop in advertising costs'' (p. 75). The major redesign of the Honda Odyssey in 1999 had a persistent, beneficial effect on the margins for the vehicle, which continues to enjoy strong sales without virtually any promotional incentives (White 2001). Hertenstein et al. (2005) even suggest that designing durable and high-quality products can reduce warranty expenses and products designed for easy installation and first use can reduce after-sales service and repair costs; likewise, designing products with fewer parts or the common parts to other products will decrease the costs of material, which is supported by Liker et al (1999)'s evidence that 'design to cost' approach can reduce manufacturing tooling time and product costs. The preceding discussion and the few empirical studies in literature suggest that:

H2: the more effective product design, the better performance in cost reduction.

Increasing sales while reducing costs normally boost firm's profitability. Walsh et al. (1992) find that the design conscious firms have a significantly higher profit margin than the firms without design conscious in one industry. Similarly, Gemser and Leenders (2001) find a statistically significant correlation between industrial design intensity and profit in the instruments industry in a single year examined.

In addition, good product design should consider firm's production conditions, maximizing the potential of present equipment and avoiding purchasing redundant fixed assets as well as inventories (Hertenstein et al., 2005). Three studies have examined the consequences of design decision for the amount of assets. Walsh et al. (1992) find a significant difference between design conscious and other firms for return on capital (assets) in two industries. Hertenstein et al. (2001) and Hertenstein et al. (2005) also find a positive relationship between good industrial design and return on assets. These studies provide empirical support for the following hypothesis:

H3: the more effective product design, the higher profitability.

A further consequence of the above discussion relating good performance on sales, cost reduction, and profitability to effectively designed product is that those good design firms will grow faster than the others. That is because well performed firms normally have capability to design more successful new products and then generate more quickly turnover and profit to develop than their competitors. The limited evidence available regarding design and growth is mixed. Walsh et al. (1992) find a significantly positive relationship between sales growth and design in one industry but not in the other. Such

positive relationship cannot hold true in Gemser and Leenders (2001) but they find profit growth is marginally significantly related to industrial design intensity in one industry. Hertenstein et al (2001) find a positive relationship between effective design and growth in both sales and profit but not growth in cash flows. In Hertenstein et al (2005), however, none of growth rates for sales, net incomes and net cash flow is related to design effectiveness. Although the evidence is mixed, we believe that:

$H4_{a\ (b)}$: the more effective product design, the higher growth rates for sales (net incomes).

All the above performance on sales, profitability, assets and growths of public company will eventually result in higher stock market return. Investors often assume that firms with quality products (i.e. well-designed products) are well-run firms and therefore worthy to be invested in (Lakonishok, Shleifer, and Vishny, 1994). Many financial studies report that stock markets usually welcome the announcements of the launches of new product (e.g., Pardue et al., 2000) and the investment of R&D (e.g. Booth et al., 2006; Xu and Zhang, 2004). In the same vein, we expected that stock market performance should be positively related to firm's product design effectiveness. Hertenstein et al (2005) provide direct evidence that the 'good design' firms have better stock market return than the 'bad design' firms. Therefore,

H5: the more effective product design, the higher market returns.

The type of industry may moderate the effect of product design on firm's performance. Firms in different industries allocate different resources to product design. In the industry where new products largely based on some new core technologies, the initial role of user and product design is often small. As the technologies become established and competitions become more and more fierce, some firms begin to use product design as a secret weapon to gain a sustainable competitive advantage. When the concept of design is widely adapted in this industry, the positive effect of product design on financial performance may fade away. That is to say, instead of providing a competitive edge, investing in design may no longer provide benefits to the company (Gemser and Leenders, 2001). This dynamic perspective leads me to expect that in industries where product design is commonly used, the contribution of product design to performance will be less significant than in industries where the ideology of design has recently be accepted. The empirical study of Gemser and Leenders (2001) provides direct evidence to this argument—they find that investing in industrial design in the instruments

industry has stronger influence on performance than in the furniture industry. Thus,

H6: the contribution of product design to firm's financial performance is stronger in industries where the ideology of product design is emerging than in industries having a relatively long tradition in product design.

The effect of product design on firm's performance may also vary from country to country. As we know, good design requires big bucks. For example, according to Business Week (February 14, 2004), automakers like GM and Ford have boosted spending on design by at least 50% since 1990. Just the salary and bonuses of top car designers cost almost $1 million. However, the outcomes of such huge investments are neither immediate nor certain. Indeed, product design deals with products and process not yet in existence, which makes the estimates of future cash flows very difficult--the projects may not result in any payoff (they may be entirely unproductive or failed) or may generate profits only after many years. Therefore, design is a highly risky activity, implying a big vigilance to managers and shareholders and requiring their high quality decision-makings and implementations. Prior studies in innovation have indicated the perceptions of risk of managers and shareholders are influenced by national culture (Shane, 1993) and corporate governance systems (Demirguc-Kunt and Maksimovic, 1999). The companies in a country with high risk tolerance culture and insider-dominant governance system may be more inclined to make long-term investment in risky new product design projects than their counterparts in a country with large risk avoidance and outsider-dominant governance system. Consequently, it is reasonable to assume that the impact of product design on financial performance may be different in different countries. Given the lack of direct evidence in literature, we offered no *a priori* conjectures in terms of this possible moderating effect. Rather, it will be explored in the empirical section.

3. Methodology

3.1. Data

To test the hypotheses, we regressed financial performance on firm's product design effectiveness. The sample was composed of two groups: product design-award winners and non winners. We selected the companies that had won any of the three world-class design awards from 2000 to 2006 (i.e. International Design Excellent Award, Chicago-Athena Good Design Award, and German Red Dot Award) and that are assumed to have superior design effectiveness.

Based on the information on the official websites of the above three awards, we first recorded each award-wining product's name, manufacturer, awarded year and launch year (Chicago-Athena Good Design only). There were 4158 award-wining products and 1659 award-wining companies (manufacturers). Then we looked for each company's financial data in Thomson One Banker and BVD AMADEUS databases. A conscientious effort was made to fill in the missing values from companies' annual records.

Finally, we have collected the data of 577 companies over this eight-year period (1998-2005) from 34 countries and 46 industries. To compare with these winning companies, we have randomly selected 524 non-winning companies from the same databases by strictly controlling the country and the industry. The distribution of samples is equivalent in two groups, as the X^2 test are not significant (see Table 1).

3.2 Measure

Product Design Effectiveness

Assessing the effectiveness of design is fraught with stubborn difficulties. This is due, on one hand, to the ambiguous estimation of 'design investment'. "While there are well understood ways to calculate firm's return on investment or ROI, there has not yet been developed a way to calculate a firm's return on design or 'ROD', or even to determine what proportion of the 'I' is really 'D'" (Hertenstein et al., 2001, p.11). Rarely does a firm change its product's design in isolation from other activities. Whether it is packaging, engineering design, brand design or even store interiors, the chances are the new design will be accompanied by marketing mix or sales force. In addition, design investment is subject to errors and biases caused by financial reporting and cost

accounting practices, as indicated in Hertenstein et al. (2001); especially when some design activities take place outside a firm's formal operation, the amount of design expenditure may be underestimated in some data sets. As a practice matter, firms are also reluctant to make the effort to retrieve precise information necessary to calculate the commitment to individual design projects. An objective evaluation of 'ROD' is very hard to achieve, especially at product/project level. Prior studies have turned to use subjectively evaluated design investment level as a proxy of design effectiveness (e.g. Groupe Bernard Juilhet, 1995; Gemser and Leenders, 2001). Such measure is problematic, however, since most managers have not exact numbers on the input of design. On the other hand, measuring design's input tells only part of story. Investing in design does not necessary generate fruitful results. In fact, product design is as risky as the other innovative activities and may be entirely unproductive or failed. Therefore, despite the emphasis it is given by the business world, there is neither a universal measurement, nor a single underlying indicator of product design effectiveness commonly accepted.

Design award can serve as a reliable proxy for measurement. The purpose of design awards is to recognize firm's design excellent and candidate products have to face the captious criticisms from peers and experts before some of them can win the medals. Therefore, design awards provide hard evidence to companies that their creative expenditures are well spent, reward management's foresight in using the power of design beyond the actual new product development process, and give the compelling winners the public attention and prominence. The anecdotes of successful product design stories in literature also suggest that design award well represents a firm's design effectiveness (see Haller and Cullen, 2004). Thus, herein we use each firm's design award counts as the aggregate proxy of product design effectiveness at firm level (0 for those companies without any design award): the more awards a firm receives, the more effective its product design is.

Financial performance

Six well-documented financial ratios were selected: net sales divided by total assets gross profit margin, net incomes divided by total assets, sales growth and net income growth, and market return, measuring firm's performance in terms of sales, cost reduction, profitability, growth and stock market respectively. Individual items were first taken from the financial statements of each company and then six ratios were calculated. The financial data were examined over an eight-year period—1998 to 2005

in order to minimize the influence of business cycles or industry volatility on company performance and provide reliable information. we noticed that most of products were launched two years ago before they won the 'Chicago-Athena Good Design' award (mean=2.3 year). So the data of 1998 and 1999 were also included to improve the strength of causal inferences. Finally, the average of each ratio was used as the measure.

Industries and Countries

Industries were defined by the primary two-digit standard industry classification code (SIC). Referring to varies arguments of innovation characteristics of different industries (Tylecote, 1999; ISTAT, 1988; Doudeyns et al., 1993; Mansfield, 1986; Arundel et al., 1995; Archibugi and Pianta, 1996), we classified these 46 industries of my sample companies into three types of industries: 'high design industries', in which product design has long been used (e.g., electronics, food, and textile); 'low design industries', in which the ideology of product design is emerging (e.g., metal mining, machinery, and services): and 'middle design industries' (e.g., paper and related, rubber and plastics, wholesales) which are between 'high design industries' and 'low design industries" (see Table 1).

We have also recorded the country in which each company is incorporated or legally registered. These 34 countries were classified into four groups by taking their social-economic features into account: 'North American developed countries', 'European developed countries', 'Asia-Pacific developed countries' and 'emerging countries' (see Table 1).

Table 1: Distributions of Samples by Countries and Industries

Countries	**Non-Winner**	**Winner**	**Total**
North American (2 countries)[1]	194	149	343
European (17 countries)[2]	269	370	639
Asia-Pacific (7 countries)[3]	53	47	100
Emerging (7 countries)[4]	8	11	19
		$X^2(32)=31.51, p=0.49$	
Industries			
Low Design (16 industries)[5]	103	120	223
Mid Design (10 industries)[6]	81	121	202
High Design (20 industries)[7]	340	336	676
		$X^2(45)=49.22, p=0.31$	
Total	**524**	**577**	**1101**

Notes:
1 includes Canada and the USA.
2 includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Liechtenstein, Netherlands, Norway, Portugal, Slovenia, Spain, Sweden, Switzerland, and United Kingdom.
3 includes Australia, Hong Kong, Japan, Korea, New Zealand, Singapore, and Taiwan.

4 includes Bermuda, Cayman Islands, Czech Republic, India, South Africa, Thailand, and Turkey.
5 includes 10, 16, 17, 28, 29, 33, 34, 49, 60, 61, 65, 67, 73, 75, 80 and 87.00 (2-digit SIC code, see www.ohsa.gov).
6 includes 26, 30, 32, 39, 47, 50, 51, 53, 59, and 89 (2-digit SIC code).
7 includes 20, 22, 23, 24, 25, 27, 31, 35, 36, 37, 38, 45, 48, 52, 54, 56, 57, 70, 78, and 79 (2-digit SIC code).

3.3 Results

Since my sample companies scattered all over the world and there are many intangible or tangible differences in accounting systems, national cultures and economic models, the unobserved firm heterogeneity cannot be ignored. Herein, we used latent class regression (with the package *Latent Gold 4.0*) that simultaneously classifies observations into latent segments and estimates regression models within each segment (see Wedel and kamakura, 2000). This approach directly identifies latent segments on the basis of the inferred relationship between the response variables (i.e. the six financial ratios) and the sets of explanatory and covariate variables (i.e. design award counts, type of industry and group of country).

Descriptive statistics

We first transformed the six financial ratios with nature logarithm because the distribution tests indicated that they were not normally distributed and then violated the assumption of latent class regression. Table 2 contains the descriptive statistics and the correlation matrix of the measures. We can see that design award winning companies have significantly better financial performance than non-winning companies in almost all respects, except ‘gross profit margin’ (p=0.148) and ‘sales growth’ (p=0.068). The correlations were within acceptable limits with the highest correlation=-0.273.

Table 2 : Descriptive Statistics of Variables

Variables	Mean (S.D)				1	2	3	4	5	6	7	8	9
	Total Sample	Winning Group	Non-Winning Group	T-Test for M. Equity									
1. Awards Counts		4.338 (8.885)				.050*	.000	.093**	-.006	.072*	-.071**	-.078**	.064
2. Industries							-.049	.001	-.059*	.007	-.055	.005	.082*
3. Countries								.193**	-.114**	-.078*	-.041	.017	-.101*
4. Net Sales/ Total Assets	1.1454 (0.6588)	1.2862 (0.6849)	1.0165 (0.6066)	P<0.001					-.053	.114**	-.244**	.046	-.037
5. Gross Profits Margin	0.3335 (1.6152)	0.2306 (2.5034)	0.398 (0.5564)	P=0.148						.042	-.012	.031	.220**
6. Net Incomes/Total Assets	-0.1623 (1.8605)	0.0009 (0.3106)	-0.3112 (2.5477)	P=0.006							.109*	-.273**	.239**
7. Net Sales growth	0.9886 (15.2651)	1.7592 (20.9564)	0.144 (2.4689)	P=0.068								.233**	.204**
8. Net Incomes Growth	0.021 (11.4008)	1.0636 (12.5595)	-0.93 (10.1493)	P=0.006									.050
9. Market returns	13.0689 (81.7813)	32.0904 (134.7602)	4.9886 (40.2801)	P=0.005									

*: $p<0.05$

**: $p<0.01$

Model estimation and selection

Latent class regressions test the statistical significance of the initial set of indicators. We removed non-significant variables from the regression models, in order to identify an optimal model based on the following criteria (see Martinez Guerrero et al, 2007):

--L^2 (L-squared): the "likelihood-ratio goodness-of-fit value" measures the degree of association which a certain model does not explain. A higher value of L^2 indicates a poorer model fit and a higher degree of unexplained association in the data.

--Bayesian Information Criterion (BIC): measures such as BIC AIC CAIC and AWE allow for comparisons between different models based both on their model fit and parsimony. Recent research suggests that they are the most useful information criteria for model selections in latent class analysis (Magidson and Vermunt, 2004). Lower BIC values characterize better solutions.

--Classification Error: It reports information about the proportion of cases classified into an incorrect class or group when researcher classifies cases based on the highest membership probability of each case. The smaller the better the model fits to the data.

--R^2: The R-squared represents the proportional reduction of errors of a concrete model, compared with the baseline model.

Table 3 shows the values of these criteria for the selected regressions models. We finally determined that two segments for 'ROA' and 'Market Return', three segments for 'Sales/Total Assets', 'Gross Profit Margin' and 'Net Income Growth', and four segments for 'Sales Growth'. The Scheffé multiple comparisons of means of dependent variables indicated that the cross-segmental financial performance is distinctive in almost all aspect except 'market returns' (see the Note 1 in Table 4).

Table 3: Values of Selection Criteria

Model	Classes	L^2	BIC	Npar	Class Err.	R^2
Sales/Assets	3	-57.0517	296.207	26	0.1782	0.7178
Gross Profit	3	-12.0935	206.2903	26	0.2317	0.6626
Income/Assets	2	-325.9291	763.9217	16	0.2887	0.3065
Sales Growth	4	-619.5644	1491.272	36	0.3081	0.7983
Income Growth	3	-601.6743	1385.452	26	0.3544	0.5173
Market Return	2	-327.8805	907.9041	36	0.1158	0.7293

In total, there were six latent class regression models. The first five models aim to explain firm's five different financial ratios on the basis of product design effectiveness (award counts) and the interactions between award counts and three different types of industry. The last model considers market return as a function not only of design effectiveness (award counts) and its interaction with industry, but also of the proceeding five ratios and their interactions with design effectiveness. Table 4 contains the results of model estimations.

Firm's design effectiveness (measured by design award counts) positively affected firm's financial performance in almost all segments, in support of my hypotheses H1-5. The interaction between design awards and the type of industry varied from segment to segment: design awards had totally non-significant effect on firm's financial performance in the 'high-design' industries but had either positive or negative effects in the 'low-design' and the 'middle-design' industries, partially supporting the H6. In the following texts, we explained the findings across the segments for each financial ratio.

--Sales/Total Assets: as predicted in H1, design effectiveness strongly affects firm's sales performance in all segments. This effect is also significant in the middle-design industries. Segment 1 (61%), the biggest segment and mainly composed of the companies in Europe, the Asia-Pacific and emerging countries, outperformed much the other two segments in terms of sales and design awards. Firms in Segment 2 (47%) are mainly from North American and have modest sales performance. Segment 3 occupies only 8% of samples, which are mainly from Europe and America. Although the firms in S3 performed poorly in this period, design effectiveness has the strongest positive effect on sales performance, suggesting that for them, winning more design awards will largely stimulate their sales.

--Gross Profit Margin: My H2 holds true, as design effectiveness have very strongly positive effects on gross profit margin in two main segments (S1 and S2) as well as a modest positive effect in Segment 3. However in S1 (47%), which is mainly composed of European and American firms, the negative effect of interaction between design awards and the low design industries indicates that instead of reducing product costs, product design increases the expenditure in these industries. In S2 (46%), which is mainly composed of firms from Asia-Pacific, North America and emerging countries, design effectiveness strongly contribute to cost reductions in general but slightly in the low-design industries. The main and interaction effects of design become modest for the rest companies in S3 (7%) that mainly come from emerging and Asia-Pacific countries and have won much less design awards than the others.

Table 4: Results of Model Estimations

N=1101	1.Sales/Total Assets	2. Gross Profits Margin	3. Net Incomes/Total Assets	4. Sales Growth	5. Net Incomes Growth	Market Returns

Segment	S1	S2	S3	S1	S2	S3	S1	S2	S1	S2	S3	S4	S1	S2	S3	S1	S2
Seg Size	65%	27%	8%	47%	46%	7%	59%	41%	67%	14%	14%	5%	52%	32%	16%	84%	16%
Mean[1]	1.30	0.71	0.49	0.59	0.30	0.12	0.06	0.02	0.09	0.01	0.49	19.63	0.30	1.97	0.70	17.64	12.68
M. of Awd	2.65	1.57	0.45	2.41	2.25	0.36	2.31	2.12	2.21	2.28	3.3	1.12	2.26	2.45	1.25	2.37	0.31
Award	**3.26**^{**2}	**2.52****	**4.39****	**5.49****	**8.62****	**0.59****	**9.21****	**-3.40****	**2.55****	**3.69****	**1.54****	**-0.34****	**2.40****	**-4.45****	**1.46****	**-0.13****	**5.78****
Awd x low	n.s.	n.s.	n.s.	-2.71*	0.01*	0.79*	**-2.66****	**1.65****	**-2.45****	**-1.03****	**1.35****	**2.35****	n.s.	n.s.	n.s.	n.s.	n.s.
Awd x mid	**0.19***	**1.76***	**2.53***	n.s.	n.s.	n.s.	n.s.	n.s.	**-3.41****	**1.95****	**-2.38****	**3.43****	n.s.	n.s.	n.s.	**0.21****	**-5.12****
Awd x high	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
1.																n.s.	n.s.
2.																**0.37****	**3.25****
3.																**2.73****	**2.50****
4.																**5.91****	**3.37****
5.																n.s.	n.s.
Awd x 1.																**0.32****	**6.49****
Awd x 2.																**0.57****	**3.39****
Awd x 3.																n.s.	n.s.
Awd x 4.																n.s.	n.s.
Awd x 5.																**0.98****	**5.35****
Americain	***-2.83***^{2}	***0.28***	***1.34***	***1.92***	***-0.21***	***-2.91***	***3.05***	***-3.05***	***-0.95***	***-0.04***	***-1.25***	***1.03***	*-0.87*	*0.53*	*0.06*	***0.22***	***-0.22***
European	***-0.54***	***-1.62***	***1.27***	***2.55***	***-2.64***	***-1.88***	***0.27***	***-0.27***	***-0.36***	***0.88***	***-1.82***	***0.36***	*-1.77*	*0.25*	*0.84*	***-1.31***	***1.31***
Asia-Pacific	***0.8***	***0.81***	***-0.83***	***-1.34***	***1.28***	***1.33***	***-1.79***	***1.79***	***0.06***	***1.09***	***0.95***	***-0.89***	*-0.02*	*0.38*	*-0.25*	***-1.12***	***1.12***
Emerging	***0.76***	***-0.09***	***-0.35***	***-0.63***	***-0.05***	***1.13***	***-0.45***	***0.45***	***0.51***	***-0.82***	***0.58***	***0.28***	*0.99*	*-0.47*	*-0.19*	***0.78***	***-0.78***

1: the results of the overall test of means across segments for each ratio: 961.34**, 671.25**, 327.58**, 654.01**, 228.51**, and 0.018, respectively.
2: the numbers in bold mean the cross-segmental equivalence test (*Wald* =) is significant.
*: $p<0.05$ **: $p<0.01$

--Net Incomes/Total Assets (ROA): the impact of design effectiveness on profitability is mixed. In Segment 1 where firms mainly come from North America and Europe (59%), design effectiveness has a very strong effect on profitability, but this effect is reversed in conjunction with the low-design industries. This phenomenon can be linked to the effect on gross profit margin in Segment 1: since the production costs increases with design awards in American and European low-design industries, it is reasonable that the profitabilities consequently decrease. For those firms in the Asia-Pacific and emerging countries which mainly constitute the S2 (41%), the negative effect of design awards on ROA suggests that design seems to be so costly that design expenditures swallow up their profits. However, in the low-design industries, this effect becomes positive.

--Sales Growths. The samples were divided into four segments. In the biggest segment S1 (67%), firms were mainly from American, European and emerging countries with modest sales growth. The S2 (14%) is composed of firms mainly from Europe and the Asia-Pacific that performed poorly. Firms in S3 (14%), mainly from the Asia-Pacific and emerging countries, grew quickly in this period. The S4 takes up only 5% of samples but the average sales growth rate of its component companies reached 19.63. According to common senses, such rapid sales expansion is so rare that we believed that the outlet samples were allocated to this segment and thus the estimations of the S4 were excluded from consideration. In the first three segments, design effectiveness was consistently and positively related to sales growth, in support of H4a. However, this effect varied from segment to segment after taking the types of industry into account: in S1, it was negative in both low- and middle-design industries; it was also negative in S2's low-design industries of and in S3's middle-design industries while positive in S2's middle-design industries and in S3's low-design industries.

--Net income growth: In this regression the group of countries could not significantly characterize different segments. None of the interactions between three types of industry and design effectiveness significantly affected net income growth. Design effectiveness significantly contributes to the modest net income growth in the S1 and S3. Conversely, this effect was negative in Segment 2, the best performed segment, suggesting that for the firms in this segment, spending money on the pursuit of design awards have jeopardized the augment of their bottom lines. In general, the slightly

negative mean of the effect of design (-0.003) suggests that irrespective of the segments, design effectiveness does not contribute to firm's net income growth. Thus, my H4b does not receive support.

--Market Return. The samples were grouped into one large segment (84%) with better return in stock market, in which many firms are from North America and the emerging countries, and one small segment (16%) with relatively worse market return, in which firms are mainly from European and Asia-Pacific developed countries. Sales growth, ROA and gross profit margin positively impacted on market return in both segments. In S1, the main effect of design effectiveness on market return was slightly negative but reversed in the middle-design industries. The design effectiveness also positively affected on market return, as the firms had better accounting-based performance in terms of sales/total assets, gross profit margin and net income growth. In S2, although firms had won much less design awards than their counterparts in S1, the design effectiveness and its interaction with net income growth had strong influences on market return (5.78, $p<0.01$; 5.35, $p<0.01$, respectively). The effect became even stronger (6.49, $p<0.01$) in conjunction with sales performance (sales/total assets). However, for the firms in the middle-design industries, their market returns were decreased by design awards.

3.4 Discussion

Despite the growing importance of product design in practice, there are very few insights into its performance implications. By relating product design effectiveness to firm's financial performance, this paper addresses the call for deepening our understanding on the financial impacts of marketing strategy in general and product design in particular (MSI, 2006). The findings provide compelling evidence from all over the world that product design consistently contribute to firm's financial performance, notably in respects of sales, sales growth and cost reduction, confirming managers' impressions that "good design is good business". Furthermore, the varied main and interaction effects of product design across different segments indicate firm heterogeneity in the value relevance of product design and support the statement that the impact of design on company performance is not unconditional (Gemser and Leenders, 2001). In fact, product design's financial contribution varies with countries and industries.

In Europe and North America, where firms have centuries-long design tradition,

the mature product design has salient effect on financial performance. Investing in product design in these two continents helps firms handle fierce competition, efficiently use assets to generate profitable sales and achieve rapid sales growth. Recent studies by various European design agencies (state-funded bodies that promote national innovation), have corroborated that these impacts are real. For example, In Norway, 63% of companies that have already integrated design methods into their business reported steadily growing profits over the past four years. In Britain, almost half of the companies interviewed by the national Design Council that use design in everyday business have seen a boost in sales, profits and competitiveness. In Spain, managers at 40% of all companies interviewed believe design has a significant impact on sales (Tiplady, 2006).

In Asia-Pacific and emerging countries, although firms there have been slower to develop design than their western counterparts during last two centuries, the contribution of product design to sales and gross profit now has become evident. Last decade witnessed Asian design grew up. A good example is Samsung. Since 2000, Samsung's design budget has been increasing 20% to 30% annually and its endeavor has paid off: helped by its innovative designs and egalitarian approach, Samsung has emerged as the best-selling brand in high-end TVs in the U.S., and the world's largest LCD computer monitor producer, with 17% of the global market (Business Week, 2004). However, due to the short history of design, firms in these countries still do not have the breadth and depth in design of Motorola, or the ingrained design culture of Apple Computer. And their recent huge design expenditures need times to be amortized. Therefore, product design does not have a good enough impact on these firms' bottom line. In addition, the negative effect of product design on net profits may be pinned on the famously weak intelligent protection in the Asia-Pacific and emerging countries (for example, in 2004 the piracy rate in this region is 53%, much higher than the worldwide average 35%; BSA & IDC, 2005). In the countries where well designed products can be easily copied by the competitors, design innovators cripple from the unfair competitions and lose benefits from lack of a legitimate market and costs of ineffectual enforcement.

The type of industry involved also moderates the relationship between product design and firm's financial performance. In the high-design industries, instead of providing a competitive edge, investing in product design may become a *conditio sine qua non*: without it, firms are unable to compete, but design no longer provides advantages since most of competitors have used it as a strategic weapon. In fact, as found in this study, the positive effect of product design on firm's performance has faded away as the strategy of design becomes banal.

By contrast, design in the low-design industries, notably in the services industries, begins to display its talent for helping firms to escape price competitions. This finding concurs with the results of Gemser and Leenders (2001) and Yamamoto and Lambert (1994). In the Asia-Pacific and emerging countries, product design effectiveness is positively related to gross profits and net incomes. In Europe and North America, however, these effects turn into negative, implying that many companies in the low-design industries have not yet successfully translated user research into products and services. Perhaps that is because American and European managers in these industries still do not realize that their services and products can and should be designed.

In the middle-design industries, product design can stimulate the turnover irrespective of countries, indicating that in crowded marketplaces faced with increasing standardization, customers in these industries were willing to pay for the added value of design. However, product design prevents firms from growing in both middle- and low-design industries, suggesting that over time, the effect of product design on sales cannot last out and there is still a long journey ahead for advocates of the successful implementation of design in these industries.

Finally, the slightly negative effect of product design on market return reflects the speculative nature of the phenomenal stock market appreciation during that period. This finding is contrasted to the study of Hertenstein et al.(2005). Perhaps in general investors treat design expenditures as costs. Generally investments in product may take long time to see their reward, or may even result in failure. Unlike the investment in property, plants, equipment and inventory, design activities are characterized by great uncertainty in future cash flows. As a result, investors perceive that the total risk of returns increases with the design intensity and then pay much more attentions on traditional accounting indicators (i.e. sales growth, ROA, gross profit margin). However, for the firms in Segment 2, especially those from European and Asia-Pacific developed countries, investors seem to be pleasantly surprised at design awards. Perhaps that is because winning design awards are relatively rare events for these companies, the psychological impact on investor’s expectation is much stronger than for their counterparts in S1, in which such news on design awards appears to be ordinary. In addition, good design is appreciated by investors when design leads to good financial performance. Nevertheless, whether or not implementing product design strategy in the middle-design industries is still a controversy issue, since such endeavor is just slightly rewarded is S1 but strongly punished in S2 by investors.

3.5 Managerial Implications

This study's findings, which synergy between aspects of firm's product design effectiveness and external environments, not only represent a useful extension to strategy management research in general and to design studies in particular, but also generate useful implications for management practice. Given the increasing pressures on designers to demonstrate the financial accountability of product design and the limited prior research on product design's financial contribution, designers can trumpet the power of design based on the significant main and interaction effects of product design on firm's financial performance. Product development managers can use the current findings to forcefully convince various naysayers or to get top management support.

In addition, product design does not offer unilateral benefits to all firms. Instead, it is contingent on the type of industry and the group of countries. This finding provides action points to managers to maximize the effect of product design:

In general, firms should keep investing in design to maintain their leading-edge products. Managers and designers should be encouraged to think broadly about how the attributes and features of product (or service) enable firms reap large returns on sales, sustain a higher price while reducing manufacturing (or servicing) costs as well as the quantities of assets associated (Hertenstein et al., 2005). Specially, for American and European firms in the low- and middle-design industries, managers should attach much importance to design. With corporations increasingly desperate to get in touch with their customers, the design paradigm 'sketching user experience' spreads apace. It's more important than ever for firms in these industries to improve their consumer experience, which the firms in the high-design industries have done for decades. As the economy shifts from the economics of scale to the economics of choice and as mass markets fragment and brand loyalty disappears, designing service with high customer satisfaction, or products with features, aesthetics, ease of use, and quality superior to those of competitors will enable the firm to increase sales volume, to command higher prices or reduce costs, and consequently to generate higher profit margins and stock market returns. In the Asia-Pacific and emerging countries, we have seen that Japan, Taiwan, Korea and Hong Kong, etc. used design to move from manufacturer into a producer of well-known branded products during the last two decades. Now China is dedicated to moving "Made in China" to "Designed in China". Locally designed and manufactured *Haier* appliances and *Legend* computers are exporting all over the world.

Such strong commitment to product design should be continued to emulate the success of their western competitors. Meanwhile managers should think much of design intensity and design property protection so that successful design can create lasting advantages and boost the bottom line.

Finally, managers will benefit from applying the study's specific findings to developing investor communications programs that may increase their firm's stock market returns. In doing so, managers should actively reveal not only how design can turn their ordinary products into fashionable best-sellers, but also how design fits to the characteristics of industry and how much value design can add to traditional accounting-based performance.

3.6. Limitations and future research

Proving that "good design is good business" and that there is a causal relationship is an extremely difficult proposition (Hertenstein et al., 2005). Although this study has taken a step forward answering this tricky question, the results presented here should be viewed in light of several limits.

First of all, this study used design award counts as proxy to measure aggregate product design effectiveness at the firm level. This broad brush indicator, however, is not practical for managers systematically assess their firm's design competence and improve design performance. Future studies should follow the score-board approach to develop a multidimensional scale that will give managers and designers the opportunities to analyze product design effectiveness at different levels of abstractions while still allowing for the same strict assessment of construct validity. Such a measurement can also help us solve the limitation of sample composition in the present study. Herein we used a group of award-winning companies which were not randomly selected. The sample quality may be reduced by selection bias toward "opt-in" sample because different firms have different propensities for participation in design competitions. Therefore, it is too bold to assume that award winners have superior product design effectiveness than those do not participate. Future studies should use the multidimensional scale to measure firm's objective design effectiveness by conducting large-scale surveys.

In addition, the evidence of firm heterogeneity in the latent class regressions indicates that the effect of product design on firm's performance should be contingent in nature. This study only includes two contextual factors namely, the type of industry and

the group of country. There is a myriad of factors and relationships that merit consideration along the causal chain from design to corporate performance. For example, the varied role of design in new product development may moderate the impact of design (see Perks et al, 2005). Under today's business circumstances, it is reasonable to presume that the contribution of design in the firms where designers work as process leader will surpass that in the firms where designers are just functional specialist or part of multifunctional team.

Finally, the quantitative tests in this study can only tell what the financial outcomes of design are but cannot illustrate how firms achieve "good design". Further investigation of the design process by which product design translates into improved firm performance is required. Future research can adopt qualitative methods such as anthropology, case studies and interviews etc. to gain more insights into the black-box of design.

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