

STRATEGIC IMPLICATIONS OF VALUATION METHODS

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Strategic Implications of Valuation Methods

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ABSTRACT

Strategy is ultimately aimed at creating shareholder value, placing valuation in a central role linking finance and strategy. Focusing on growth options, this paper uses a unique “perfect information” model to examine, from a strategy point of view, the relationship between the market value of the firm and its intrinsic, or DCF, value. Although the research is at the level of the firm, the results have implications at the level of individual strategies and projects, since a firm can be conceptualized as a collection of projects. The findings highlight the relationship between the value of growth options and macroeconomic conditions, industry characteristics, and firm-specific factors.

Key words: growth options, valuation, financial theory

INTRODUCTION

“Finance theory and strategic planning could be viewed as two cultures looking at the same problem.”

—Myers (1984: 130)

In a classic paper, Myers (1984), a finance theorist, noted both the convergence and the divergence between finance and strategy, and developed forceful arguments that finance theory and strategic management need to be reconciled, remarking that such a reconciliation would require effort from both sides of the academic divide. Similarly, Bettis (1983), a strategy scholar, noted that, while often at odds on objectives and methods, finance theory and strategic management were pursuing many of the same issues, and so also argued for a reconciliation of the two fields. Both Myers (1984) and Bettis (1983) saw the role of valuation as an important linkage, or bridge, between finance and strategy—strategy concerned with allocating firm resources in order to achieve a competitive advantage, finance concerned with allocating firm resources in order to increase shareholder wealth (firm value). Myers (1984) pointed out, “This would seem to invite the application of finance theory, which explains how real and financial assets are valued. The theory should have direct application not only to capital budgeting, but also to the financial side of strategic planning” (1984: 128). In other words, how can we logically make strategic decisions without some understanding of how they will ultimately impact firm value? The valuation of assets—real or financial—as investments is a crucial input to the strategic decision-making process (Folta and Miller, 2002; Varaiya *et al.*, 1987). In fact, the value of the firm, as determined by the market, is a critical indicator, if not the most critical indicator, of strategic effectiveness (McTaggart *et al.*, 1994; Rappaport, 1998; Varaiya *et al.*, 1987).

In 1984, Kester took a potentially large step in reconciling finance and strategic management arguing, “companies can reduce the guess work of investment analysis by clearly linking current capital budgeting decisions with strategic opportunities”(1984:153). Based on large-scale field research, he determined managers often argue that an inadequate valuation must be weighed against the “strategic benefits” of a project, such as the future opportunities the

project will create for the firm. Similarly, Myers (1984) suggested, “The option value of growth and intangibles is not ignored by good managers even when conventional financial techniques miss them. These values may be brought in as 'strategic factors' dressed in non-financial clothes” (1984: 136). Kester (1984) and Myers (1984), however, noted that these “growth options” cannot be valued using a traditional discounted cash flow (DCF)—net present value (NPV)—analysis. Kester (1984) argued that these "growth options" are analogous to, and, therefore, can be valued similarly to, financial call options. Today, the “growth options” of Kester (1984) and Myers (1984) would be called “real options”, “real call options”, “call options on real assets”, and may be valued using the Real Options Approach (ROA) to capital budgeting. The idea of “valuing strategic factors” (or real option analysis as it would be called today) is obviously central to strategy and to the connection of strategy with financial analysis. Furthermore, though there has been considerable research on real options in the strategy literature, the connection with market value first empirically demonstrated by Kester (1984) remains largely unstudied (a notable exception includes Reuer and Tong (2003)).

To illustrate the potential importance of growth options, Kester (1984) roughly estimated the value of the growth options in the market value of equity¹ of a sample of 15 firms – 3 in each of 5 industries. He modeled the value of a firm's growth options as equal to the firm's current market value less the value of a perpetuity of the firm's current annual (1983) earnings capitalized at 15%, 20%, or 25%. The capitalized current earnings represent an estimate of the value of the assets in place. The growth option values he thus calculated ranged from 7% to 88% of the market values for the firms in his sample, suggesting that the value of growth options accounts for much of the market value of an average firm. Furthermore, he found that the growth option

¹ Kester (1984) used the market value of each firm's equity, obtained from the August 12, 1983 Value Line Investment Survey, to represent the value of the firm's assets in place plus the value of the firm's growth options. We also use the market value of each firm's equity as total value. However, from this point forward, we use the term "market value of the firm" (or "the firm's market value") to mean the market value of the firm's equity, and we determine this value by multiplying the firm's stock price at time t by the number of outstanding shares at time t.

value component of the firm's market value appeared to vary with industry. It is worth noting the obvious. Kester's study, while enormously influential, suffers from a very small sample size and an overly simple, perhaps naïve, methodology. These are shortcomings that the current paper aims to address in the process of further exploring the strategic issues related to valuation.

In the roughly 20 years since these three papers (Bettis, 1983; Kester, 1984; Myers, 1984) were published, progress on reconciling finance and strategy has been significant (e.g., Chatterjee *et al.*, 1999; Lubatkin and O'Neill, 1987; Miller and Bromiley, 1990; Miller and Leiblein, 1996; Miller and Reuer, 1996; Ruefli *et al.*, 1999; Wiseman and Gomez-Mejia, 1998). Yet the reconciliation is still far from complete; a wide gulf still divides the "two cultures looking at the same problem" (Myers, 1984: 130). This research attempts to help bridge a part of that gulf by empirically examining, from a strategic point of view, the relationship between the market value of a firm and its DCF value, or "intrinsic" value. Building an *empirical* understanding of the relationship between real options and valuation is important to progress in tying strategy to shareholder wealth creation.

Kester's (1984) approach serves as a foundation for the examination of the predictive ability of DCF models and their relationship with growth options. We extend his approach to a more sophisticated DCF valuation model and a more rigorous empirical assessment of these models. Rather than rely only on ex ante estimates of value, we use "perfect information", where the hypothetical investor has knowledge of actual cash flows and financial returns for a decade into the future to determine an intrinsic value. We investigate and discuss the role of growth options in explaining the relationship between the market value of a firm and its intrinsic value. The majority of firms continue to rely on DCF models in their corporate capital budgeting practices (Graham and Harvey, 2001). Our paper highlights important issues in the predictive ability of DCF models—that of market expectations and their relationship with critical factors—economic conditions, industry membership, and firm specific capabilities. This study raises important questions concerning the use of DCF models in the capital budgeting practices of firms.

The competitive consequences of “incorrect” choices can be potentially serious, as discussed by Christensen and Bower (1996).

The next section discusses the DCF framework and its ability to account for the value of corporate growth opportunities. We also briefly highlight the connection between DCF and real options frameworks in the context of growth options. We continue by presenting our replication and extension of Kester’s (1984) tests in a three-phase approach. The first phase employs Kester’s (1984) model using a different data set. Phase two involves the use of a different data set and a different source of value in Kester’s (1984) model. Finally, the third phase extends Kester’s work, detailing a more sophisticated DCF model used to conduct further tests of Kester’s (1984) findings. We combine the presentation of phases one and two since they rely on the same DCF model with different inputs. The modeling and results section is followed by a discussion of methodological issues. We conclude with implications for both current research and business practices, as well as for future research.

VALUATION FRAMEWORKS

Today, few would argue that one key to an effective strategy is the allocation of firm resources—tangible and intangible—so as to achieve a competitive advantage. Often these allocation decisions are made in the context of capital budgeting, and this is especially true of tangible assets. In fact, it could be argued that for a wide range of resources, allocations should be made through capital budgeting informed by strategy, or as some would put it, strategy informed by capital budgeting. Which comes first in the grammatical construction is irrelevant—both are intertwined, and critical to resource allocation decision-making.

For example, consider a formal “project”, since many, if not most, resource allocation decisions appear in the form of some sort of formal project: a new plant, the exit from a product line, a market entry, a firm acquisition, a new service location. In fact *a firm can be conceptualized as a collection of projects*. This view of the firm as a collection of projects, some

of which may not be formally viewed as such by managers in the firm, is common in the finance literature (for example, see Brealey and Myers (1996)). For purposes of the current paper, this view allows the results obtained at the firm level to also be applicable at the project level.

The traditional and widely used valuation framework for analyzing projects is, of course, a DCF analysis, which is used to determine the project's NPV. Such an analysis requires, as inputs to project valuation, the free cash flows the project will generate, the economic life or forecast period over which these free cash flows will occur, any terminal value (net salvage value or residual value), and, finally, the project's risk-adjusted discount rate. The appropriate discount rate for such an analysis is the project's opportunity cost of capital, is reflective of the project cash flows' risk and timing, and is theoretically defined as the expected rate of return, in equilibrium, of an efficient market traded security of equivalent risk class as the project. Because of the difficulty in finding such a rate of return, however, in practice, the cost of capital of the firm as a whole may be used, even though it is not theoretically correct unless the project has the same risk as the firm as a whole.

Myers (1984), Baldwin and Clark (1992), Dixit and Pindyck (1994), Trigeorgis (1996), Amram and Kulatilaka (1999), and others, have detailed the troublesome assumptions and valuation issues of the traditional DCF valuation framework. For example, a traditional DCF analysis assumes passive management of the investment, an “all-or-nothing” valuation, a fully reversible investment, a “now or never” decision, and a reduction in value due to uncertainty. Thus, the value of managerial flexibility to alter the path of an investment, to spawn a new investment, or to pursue a sequential investment in stages cannot be fully accounted for in traditional DCF valuation models, and, as a result, the use of such static valuation models is called into question. Given the importance of valuation in strategic planning decisions (Robins, 1992; Varaiya *et al.*, 1987), these arguments suggest that such decisions based solely upon standard DCF models may be based upon incorrect assessments of value.

In recent years, the Real Option Approach (ROA) to capital budgeting, and its associated real option valuation models, have been gaining prominence in the strategy literature (e.g., Bowman and Hurry, 1993; Folta and Miller, 2002; Kogut and Kulatilaka, 1994; McGrath, 1997; Reuer and Leiblein, 2000). A real option gives a firm the right, but not the obligation, to take a certain action, sometime in the future, at some cost. These models allow for contingent decision-making, i.e., decisions can be made later based on the actual unfolding of events, and do so by being able to value asymmetric payoffs, which lie at the heart of option-pricing. Thus, an option-based valuation can value managerial flexibility by accounting for non-linear and dynamic decision-making, and is a reasonable representation of the logic of managerial decision-making. In practice, capital investments are determined by managerial discretion, where the firm's available options to (dis)invest in real assets are evaluated on an ongoing basis—then exercised, deferred, or allowed to expire.

For our purposes here, we are concerned with the real options called growth options, which are, of course, the growth options that Kester (1984) and Myers (1984) discussed. Kester (1984) suggests that the market value of a firm is composed of the value attributable to its assets in place (V_{aip}) and the value attributed to its growth options (V_{go}): $V_{firm} = V_{aip} + V_{go}$. Furthermore, he suggested that the DCF model only captures the value of the assets in place (V_{aip}), and not the value of growth options (V_{go})—*the value of “strategic factors”*.

Specifically then, growth options give the firm the right, but not the obligation, to make a follow-on investment in the future, again, at some cost. For example, consider a European firm thinking about entering the consumer packaged goods industry in India. By establishing a distribution system and a sales force for a particular packaged good, the firm has acquired the right to distribute and sell additional consumer packaged goods in the future. As a further example, consider Intel. By investing in the development of the first microprocessor, Intel acquired the right to invest in the next generation of microprocessors.

In fact, there is often a chain or series of growth options embodied in an initial project. For the hypothetical consumer packaged goods firm just discussed, having established a single product, a second, third, and so forth can be marketed. At some point this could lead to the establishment of a pilot plant, followed by a full-scale plant. This plant could then lead to expansion to neighboring countries in the same pattern followed in India. In the case of Intel, investment in a second-generation microprocessor led to a third generation, then a fourth generation, and so on. These compound growth options turned out to be extremely profitable for Intel. In addition, as noted above, this logic not only applies to projects, but to firms as well, since, as Myers (1984) and numerous others since have pointed out, a firm can be conceptualized as a collection of projects.

The growth option value that Kester (1984) determined for each firm actually represents the present value of the total chain of the firm's growth options. Figure 1 summarizes Kester's (1984) research. It is useful to note in this figure that the portion of a firm's market value attributable to growth options varies by industry.

Insert Figure 1 here

Given that most firms continue to rely heavily on DCF valuation models (Graham and Harvey, 2001), the ability of a firm to effectively and strategically allocate its resources, and, thus, to survive in the competitive marketplace, is dependant on the firm understanding the limitations of the DCF valuation framework. Consequently, drawing on the general approach of Kester (1984), we use his original research design, and then we extend his conceptual approach to a more sophisticated DCF model to further explore the predictive ability of the traditional DCF valuation framework.

RESEARCH METHODS AND RESULTS

This research employs a three-phase design as explained in Figure 2.

Insert Figure 2 here

The first phase involves the replication of Kester's (1984) original model, now using a large cross-sectional sample of firms. While Kester's (1984) arguments have enormous intuitive appeal, the empirical support provided in his study is limited with only 15 firms in the sample. The second phase also employs Kester's (1984) model, but with cash flows used as inputs to the model instead of earnings. Cash flow is a more appropriate measure of value according to finance theory. The third phase extends Kester's (1984) conceptual approach to a multi-period DCF model, which is a more appropriate model for valuing an a firm's equity, and is similar to the valuation models commonly taught in business schools, as well as those used in practice.

Data and Sample

The sampling period for this study extends from 1989 to 1998. The initial sample consists of the firms that comprised the S&P 500 as of January 1, 1989 combined with the S&P 500 membership list as of December 31, 1998. While most firms remained on the S&P 500 list from the beginning (1989) to the end (1998) of our sampling period, the membership list of the S&P 500 does change over time. As a result, the combined list of the S&P 500 at these two points in time consists of 675 large public companies from a cross-section of industries. However, the DCF models used in this research require that data for each firm be available throughout the entire 1988 to 1999 period. Due to lack of data at some point during the specified 10-year period, the sample reduced to 448 firms.

Each DCF valuation performed uses "perfect information" data, where "perfect information" refers to the use of actual equity cash flows and returns, rather than ex ante forecasts or estimates. Thus, the values yielded by the DCF models represent the intrinsic values of the

firms as of January 1, 1989, and are based on the actual equity cash flows and returns that occurred from 1989 through 1998. It is as if the analyst had a completely accurate forecast, as of the beginning of 1989, of the equity cash flows and returns for 1989 to 1998. The individual data items necessary to determine the actual equity cash flows and returns are obtained from COMPUSTAT.

To assess the predictive ability each DCF model, we compare a firm's intrinsic value to its January 1, 1989 market value. Specifically, we use the log of the ratio of the intrinsic (DCF) value to market value, similar to Kaplan and Ruback (1995). This log ratio represents a measure of the valuation error of the DCF model. If the intrinsic value equals market value, the ratio will be 1, and the log ratio will be zero. If the intrinsic value is less (greater) than market value, the ratio will be less (greater) than 1 and the log ratio will be negative (positive). Kaplan and Ruback (1995) suggest the use of the log ratio because it "...is symmetric with respect to overestimates and underestimates" (1995: 1070). We perform two-tailed t-tests to determine whether the valuation errors are significantly greater/less than zero. It also should be noted that, similar to Kester (1984), we assume throughout this research that the market value of a firm is the "true" value of the firm.

Phase One: Replication of Kester (1984)

Using firm earnings for a single year (1983) and a range of discount rates (15%, 20%, and 25%), Kester (1984) calculates each firm's value using a simple perpetuity DCF model.

$$\text{Firm Intrinsic Value} = \frac{\text{Firm Annual (1983) Earnings}}{\text{Discount Rate}}$$

For this phase of our research, we replicate Kester's (1984) analysis, using the new sample of 448 firms. We use 1989 earnings available to common shareholders and follow Kester's (1984) exact design—annual earnings capitalized at 15%, 20%, and 25%—to determine a range of intrinsic values for each firm. This tests whether or not Kester's (1984) findings can be replicated using a more recent and larger sample.

Phase Two: Replication of Kester (1984) using Cash Flows

For the second phase of this study, we use 1989 cash flow to equity, not earnings, and, again, follow Kester's (1984) design—annual equity cash flow capitalized at 15%, 20%, and 25%—to determine a second range of intrinsic values for each firm. We do this second analysis to determine if Kester's (1984) findings can be supported using a more recent and larger sample *and* a theoretically superior source of value—cash flow. According to finance theory, the value, or worth, of an asset is the present value of the future cash flows—not earnings—the asset is expected to generate. The general formula for determining a firm's annual cash flow to equity is as follows:

Year t Cash Flow to Equity

$$= \text{Year } t \text{ Net Change in Cash} + \text{Year } t \text{ Cash Common Stock Dividends Paid}$$

The Net Change in Cash incorporates payments to creditors, federal and state governments, and other stakeholders, and, thus, represents the cash available to the common shareholders.

However, Cash Common Stock Dividends Paid, which appears as a reduction to the Net Change in Cash, also represents payments to the common shareholders, and so needs to be added back.

The Net Change in Cash and the Cash Common Stock Dividends Paid were both obtained from each firm's *Year t* Statement of Cash Flows. For this particular analysis, *Year t* is 1989.

There seems to be no reason to believe there has been a fundamental change in how market participants conceptually view and ascribe value to corporate growth opportunities. Kester's (1984) findings would suggest, then, that we should expect both perpetuity DCF models to undervalue, to various degrees, a firm's market value, and that we should see negative log ratio valuation errors.

Results of Phases One and Two: Replication of Kester (1984) with Earnings and Cash Flow

Table 1 below presents the results of the two replications (earnings and cash flow to equity) of Kester's (1984) research.

Insert Table 1 here

Results indicate that, on average, a perpetuity DCF model noticeably undervalues a firm's market value, assuming the correct assessment of firm value is its market value, and regardless of the source of value—earnings or cash flow to equity. The log ratio valuation errors range from -56.49% to -107.57% for the earnings model and from -138.48% to -189.56% for the cash flow to equity model. All results are significant at the 1% level. On the surface our initial tests appear to support Kester's (1984) findings, however a more detailed reconciliation suggests that Kester (1984) may have underestimated the amount of firm value attributable to growth options.

Kester (1984) subtracted the intrinsic value from the market value to determine a percent of market value attributed to growth options. Kester (1984) found this percentage to range for the 15 individual firms in his sample from 4% to 88%, with an average of 41.9% (15% discount rate) and 65.13% (25% discount rate). When the valuation errors in Table 1 are converted to a percentage of market value (using the inverse of the log function), our analysis suggests that growth options represent, on average, 43.2% (15% discount rate), 57.4% (20% discount rate), and 65.9% (25% discount rate) of market value when earnings are used. Thus, our earnings model results of phase one are very similar to Kester's (1984). However, when cash flows are used instead of earnings, growth options represent, on average, 74.9% (15% discount rate), 81.2% (20% discount rate), and 84.9% (25% discount rate) of market value. Since cash flows represent a more appropriate measure of firm value, this suggests the portions of firm market value

attributable to the value of growth options may actually be substantially larger than those observed by Kester (1984) when cash flows are used instead of earnings.

Phase Three: Extension of Kester (1984)

The perpetuity DCF models used in the first two phases of this research are very simple models, and do not necessarily represent those used in practice or taught in finance courses. In many ways they represent the calibration of our results and sample back to Kester's original work. Therefore, we next extend Kester's (1984) work significantly by testing the predictive ability of a more sophisticated—10-year, multi-period—DCF model. We continue to use perfect information data in the form of actual annual equity cash flows and returns as inputs to the model. But now we assume a 10-year investment horizon, and determine the intrinsic value of the firm as the sum of (1) the 1989 present values of the firm's annual (1989 to 1998) cash flows to equity and (2) the 1989 present value of the firm's ongoing, more commonly called residual, value (1999 and on). Thus, the January 1, 1989 intrinsic value of the firm is determined as follows:

1/1/1989 Intrinsic Value of the Firm =

$$\begin{aligned} & \text{1/1/1989 Present Value of the 1989 to 1998 Annual Cash Flows to Equity} \\ & + \text{1/1/1989 Present Value of the 12/31/98 Residual Value} \end{aligned}$$

The relationship between risk and return is central to finance theory. Traditional DCF models typically use equity rates of return (discount rates) determined by using the Capital Asset Pricing Model (CAPM), which is an expectations model, i.e., an *ex ante* framework. Since we are using perfect information, i.e., *ex post* data, we use actual firm performance to determine the equity rates of return. The Year *t* equity rate of return is determined as follows:

Year t Equity Return =

$$\frac{\text{Stock price @ end of Year } t + \text{Common Dividends Paid in Year } t}{\text{Stock price @ end of Year } t-1} - 1$$

We calculate the actual equity rate of return for each firm for each year from 1988 to 1999, and, in order to avoid skewing a given valuation due to an unusually high or low return in any single

year, we use 3-year moving averages of actual equity returns as our discount rates. To calculate the January 1, 1989 present value of the 10 (1989 to 1998) annual cash flows to equity, each annual cash flow is discounted one year at a time using the 3-year moving average equity rates of return actually experienced during the sampling period. The January 1, 1989 present values of the 10 cash flows are then added together.

For our purposes here, the firm's residual value represents the value of the firm for 1999 and beyond, as of the end of 1998. Consistent with finance theory and practice, we model the residual value as a perpetuity. We assume a 4% growth rate for the cash flows to equity occurring after 1999, which is the rate Kaplan and Ruback (1995) suggest as an appropriate growth rate.

$$\text{Firm Residual Value} = \frac{\text{1999 Equity Cash Flow}}{\text{January 1, 1998} \quad [3\text{-year Moving Average Discount Rate for 1998}] - 0.04} \\ (g=4\%)$$

Negative residual values occur when the 1999 cash flow to equity is negative. Since 1999 occurs during an economic boom, a negative 1999 cash flow to equity could be due to a high level of firm capital expenditures that year. Alternatively, a negative residual value might suggest that the firm is no longer a viable entity, and, therefore, should be dropped from the sample, similar to firms that became non-viable entities and data was no longer available. Whatever the reason for the negative 1999 equity cash flow, modeling negative equity cash flows into perpetuity is not reasonable; a firm having a negative residual value is not representative of an ongoing firm. If a firm's 1999 equity cash flow is negative and the firm was a viable entity in 1999, the 1998 equity cash flow is compounded forward one period using a 4% growth rate.

$$\text{Firm Residual Value} = \frac{\text{1998 Equity Cash Flow} * 1.04}{\text{January 1, 1998} \quad [3\text{-year Moving Average Discount Rate for 1998}] - 0.04} \\ (g=4\%)$$

If the 1999 equity cash flow is negative and the 1998 equity cash flow compounded forward one period is negative, the firm was excluded from the sample of 448 firms, reducing the sample of firms, for the 10-year, multi-period DCF model, to 232 firms².

The January 1, 1989 present value of the residual value is determined by discounting its 1998 value, year by year, using the 3-year moving average discount rates, exactly as was done with the annual cash flows to equity.

The final step, again, is to assess the predictive validity of this 10-year, multi-period DCF model by comparing the resulting intrinsic value with the firm's market value as of January 1, 1989 using the Kaplan and Ruback (1995) valuation error measure previously described.

Although using actual cash flows for ten years captures the value of the firm's exercised growth options, the firm may still have unexercised growth options. In fact, it is a question of substantial interest to see what option value lies beyond our ten-year perfect information horizon. We continue to see no reason to expect the DCF intrinsic values to be, on average, equal to or greater than the firms' market values. Thus, we continue to expect to see negative log ratio valuation errors.

Results of Phase Three: Extension of Kester (1984)

Table 2 shows the valuation error of the overall predictive ability of this 10-year, multi-period DCF model, as well as the proportion of the firm's intrinsic value accounted for by its residual value³.

Insert Table 2 here

² Of the 232 firms in our sample, the 1999 equity cash flow was negative for 32 of the firms, thus requiring the calculation to compound forward the 1998 equity cash flow.

³ The proportion of intrinsic value accounted for by residual value was calculated as the 1989 present value of the residual value divided by the 1989 intrinsic value.

As Table 2 shows, this 10-year, multi-period DCF model appears, on average, to fairly approximate or even slightly, though not significantly (11.02%, $p = 0.07$), overvalue a firm's market value. The residual value comprises, on average, 45.49% of the intrinsic value, suggesting that long-term, i.e., greater than 10 years, expectations represent a significant portion of a firm's current value. Although the relative magnitude of the residual value seems rather large, it is in line with those seen in firm valuations done in practice. These results are somewhat surprising, and contradict those of Kester (1984), as well as those of our two replications of Kester's (1984).

Further Analysis

To further explore our results from phase three, we segment the data in two additional ways: by macroeconomic conditions and by industry. Each of these could be a factor in the value of the growth opportunities actually available to firm, or as perceived by the market. During periods of economic growth, firms most likely have ample access to the capital necessary to pursue growth opportunities. In contrast, during periods of economic decline, firms may not have the capital, or other resources, necessary to pursue growth opportunities, thus limiting the perceived value of their growth options. Furthermore, as Kester's (1984) results indicate, the percentage of firm value attributable to the value of growth options varies by industry.

Further Analysis: Macroeconomic Conditions

The 10-year sampling period used in this research, 1989 to 1998, experienced a wide range of economic conditions, and represents a period of time that witnessed both sides of a business cycle. During approximately the first half of the sampling period, the late 1980s and early 1990s, the economy experienced an economic recession. The economy emerged from the recession around 1992 or 1993, and entered an economic boom that is still underway at the end of the sampling period, 1998. Thus, we partition the 10-year sampling period into two 5-year periods, 1989-1993 (economic recession) and 1994-1998 (economic boom). We then reassess the predictive ability of the multi-period DCF model for these two 5-year sub-periods. Table 3 below presents the results of these tests.

Insert Table 3 here

The results show that during the first 5-year period (1998-1993: economic recession), the multi-period DCF model, on average, reasonably estimates a firm's market value. That is, the implied value of a firm's assets in place is approximately equal to its market value. In the second 5-year period (1994-1998: economic boom), the multi-period DCF model now significantly undervalues (-45.46% , $p < 0.01$) a firm's market value⁴. In both cases, the residual value represents slightly more than 55% of the intrinsic value, which is a somewhat higher proportion than seen in the full 10-year sampling period results.

Further Analysis: Industry

Industries differ in terms of their life cycles and growth trajectories, and so it is reasonable that the availability of growth opportunities might differ across industries. Kester's (1984) results did seem to suggest variation in growth option value by industry—electronic and computer firms, on average, had higher growth option values and food-processing firms, on average, had lower growth option values. Hence, to investigate the impact of industry we partitioned the data according to industry membership based on the SIC Divisions, i.e., groupings of two digit SIC codes into larger divisions, obtained from COMPUSTAT. One modification was made to the SIC Divisions: industries relating to technology were broken out separately. Categorizing the sample firms in this manner leads to 11 industry groups: (1) Conglomerates; (2) Construction; (3) Finance, Insurance & Real Estate; (4) Manufacturing; (5) Minerals; (6) Pharmaceuticals; (7) Retail Trade; (8) Services; (9) Technology; (10) Transport, Communication & Utilities; and (11) Wholesale Trade. Six industry groups—Conglomerates, Construction, Minerals, Pharmaceuticals, Services, Wholesale Trade—consist of less than 15 firms each, and

⁴ Converting these valuation errors to determine the proportion of market value represented by growth options shows that in the first 5-year period, approximately 9.4% of market value is attributed to growth options. In the second 5-year period, growth options represent approximately 36.5% of market value.

are considered too small for any meaningful statistical analysis. Thus, we focus on the remaining five industry groups—Finance, Insurance & Real Estate; Manufacturing; Retail Trade; Technology; Transport, Communication & Utilities; Wholesale Trade. Table 4 below presents the analysis of the predictive ability of the full 10-year, multi-period DCF model for these five industry groups.

Insert Table 4 here

As Table 4 shows, for the entire 10-year sampling period, the multi-period DCF model yields intrinsic values that reasonably approximate market value for firms in three of the five industry groupings—Manufacturing, Technology, and Transport, Communication & Utilities. The model significantly overvalues (99.9%, $p < 0.01$) firm value for the Finance, Insurance & Real Estate industry group, but it significantly undervalues (-33.4%, $p = 0.01$) firm value for the Retail Trade industry group. These findings appear to support Kester's (1984) implication that industries vary in terms of the level of growth options available to firms, even for the industries in Table 4 whose mean valuation errors are not significantly different from zero. However, these results are somewhat surprising, particularly with respect to the Technology industry group, where one would expect firms to have considerable growth opportunities available to them and the market to perceive substantial growth option value. These findings relating to the effects of industry membership are discussed further below.

But, before moving on to the discussion of the implications of our findings, we discuss methodological issues we consider worthy of noting.

METHODOLOGICAL ISSUES

There are three methodological issues of concern with this research. The first relates to the sample of firms—exit and entry bias. The second relates to the underlying process for determining growth option value—indirect valuation a firm's growth options. The third is concerned with the firm residual values used in the multi-period DCF models—assumed growth rate for the cash flows to equity and unrealistic discount rates potentially resulting in unreasonably high or low residual values for some firms in the sample.

Exit and Entry Bias

The most obvious methodological issue inherent in this research is closely related to survivor bias and could be called “entry and exit bias”. Exit bias corresponds to what is normally called survivor bias. The original sample was systematically reduced to obtain firms with complete data for the 10 years of the study. Firms that ceased to exist, whether through acquisition or through failure during the 10-year period, are an obvious source of potential survivor bias. This is inevitable and common in long-term studies of firm populations. For the present study, it seems reasonable that the firms that thus exited probably had fewer growth options available to them. Hence the result would be in the direction of a greater growth option value in the remaining sample.

The closely related issue is firms that entered the S&P 500 during the 10-year period of the study, but were not included due to not having been a part of the subject population during all of the 10-year period. For this group of firms, it seems reasonable that they would be relatively fast growing firms with many growth options. Hence the result of their not being included would be in the direction of lower growth option value in the sample than if these firms had been included. This likely effect of “entry bias” is in the opposite direction of the “exit” or survivor bias. Whether or not the net effect of the two would cancel each other cannot be determined, but

it seems safe to say the net effect would be to reduce the magnitude of any resulting bias from either “entry” or “exit”.

Indirect Valuation

Another important methodological issue is the indirect approach used to estimate the value of the growth options as a remainder: market value less the intrinsic value, as Kester (1984) used, or the log ratio of intrinsic value to market value used in this study. The accuracy of this indirect approach relative to other possible direct approaches is unknown. In particular, it may be possible to calculate directly the value of the growth option portion of a firm's market value using standard option-pricing techniques, such as the Black-Scholes model or the binomial lattice model. Such a Real Option Approach would require possibly severe assumptions about the option pricing input parameters and their values (Lander and Pinches, 1998), but ultimately may add considerable insight. These approaches may be a fruitful line of inquiry for future research if appropriate methods can be developed.

Residual Values

There are two areas of concern related to residual values with respect to the multi-period DCF models. First is the assumed growth rate for the cash flows to equity used in the full 10-year, multi-period DCF model. We use 4%, the rate Kaplan and Ruback (1995) use, which allows for a modest growth rate for the firm after inflation. Lower or higher rates could have been used, but 4% was in line with standard research practice and seemed reasonable.

The second residual value methodological concern is that of extreme discount rates resulting in unrealistically high or low firm residual values, which are used in perfect information multi-period DCF models. Even though we use discount rates that are 3-year moving averages, we use actual returns to equity to calculate the 3-year moving averages, and firms may have had unusually high or unusually low actual returns to equity at the end of the sampling period, 1998. Firms that earned unusually low equity rates of return around 1998 would have low discount rates and, therefore, produce higher residual values and firm intrinsic values (via less discounting of

future cash flows). On the other hand, firms that earned unusually high equity rates of return around 1998 would have high discount rates and, therefore, produce lower residual values and firm intrinsic values. We experimented with discount rate floor and ceiling values that represented reasonable historical upper and lower bounds on equity returns into perpetuity. The result was a slightly higher overvaluation (roughly 21% versus and original overvaluation in Table 2 of 11%). These bounds did not change the sign of the results and did not substantially change the magnitude of the results. Hence we have reported only the unbounded results here.

With these methodological issues in mind, we now turn to a general discussion of implications of our findings.

DISCUSSION

The research reported in this paper was motivated by the work of Kester (1984), Myers (1984), and Bettis (1983). The overall purpose of this paper was to help bridge a part of the gulf that has separated finance and strategy regarding valuation. In particular this involved examining the presence of “strategic factors” in the form of growth options. Managers have long used “strategic factors” to justify investments that did not seem to be economically viable on their own, due to low or negative net present values. The growth options of Kester (1984) and Myers (1984), and the theory underlying real option analysis are an important link between strategic analysis and financial analysis. Drawing on the general approach of Kester (1984), we first use his original research design and then a more sophisticated DCF model, with a larger sample of firms and perfect information data, to further explore the predictive ability of the traditional DCF valuation framework. The results are discussed below. Some of the discussion will inevitably repeat issues previously mentioned, but hopefully will organize them in a way that an overall pattern can be discerned. The discussion is divided into two parts: (1) general discussion and (2) a possible explanation.

General Discussion

The pure replication of Kester (1984) using annual earnings and a much larger sample results in large and highly significant negative valuation errors (see Table 1), and hence in the imputation of a considerable growth option value component, on average, into firm market values. Kester's (1984) small sample size makes meaningful comparisons difficult, but our resulting estimates of growth option values seem to roughly correspond to those in the Kester (1984) sample. When the more theoretically correct cash flow to equity is substituted for earnings, the valuation errors are again large, negative and highly significant, and estimated growth option values are substantially larger than Kester (1984) originally suggested from an earnings model. Results from phase two of the study suggest that growth options account for approximately 75 to 85% of the market value of a firm. On the surface this would seem to suggest that Kester (1984) underestimated firm growth option value. However, it can be conjectured that the relatively difficult economic situation (high inflation and high interest rates) present in 1983 may have caused investors to be less sanguine about the future prospects for growth than they were in 1989.

The model incorporating perfect information data for the full 10-year sampling period and using actual 3-year moving average discount rates for each firm, considerably changes the picture from the replications of Kester (1984) just discussed. The average valuation cannot be statistically shown to be different from zero at the 5% or greater level (see Table 2). This suggests that the perfect information data, along with a residual value calculation incorporating a 4% growth rate in equity cash flows, accurately captures, on average, the market value of the 232 firms in the sample. In other words, this model does not, on average, find growth option value in a firm's market value, but rather, only the value of its assets in place in 1989 or put in place in the following decade. This appears to be in direct conflict with Kester's (1984) original work, as well as our two replications of Kester's (1984).

To help to understand the result for the full 10-year sampling period, it is useful to consider exactly what the 10-year perfect information DCF valuations represent. They capture not only the value of cash flows from the assets in place as of the beginning of 1989, but also the value of the cash flows from growth options that were exercised, or allowed to expire, by the firms during the 10-year period. In addition, the residual value captures a simple estimate of the growth options that may exist beyond the 10-year period. Hence, comparing a simple perpetuity model with a multi-period model is not a pure comparison. However, the overall result of the 10-year perfect information DCF model does suggest that, on average, firms in the sample exercised approximately all of the growth options investors envisioned, as of the start of 1989, during the following 10-year period. It should be noted that ten years is an upper bound on this result. It could actually be that a shorter time period is the bound on investor expectations for significant growth options. It should also be kept in mind that this is an average calculation and may admit of longer and shorter time periods for individual firms, or industries. Understanding the time horizons of investors may be useful in strengthening the relationship between firm market performance and strategic planning. Thus, the exploration of investor time horizons, including the effects of strategy, growth options and industry characteristics on such horizons, represents potential avenues for future research.

Deeper analysis yields further insight by considering the results in Tables 3 and 4. Table 3 shows the results of the multi-period DCF models created by partitioning the full 10-year sampling period into two 5-year sub-periods, each representing one side of a business cycle: economic recession (1989-1993) and economic boom (1994-1998). The lack of under-valuation in the first 5-year period, when economic conditions were unfavorable, seems to imply that the market perceives, on average and during such bad times, few if any growth opportunities available to firms. Investors appear to be pessimistic or myopic during economic recessions, which is not conducive to seeing future growth. However, the results for the 2nd 5-year sub-period suggest that, by 1994, investors were starting to think optimistically about future growth

opportunities available to firms. The significant DCF under-valuation (and resultant growth option value) for the second 5-year period, when current economic conditions were favorable, seems to imply that the market perceives, on average and during such boom times, substantial growth opportunities available to firms. Economically good times lead to an optimistic attitude, which, in turn, is conducive to seeing a future resplendent with opportunity. Extending this pattern, however, would suggest that this optimism disappears as economic conditions once again degrade. The sensitivity of growth option value, represented in firm market value, to general economic conditions and the shifts in investor psychology they engender is obvious. Interestingly, this suggests that companies will not be rewarded during the down stage of the cycle for investing in strategies and associated projects that incorporate significant growth options.

In Table 4, results are now broken down by broad industries. Of the five industries with adequate sample sizes for study, one shows significant under valuation, i.e., high growth option value in firm market value (retail trade), while one shows considerable over valuation (finance, insurance and real estate). While not all valuation errors are significantly different from zero, Table 4 shows that the valuation errors do vary by industry, as suggested by Kester (1984). Industry characteristics appear to play a role in the level of growth options available to a firm. Further exploration of the effects of different industry characteristics on growth option values may yield additional insights. Alternatively, from a valuation perspective, DCF models may be less appropriate in certain industries. Yet, as alluded to above, these industry results also raise an interesting issue.

What is most troubling is that the “technology” industry does not show a statistically significant option value component. One would expect that technology would be the most likely category for growth options, given how technologies can grow and branch in ways that cannot be fully anticipated. Two points are relevant here. The first, less important, point is that the sample size is only 17 “technology” firms, making it very difficult to detect modest deviations from zero. This point is relevant since the mean valuation error of these 17 firms is a negative 13.9%, which

is not significant ($p = 0.53$). Such a valuation error in a larger sample of firms might suggest might make possible the detection of undervaluation, as evidenced by Table 2.

Examining the valuation errors within the technology category on a firm-by-firm basis makes the more important point. Of the 17 firms in the sample, fully 13 have negative valuation errors (in line with imputed growth option value). The mean of these 13 negative valuation errors is -54.5%, and contains some likely candidates for having notable growth option values in 1989: Intel (-55.8%), Texas Instruments (-57.7%), and Advanced Micro Devices (-72.8%). These three firms are, of course, major players in the semiconductor industry. By contrast, three of the four firms with positive valuation errors are Lockheed Martin (251.2%), Raytheon (42.1%), and Harris (79.0%). These are all major defense contractors, and 1989 was a time of substantial decline in the USA military procurement budget. The cold war was ending, and the so-called “peace dividend” was expected from much smaller defense budgets. As these positive and negative valuation errors examples suggest, the “technology” category is very heterogeneous. A better breakdown of industries with a reasonable sample size for each would likely show considerable growth option value in industries such as semiconductors, pharmaceuticals, and computers.

In sum, the results raise important questions concerning the use of DCF models in the capital budgeting practices of firms and the connection to the creation of shareholder value. The nature of the DCF model, along with the extent of recognition and incorporation of influential factors from the investment context, may lead to different valuations, and hence different investment choices. If managers and executives are to better tie investment in strategies and projects to the creation of shareholder value, these issues will have to be much better understood. (This is an obvious direction for future research.) Furthermore, growth option value (or, alternatively, DCF valuation error) is dependent on a number of different variables. It is to this issue we now turn.

A Possible Explanation

In this section we offer a possible explanation for the results just discussed. The overall pattern of the results suggests that the growth option value contained in the market value of a particular firm depends on three general factors that impact investor expectations: (1) the macroeconomic environment; (2) the industry in which the firm participates; and (3) firm specific factors.

The impact of the macroeconomic environment can clearly be seen in Table 3. The industry results summarized in Table 4, using the broad and crude industry categories, show the impact of industry. Finally, the specific technology firm examples, discussed in the previous section, illustrate the impact of firm specific factors. Furthermore, a good deal of strategy literature and practice is directed toward the creation of growth options on the individual firm level. In fact, it could be argued, that the concept of core competence is, at base, a theory of growth option creation at the firm level. Obviously, all three of these factors change over time thereby altering the percentage of firm market value represented by growth option value.

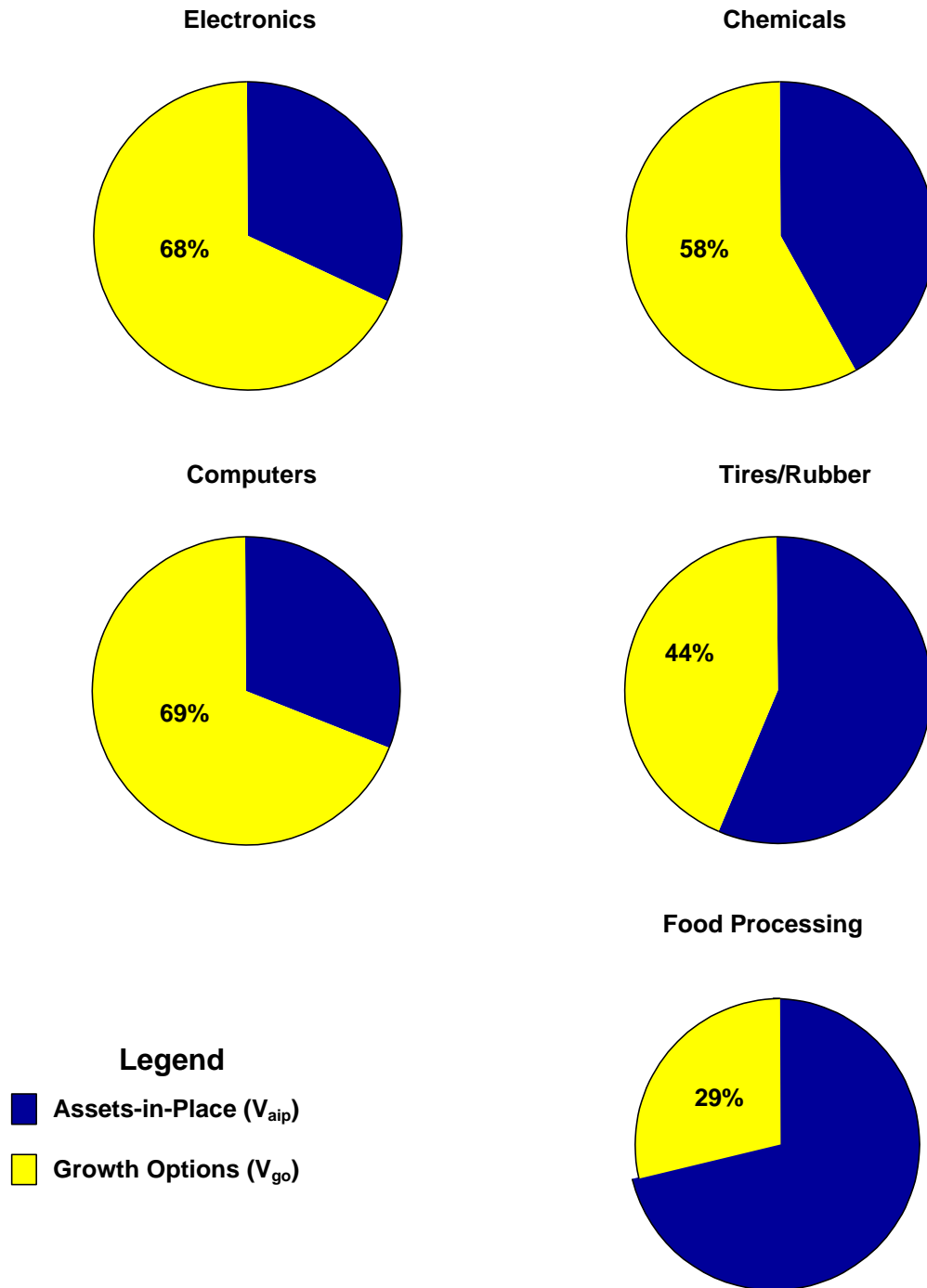
It should also be noted that the three factors probably interact in various complex ways. For example, the macro economy impacts different industries in different ways. Untangling the impact of various factors, and their interactions over time, represents a difficult but important issue for future research. A complex partitioning of the variance in option value with a large sample of firms stratified by meaningful industry categories and broad strategies within them will likely be necessary. Such a study could be crucial in connecting strategy with valuation.

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Figure 1: The Value of Growth Options as a Percent of Firm Market Value, by Industry
As Per Kester (1984)*



* Kester values each firm at three different discount rates, and he has three firms in each industry. Each chart here represents the overall industry average of Kester's results.

Figure 2: Overview of Research Design

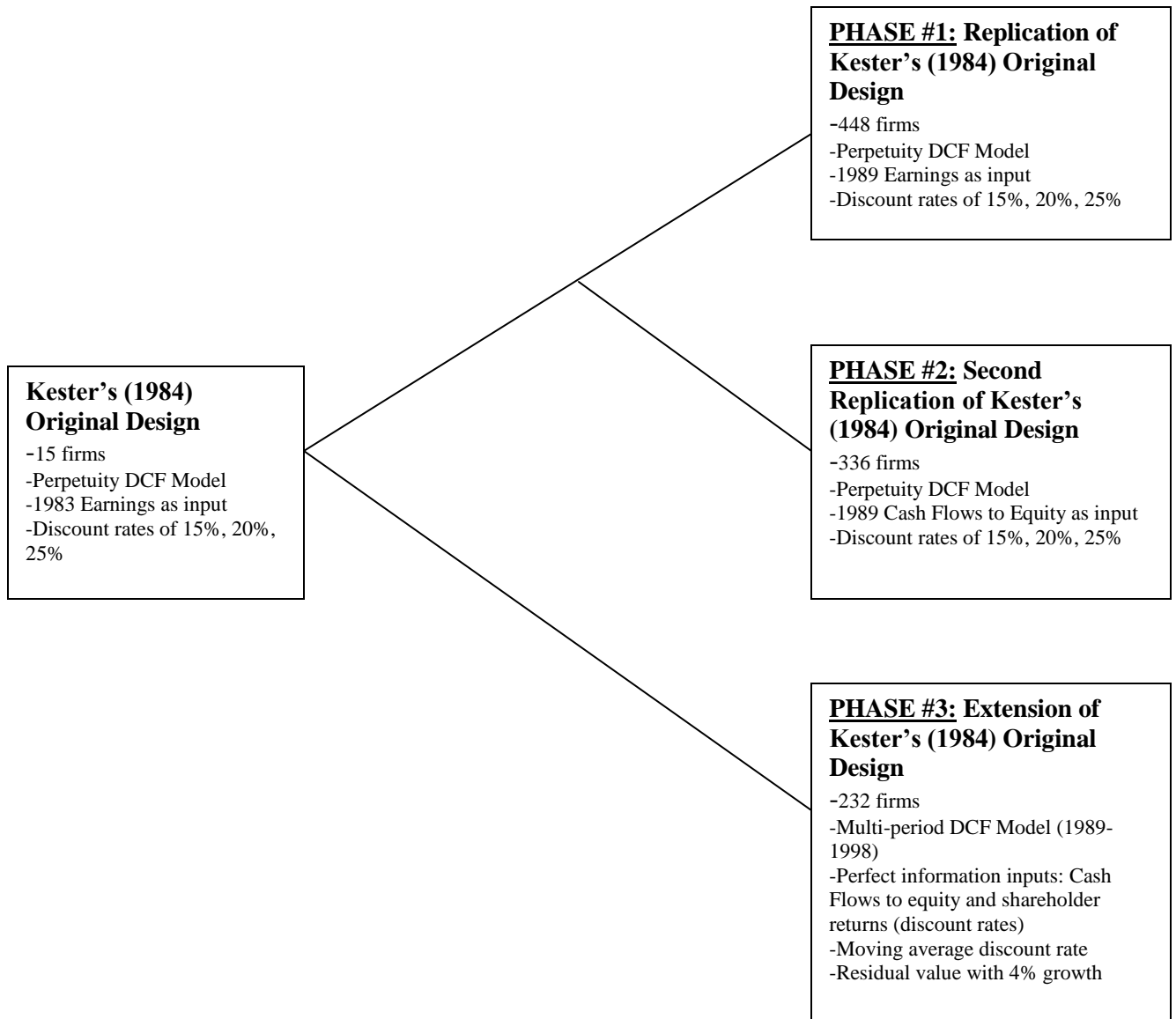


Table 1: Results of Phases One and Two--Tests to Replicate Kester's (1984) Model

	Mean Valuation Error Discount Rate=15%	Mean Valuation Error Discount Rate=20%	Mean Valuation Error Discount Rate=25%
Phase One: Earnings (N= 448)	-56.49% t = -18.052 p < 0.01	-85.25% t = -27.246 p < 0.01	-107.57% t = -34.377 p < 0.01
Phase Two: Cash Flow to Equity (N= 336)	-138.48% t = -21.008 p < 0.01	-167.24% t = -25.372 p < 0.01	-189.56% t = -28.758 p < 0.01

Table 2: Results of Phase Three--Tests of Predictive Ability of the 10-Year, Multi-period DCF Model

Valuation Error (N= 232)	Residual Value as a Percent of Intrinsic Value
11.02% t = 1.807 p = 0.07	45.49% (g = 4%)

**Table 3: Results of Further Analysis--Tests of Predictive Ability of the Multi-period DCF Model
Using 5-year Sub-Periods**

Valuation Error Using Perfect Information	Residual Value as a Percent of Intrinsic Value	Valuation Error Using Perfect Information	Residual Value as a Percent of Intrinsic Value
1989 - 1993	1989 - 1993	1994 - 1998	1994 - 1998
Economic Recession (N= 187)	Economic Recession	Economic Boom (N= 232)	Economic Boom
-9.88% t = -1.154 p = 0.25	58.76% (g = 4%)	-45.46% t = -6.514 p < 0.01	56.89% (g = 4%)

Table 4: Results of Further Analysis--Tests of Predictive Ability of the 10-Year, Multi-period DCF Model (For Industry Groups with Data for 15 or More Firms)

	Valuation Error Using Perfect Information 1989 – 1998	Residual Value as a Percent of Intrinsic Value 1989 - 1998
Finance, Insurance & Real Estate (N= 31)	99.9% t = 5.24 p < 0.01	32.13% (g = 4%)
Manufacturing (N= 86)	-7.4% t = -0.85 p = 0.39	48.42% (g = 4%)
Retail Trade (N= 24)	-33.4% t = -2.76 p = 0.01	45.71% (g = 4%)
Technology (N= 17)	-13.9% t = -0.64 p = 0.53	43.88% (g = 4%)
Transport, Communication, & Utilities (N= 40)	17.1% t = 1.30 p = 0.20	45.88% (g = 4%)