The Product Life Cycle: A Paradigm for Understanding Financial Management

Benton E. Gup and Pankaj Agrrawal

The product life cycle has been overlooked by academicians who examine the financial aspects of corporate behavior and teach finance. This article demonstrates how the life cycle concept can be used to enhance both research and teaching by demonstrating how key financial variables, such as market returns, beta, book-to-market value, dividend payout ratios, and others, can be expected to change over the course of a firm's life cycle. These variables capture the essence of corporate growth. The statistical results from a sample of 981 firms suggest that the life cycle provides unique insights for evaluating corporate growth and performance, and corporate risk and return.

■ According to Steiner (1969), every product goes through a life cycle that is based on the observable fact that sales volume and profits of a typical product follows an S-shaped curve (see Exhibit 1). Moreover, the product evolves through various phases of development — pioneering, expansion, stabilization, and decline — that are defined by inflections in the growth rate of sales. Each phase of the life cycle has different characteristics, which will be examined shortly.

The life cycle concept also applies to firms and industries. Mueller's (1972) "Life Cycle Theory of the Firm" is an early example of a major article using this concept in the economic analysis of firms. He later explored the subject in greater depth in his book (Mueller, 1986). Porter (1980) stated that the product life cycle is the grandfather of all concepts for predicting the probable course of industry growth. More recent research involving the life cycle includes: Janovich and McDonald (1993); Boyan and Londregan (1990); Parshley and Phillippatos (1990); Sherwood-Call (1992); and Weinberg (1994). Other studies, such as Lakonishok, Shleifer, and Vishny (1994), and Davis (1994), have included the growth rate of sales as a variable in their research, but they did not refer to the life cycle.[1] Thomas (1995) explained that the Boston Consulting Group valuation model "fades" a firm's growth rates of cash flow return on investment (CFROI) and assets "toward corporate averages consistent with life cycle theory and empirical evidence..."

The life cycle is an easy-to-understand, intuitively appealing concept that facilitates understanding of how a firm's financial policies, such as the dividend payout ratio, may be expected to change as it matures. Students relate to the fact that *de novo* firms are going to have different financial characteristics and behavior than mature firms. Thus, the life cycle provides a realistic and dynamic framework for explaining financial management policies. For example, the Myers (1984) Pecking Order Theory may be discussed within the context of the life cycle.

The article is divided into four sections. The first gives a brief overview of a typical industry life cycle and the financial implications for firms within that industry. Section II presents cross-section data for a sample of 981 firms to illustrate how selected financial characteristics of firms change over the course of a firm's life cycle. Section III examines the P-values associated with Pearson correlations for the variables that we examined. Section IV presents our conclusions.

This article is based on a tutorial about the product life cycle that was presented at the 1994 annual meeting of the Financial Management Association in St. Louis, MO, and more recent information.

Benton E. Gup holds the Chair of Banking at the University of Alabama in Tuscaloosa, AL 35487. Pankaj Agrrawal is a Quantative Analyst at Vestek Systems in San Francisco, CA 94111.

[1] For a review of the literature, see *The CAPM Controversy: Policy and Strategy Implications for Investment Management*, Harrington and Korajczyk (1993). Discussion of the life cycle is absent from the review.

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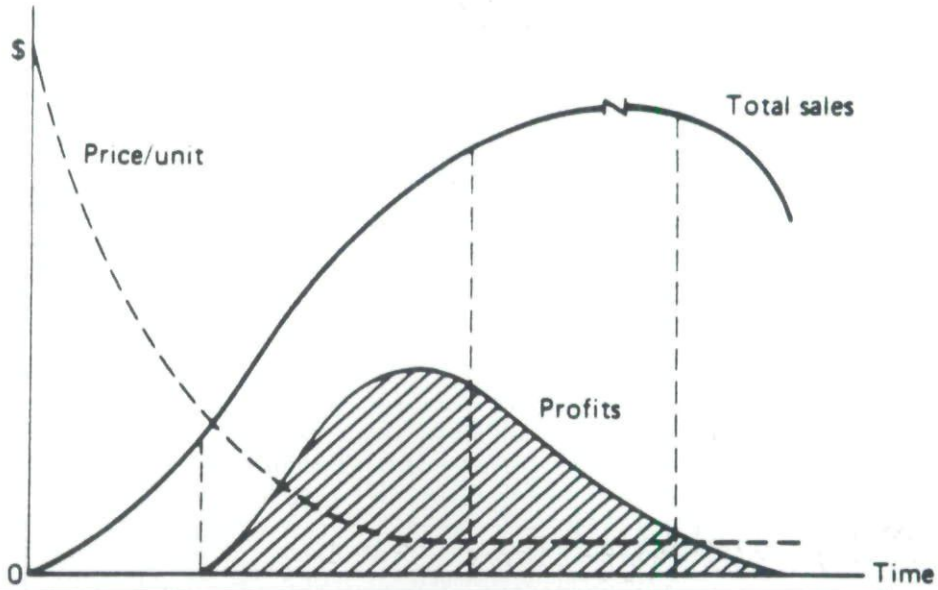
Exhibit 1. Phases of Development



Phases	Pioneering	Expansion	Stabilization	Decline
Number of Firms	Few	Increasing competition	Decreasing number of firms	Few firms remain
Price/Unit	High	Falling prices as production and competition increase	Prices continue to decline to low level	Prices stabilized at low level
Profits	Losses due to developement and marketing costs	Profits increase as total sales rise. When the rate of total sales decreases, profits will diminish	Profits fall	Diminishing profit and losses

I. Typical Product Life Cycle

A typical product life cycle for an unregulated industry is illustrated in Exhibit 1. Total sales, unit prices, and profits are represented on the vertical axis, and the four phases of development are shown on the horizontal axis. The pioneering phase begins when a new product, such as cellular telephones, is introduced in the market. Initially, the producers experience losses due to high development and marketing costs, and few sales. The losses turn into profits as sales increase. If there is sufficient demand for the product, new firms will enter the industry. The increased competition results in lower prices, but higher total sales.

The expansion phase of the life cycle is characterized by increasing sales, increasing competition, and falling prices. Total industry profits rise and peak during this phase. More will be said about profits shortly. Large numbers of competitors fail during the expansion phase. For example, although there were more than 1,500 firms manufacturing automobiles since they were introduced, only a few firms remain today (Kemmerer and Jones, 1959). Hamilton (1994) states that in the past 20 years there were more than 1,000 firms in the biotech industry. Predictions are that only a few will survive.

Sales peak during the stabilization phase. The break at the top of the sales curve in Exhibit 1 indicates that the length of the life cycle for some industries or firms is longer than for others. For example, the life cycle for electric utilities is longer than it is for software developers.

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Exhibit 2. Financial Considerations in the Phases of the Life Cycle

	Pioneering	Expansion	Stabilization	Decline
Cash Requirements	Heavy Cash Use	Cash Use	Cash Generator	Generates Surplus Funds Until Losses Occur
Cash-Dividend Policy	No Cash Dividend	Small Cash-Dividend Payout Ratio - Increasing	Increasing Cash Dividend	Large Cash-Dividend Payout Ratio- None if Losses Occur
Risk	High	High	Average	Low

Notice that total industry profits decline before industry sales peak. Readers familiar with microeconomic theory will recognize that profit maximization occurs when marginal revenue equals marginal cost, which is before total revenues peak. One can think about the curve representing the growth rate of sales as being similar to total revenues.

The stabilization phase is characterized by a small number of surviving firms who try to maintain or expand their market shares. They may expand internally by introducing products and entering new markets. Alternatively, they may expand externally by forming strategic alliances with other firms or by mergers and acquisitions. Mature firms generally acquire smaller, faster-growing firms.

The declining phase of the life cycle is characterized by diminishing sales and profits and fewer firms. A word of caution is in order. Being in the declining phase of the life cycle does not necessarily spell doom for that industry. Industries in any phase of the life cycle may be "rejuvenated" and thereby experience a rapid increase in sales. For example, the demand for ceiling fans was strong in the 1930s and 1940s when there were no alternatives for cooling. However, demand for ceiling fans declined in the 1950s when central air conditioning became popular. In the late 1970s, higher energy prices created a need for a cost-effective means for cooling of houses. Thus, the demand for ceiling fans increased sharply in the 1980s.

The life-cycle concept can be applied to firms. By way of illustration, consider McDonald's Corporation, the innovator of fast food industry. It began operations by offering hamburgers and French fries in a drive-in setting —which was a new concept. During the early expansion phase of its life cycle, there was a strong demand for their products, and sales grew rapidly. When the growth rate of sales for their basic hamburger began to slacken, McDonald's introduced new products, such as the Big Mac and the Egg McMuffin to enhance their growth. As the life cycle for each new product matured, McDonald's continued to grow by adding new products and entering new markets. When the markets in the U.S. became increasingly competitive and saturated, McDonald's opened new markets overseas. Today, McDonald's has about 16,000 fast food restaurants throughout the world. It is in the late-expansion phase of the life cycle.

Finally, the life cycle concept also is applied to portfolios of diversified firms' businesses. Business strategists use what is called a business portfolio matrix, which is a two-dimensional display comparing strategic positions of a diversified firm's businesses.[2] The three most commonly used matrix techniques are the Boston Consulting Group's (BCG) growth share matrix, General Electric's industry attractiveness-business strength matrix, and Hofer-A.D. Little's industry life cycle matrix.

The BCG 4-cell growth share matrix segregates businesses into four groups (question marks, stars, cash cows, and dogs) based on their industry growth rates and relative market shares. Businesses that are question marks are analogous to firms in the pioneering phase of the life cycle. Similarly, stars are in the expansion phase, cash cows in the stabilization phase, and dogs in the declining phase of the life cycle. The Hofer-A.D. Little is a 15-cell matrix where business units are plotted based on their stage of the life cycle and competitive position.

Against this background, selected financial characteristics of a "typical" firm over the course of a life cycle are presented in Exhibit 2. The word typical is in quotes because differences in corporate strategies result in widely divergent financial policies. For example, Cisco Systems Inc., (a leading supplier of computer networking products) has no long-term debt, while Georgia Gulf Corporation (a chemical company) in 1993 had a negative equity of $110.6 million as a result of restructuring in a leveraged buyout.[3] There are similar differences in dividend policies. McDonald's pays out about 17% of its net income as dividends, while International Dairy Queen pays none. Despite such differences, the information in the exhibit provides a framework for understanding corporate financial behavior with respect to cash, dividend policies and risk.

During the pioneering phase of the life cycle, firms are heavy cash users. The funds are used to finance the development, production, and marketing of new products. Because of the high costs, the first few products that are sold result in losses. Because of the losses and the need

[2]For more on this subject, see Thompson and Strickland (1995) and Gup (1980).

[3]For details about Georgia Gulf, see *Value Line Investment Survey* (Nov. 3, 1995, 1243).

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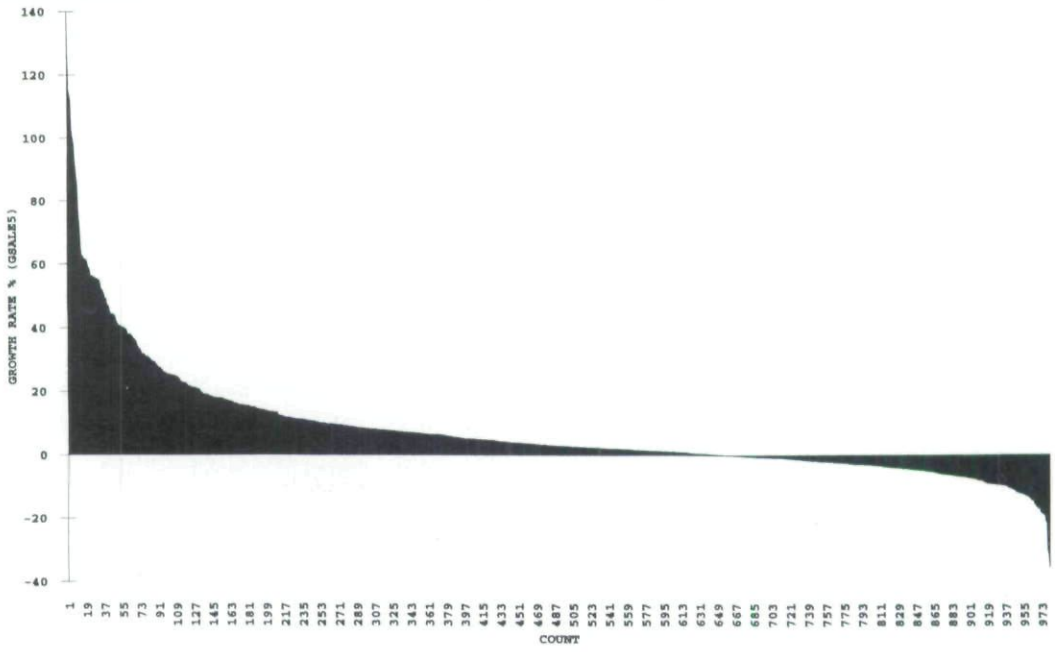
Exhibit 3. Distribution of Growth Rate in Sales (1992)



to finance growth, no cash dividends are paid. The risk, which is measured by beta or the book-to-market value, is high. High betas and low book-to-market values are associated with high risk.

The expansion phase is characterized by rapid growth in revenues that increase at a decreasing rate. During this phase, the cash demands to finance growth diminishes. Instead of reinvesting all of their earnings, the firms begin to pay cash dividends. The dividend payout ratio increases as sales grow. Finally, the beta and book-to-market values decline.

The stabilization phase is characterized by mature, surviving firms. They are profitable, but their growth rates are relatively slow. Therefore, they become cash generators. Some of the cash is paid out in the form of increased dividends. These mature firms represent the average risk of the market.

Firms enter the declining phase of the life cycle as growth slows further. An increasing portion of the surplus funds are paid out in the form of dividends. Ultimately, there are losses. Beta and book-to-market ratios are relatively low.

Next, we examine financial data for a large sample of firms.

II. Data for Firms

Exhibit 3 shows the five-year growth rate in sales for 981 firms taken from the Compustat database for 1992.[4] The sample size is based on the number of firms in the database for which all of the variables we used were available. The exclusion of firms with incomplete data restricted our sample to relatively large firms and to survivors.

Exhibit 3 reveals that a small number of firms had a very high growth rate of sales, but most experienced slower growth rates, and some were negative. To analyze the data, we divided the growth rate of sales into five sales groups whose growth rates are shown in the following table.

The logic for using five sales groups is that there is no precise definition of when one phase of the life cycle ends and another begins. Therefore, five sales groups were chosen in order to capture the life cycle and to provide more detail about the expansion phase. Recall that the expansion phase is characterized by rapid sales growth and the disappearance of firms through mergers or failures.

Sales Groups	Approximate Phase	Growth Rate of Sales (5 years.)
1	Pioneering	50% or more
2	Early Expansion	20-49.9%
3	Late Expansion	10-19.9%
4	Stabilization	0-9.9%
5	Decline	Less than 0%

The figures listed in Exhibit 4 demonstrate how growth rate of sales, numbers of firms, market value, market returns of the stocks within each group, beta, book-to-market value, and dividend payout ratios change over the course of the life cycle. They are not meant to be an empirical test of the validity of the life-cycle theory.

The pioneering phase of the life cycle is characterized

[4]Because of difficulties in graphing, the number of firms listed in the figure is 973, but the figure depicts 981 firms. Although the 1992 data is represented in the exhibits, the results for the 1991 data are similar.

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Exhibit 4. Selected Financial Data for 1992, Mean Values

Sales Group (Growth Rate of Sales)	1 (50%+)	2 (20-50%)	3 (10-20%)	4 (1-10%)	5 (Less Than 1%)
Growth Rate of Sales 5 Yrs.	103.48%	41.51%	15.45%	5.24%	-5.18%
Number of Firms	13	120	281	441	126
Market Value (Millions)	$1,987	$2,132	$3,935	$3,815	$1,066
Market Return	52.05%	15.30%	13.13%	13.70%	11.76%
Beta	1.55	1.28	1.13	0.94	0.93
Dividend Payout Ratio	0.72%	10.69%	22.01%	25.66%	24.90%
Book to Market Ratio	0.41	0.42	0.49	0.62	0.64

by high growth and high risk. As shown in the exhibit, the 13 firms in Sales Group 1 had a very high growth rate of sales. They also had high betas, low book-to-market values, and low dividend payout ratios. The stockholders were rewarded for the growth and high risks with high returns. The average market value of these firms was $1.9 billion.

There are 120 firms in the early expansion phase of the life cycle (Sales Group 2). The market value of these firms increased, but the returns on their stocks were substantially lower. As expected, the betas declined, but they were still high compared to the market average. The change in the book-to-market value was negligible. However, the dividend payout ratio increased to 10.69%.

There are 281 firms in the late expansion phase of the life cycle (Sales Group 3). The firms in this phase reach their peak market values ($3.9 billion). Nevertheless, their stock market returns are lower than in the previous phase, and their betas have reverted almost to the mean of 1. The book-to-market value increased slightly. The level of the dividend payout ratio more than doubled to 22.01%. As cash dividends and payout ratios increase, dividends account for a growing proportion of market returns. The returns of firms in the pioneering phase, for example, come mainly from capital gains because the firms are just beginning to pay cash dividends. Thus, market returns for firms in the early phases of the life cycle tend to be more volatile than those of mature firms.

The largest number of firms (441) are in the stabilization phase of the life cycle (Sales Group 4). There is some survivor bias because this is a cross-section of firms based on the five-year growth rate of sales. Observe how the market returns in Sales Group 4 are about the same as those firms in the previous group, but their betas are lower. The book-to-market value is substantially higher than it was in the previous sales groups. The dividend payout ratio reached a peak during this phase.

During the declining phase of the life cycle (Sales Group 5), the market value of the firms declined sharply, reaching the smallest value of any of the five phases because investors viewed the firms' outlook unfavorably. As expected, market returns and betas declined. There were marginal changes in the book-to-market value and the dividend payout ratios.

In review, the data suggest that firm's market valuation, market returns, book-to-market value, and beta change in a predictable way over the course of the product life cycle. Firms with high growth rates of sales tend to have high market returns, high betas, low book-to-market values, and small dividend payout ratios. Firms with slower growth rates of sales have lower market returns and lower betas. Book-to-market values and dividend payout ratios increase as firms mature. This conclusion with respect to risk and return is significantly different than a comparison of market returns with betas without taking the life cycle into account. Exhibit 5 shows the latter relationship for the 981 firms examined in this study. The random character of the figure suggests that there is no relationship between the two variables.

III. Statistical Results

In this section, we examine the statistical relationships that exist between all of the variables shown in Exhibit 4.

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Exhibit 5. Beta versus Returns 46n1

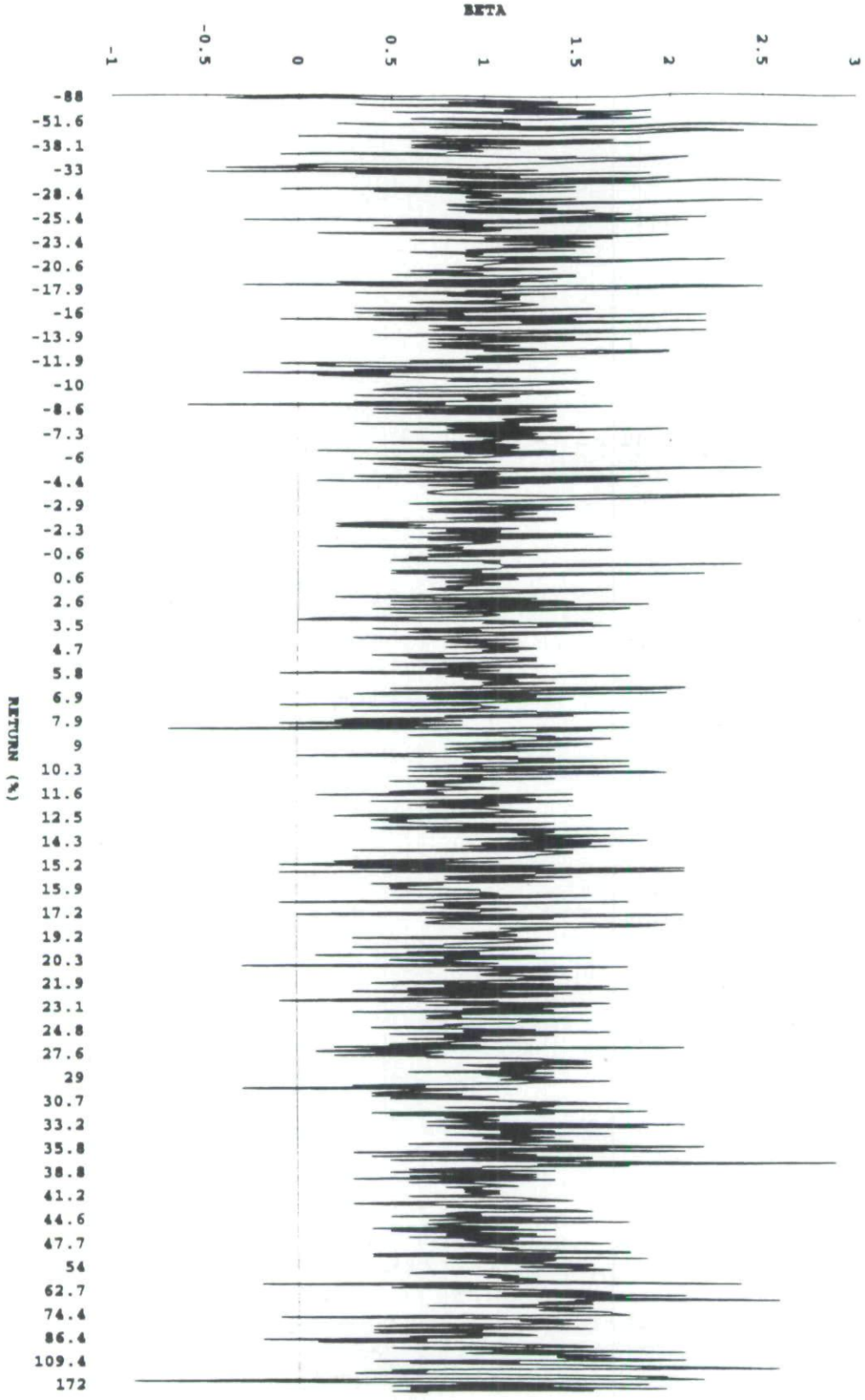

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Exhibit 6. Matrix of P-Values Associated with Pearson Correlations

Panel A. Overall

	Beta	Ret	DVPOR	BK/MK	Ln (Mkval)	GrS
Beta	0.00					
Ret	0.04	0.00				
DVPOR	-0.09	-0.01	0.00			
BK/MK	-0.14	-0.20	-0.05	0.00		
Ln (Mkval)	0.07	0.06	0.09	-0.30	0.00	
GrS	0.25	0.10	-0.06	-0.13	0.00	0.00

Panel B. Sales Group 1

	Beta	Ln (Mkval)	BK/MK	Ret	DVPOR	GrS
Beta	0.00					
Ln (Mkval)		0.00				
Bk/MK		0.02	0.00			
Ret				0.00		
DVPOR					0.00	
GrS				0.10		0.00

Panel C. Sales Group 2

	Beta	Ln (Mkval)	BK/MK	Ret	DVPOR	GrS
Beta	0.00					
Ln (Mkval)	0.02	0.00				
BK/MK			0.00			
Ret		0.00		0.00		
DVPOR	0.00		0.04	0.11	0.00	
GrS		0.05			0.01	0.00

Panel D. Sales Group 3

	Beta	Ln (Mkval)	BK/MK	Ret	DVPOR	GrS
Beta	0.00					
Ln (Mkval)		0.00				
BK/MK	0.03		0.00			
Ret			0.00	0.00		
DVPOR		0.02			0.00	
GrS				0.11		0.00

Panel E. Sales Group 4

	Beta	Ln (Mkval)	BK/MK	Ret	DVPOR	GrS
Beta	0.00					
Ln (Mkval)		0.00				
BK/MK	0.01		0.00			
Ret			0.00	0.00		
DVPOR	0.07		0.01		0.00	
GrS	0.09		0.13	0.01	0.02	0.00

Panel F. Sales Group 5

	Beta	Ln (Mkval)	BK/MK	Ret	DVPOR	GrS
Beta	0.00					
Ln (Mkval)		0.00				
BK/MK	0.06		0.00			
Ret			0.01	0.00		
DVPOR		0.03			0.00	
GrS	0.13					0.00

The robustness of the differences in the values of the variables was tested using non-parametric distribution-free analysis. The Kruskal-Wallis test indicated strong statistical differences in the means across the five sales groups for all variables except market returns which had a P-Value of 0.23 as compared to 0.00 for the rest. The smaller the P-Values, the higher the degree of statistical significance.

Panel A of Exhibit 6 presents the matrix of P-Values associated with the various Pearson correlations among the six primary variables. Eleven of the fifteen correlations have P-Values that are small enough to justify any statistical significance. In the wake of the Fama and French (1992) evidence on the lack of correlation between expected returns and beta, it is interesting to note that this sample of stocks also reports a weak correlation between beta

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and the market return (RET). However, the correlations between returns and the book-to-market value ratio (BK/MK) and between returns and size (Ln(MKVAL)) are significant.[5] Recall that Fama and French identified these two variables as the crucial filters that captured most of the risk in the cross-section of expected stock returns. However, unlike their *regressions* (covering 27 years) which showed a strong and positive relationship between returns and the book-to-market ratio, our *correlations* (covering one year) reveal a strong *negative* relationship between the two.

Panels B-F of Exhibit 6 display information for each of the five sales groups reflecting the various phases of the product life cycle. The depicted P-Values are the only ones indicating a reasonable degree of correlation between the associated variables. No clear pattern emerges here, except for the recurring significant correlations between returns and book-to-market value in three of the five groups under consideration. An indication of the association between the growth rate in sales (GrS) and returns is reflected in three of the five (Groups 1, 3 and 4). A notable exception is the absence of any significance in the correlation between beta and returns. Such evidence may be interpreted as an indication of the existence of alternate non-beta risk proxies, some of which have already been suggested.

[5]The log of the market value was used in the correlations.

IV. Conclusion

Black (1993) highlighted the importance of the problems associated with data mining devoid of any theoretical back-up. The product life cycle is a theoretical tool that sheds light on corporate financial behavior, including growth, risk, and return. The logic of the life cycle is intuitively appealing—certain financial characteristics of firms change in a reasonably predictable way as they mature. The variables that we examined include market values, market returns, betas, book-to-market value, and dividend payout ratios. These variables capture the essence of corporate growth. The fact that they do change in a systematic way suggests that research which ignores life cycle changes may be incomplete at best, or flawed at worst. ■

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