EMPIRICAL ESSAYS IN CORPORATE FINANCE: TESTING THEORIES OF MARKET IMPERFECTIONS AND COSTLY CONTRACTING

Leonard L. Lundstrum

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Bell & Howell Information and Learning Company
300 North Zeeb Road
P.O. Box 1346
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Craig Holden, Ph.D.

Robert Jennings

Doctoral

Committee

Sreenivas Kamma

Peter Pedroni

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I empirically examine the theoretical determinants of the firm's investment decision. The first essay examines the evidence on the value of internal financing to the firm. A pooled cross-sectional, time-series test is employed. Results are consistent with the hypothesis that internal financing is positively related to firm value. The second essay examines the evidence on the three theories which explain a distortion of corporate investment. A pooled cross-sectional, time-series test is employed. Results are consistent with hypothesis that the shareholders impose a myopic investment policy to prevent the manager from making long-term investments which require his continued employment with the firm, and then threatening to leave if his compensation is not increased. The third essay examines the evidence on the whether costly long-term informed trading causes the firm to under-invest in projects with long-term cash flows. An event study test is employed. The results are consistent with the hypothesis that the high cost of long-term informed trading results in the firm under-investing in projects with long-term cash flows.

The Value of an Internal Capital Market

Leonard L. Lundstrum

Department of Finance
Kelley School of Business
Indiana University
Bloomington, IN 47405-1701

and

Department of Business Management
College of Management
North Carolina State University
Raleigh, NC 27695-7229

Email: leonard_lundstrum@ncsu.edu

June 28, 2000

Abstract

A firm may create an internal capital market so that the investment opportunities of one division are funded by the free cash flow generated by another division of the firm. An internal capital may be created by buying or building divisions which are cash-starved in combination with divisions that generate cash in excess of their investment needs. The Williamson (1986) "Information Cost" theory suggests that an internal capital market increases firm value. Yet the Jensen (1986) "Firm's Cash Flow" theory suggests that an internal capital market decreases firm value. This paper tests the "Information Cost" theory versus the "Free Cash Flow" theory by examining the efficiency of an internal capital market net of agency costs.

The results suggest that, on average, the diversified firm's use of an internal capital market is positively related to firm value, consistent with the Information Cost theory. Results hold while controlling for industry, profitability, firm size and investment opportunities. When firms are partitioned on the extent of the information asymmetries between firms and investors, the results change only for those firms which face the very highest information asymmetries. The results for those firms facing the highest information asymmetries are consistent with the "Free Cash Flow" theory.

Preliminary and Incomplete – comments welcome. Please do not quote.

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Introduction

The firm may be able to maximize its value by acquiring or building diverse business segments to create an "internal capital market" in which the investment opportunities of one business segment are funded by the free cashflow generated by another business segment. These investment opportunities include profitable projects that can not be funded externally due to information asymmetries and agency costs. In such a case, an internal capital market may act as a less-costly substitute for the external capital markets. Rajan et al. (1998) suggest that the combination of segments has ramifications for each individual segment because the combination alters the power structure of the firm. The power structure effects the firm's decision-making even in the absence of any operational links between segments. Lamont (1997) finds that corporate segments are interdependent with respect to investment. Therefore combining different segments into a corporation has real consequences. I examine the positive or negative effects of these real investment consequences on firm value.

The extant theories conflict with respect to the value of an internal capital market, leaving its impact on firm value an empirical question. While the Williamson (1986) "Information Cost" theory suggests that an internal capital market has a value-increasing effect on the diversified firm, the Jensen (1986) "Free Cashflow" theory suggests that an internal capital market decreases firm value. The empirical evidence offered by Shin and Stulz (1998) provides broad evidence that the diversified firm utilizes an active internal capital market. They also find evidence that agency costs reduce the efficiency of the internal capital market. However, they do not examine the impact of an internal capital market on firm value, net of agency costs. As a result, the efficiency of an internal capital market remains unclear. This paper contributes to the literature by examining the efficiency of an internal capital market net of agency costs. The results suggest that, on average, the diversified firm's use of an internal capital market is positively related to firm value.

The Information Cost theory suggests that an internal capital market increases firm value in two ways, first by reducing under-investment costs through a reduced reliance upon the external capital markets. Under-investment costs result from information asymmetries and the "Lemons" problem as detailed by Myers and Majluf (1984). Second, an internal capital market increases firm value by increasing the efficiency of capital allocation across projects. In contrast to the Information Cost theory, the Free Cashflow theory argues that the agency costs of free cashflow associated with an internal capital market reduce firm value. The diversified firm is used here as a natural laboratory to examine the value of an internal capital market. The diversified firm is used because the Information Cost theory suggests that firms that are diversified may rely extensively upon an internal capital market to fund their investment activity. These firms may utilize an internal capital market by combining a business segment which generates free cash flow with a cash-starved business segment, creating a diversified firm. Theoretically, the cash-starved business segment may invest regardless of its cash flow. I test the Information Cost theory against the Free Cashflow theory by examining the impact of an internal capital market on diversified firm value.

The competing theories are tested using a two-stage analysis. First, the extent to which the firm relies on an internal capital market (or "Internal Financing") to fund its investment opportunities is estimated using an empirical proxy for the firm's internal financing. This proxy, called "Internal Finance" here, controls for capital expenditures and the availability of internal financing in a sales-weighted portfolio of industry-matched, stand-alone firms. This proxy differs from that used by Billett and Mauer (1998). Billett and Mauer's proxy for an Internal Capital Market is defined as the sum of segment investment in excess of segment cashflow across all of the firm's segments.

Both my large sample size and the industry-adjusted Internal Financing proxy used in this paper are important innovations relative to the Billett and Mauer paper. The advantage of the Internal Financing proxy introduced here is that it measures the firm's access to internal cash, whereas the Billett and Mauer proxy examines the firm's realized ability to invest in excess of its cash flow. Therefore this paper defines an active capital market as one in which cash flow is available for the manager to waste or to invest in wealth-creating projects. This contrasts with Billett and Mauer's proxy because they define a firm with high investment as a firm with an active internal capital market. As a result, a firm that generates a high level of available Internal Financing, but wastes it, is identified as a firm with an active internal capital market in this paper but would be identified as a firm without an active internal capital market in the Mauer paper. As mentioned earlier, the Billett and Mauer proxy does not control for heterogeneity across industries in firm access to external capital markets. This access to Internal Financing may be critical to the value of diversification, and so I control for it.

In the second stage of the analysis, those diversified firms that are the most likely, according to the Information Cost theory, to benefit from the presence of an internal capital market are identified. These firms face high costs of external financing due to the high level of information asymmetry between the firm and the capital market with respect to the firm's investment opportunities. As a result, these firms are expected to face greater under-investment costs according to Myers and Majluf (1984). The two theories are then tested against each other, first by examining the relationship between Internal Finance and firm value. Second, the interaction effect of high information asymmetries and Internal Financing on firm value is examined. Five different measures of information asymmetries and two different benchmark values against which to compare actual firm value are used for additional robustness.

The methodology introduced by Berger and Ofek (1995) is used in this paper to measure diversified firm value. Therefore I examine the percentage difference between the firm's total value and the sum of the imputed values of all of the diversified firm's segment values calculated as if they were stand-alone firms. The imputed stand-alone value of each of the firm's segments is calculated using the industry median valuation multiples of stand-alone firms. The aforementioned percentage difference is the firm's "excess value". Excess value is the firm's value in excess of the sum of the imputed values of each of its individual segments. In this manner the value of a diversified firm is compared against the value of a portfolio of industry-matched stand-alone firms.

The use of this excess value methodology in the extant research suggests that, on average, the market value of the diversified firm is less than the sum of the imputed stand-alone values of its individual segments [see Lang and Stulz (1994), Comment and Jarrell (1995), Berger and Ofek (1995) and Servaes (1996)]. The extant evidence suggests that the diversified firm's excess value has been persistently negative since the 1960s, through 1991, increasing to zero only briefly in the 1970s before falling to about -15% in the 1980s and then increasing to -13% by 1991.

While diversification may reduce firm value on average, the presence of the diversified firm's internal capital market may be value-increasing for some firms. One group of such firms is those firms that face high costs of accessing the external capital markets due to information asymmetries. For these firm's the "Lemon's" Problem leads to greater under-investment costs. The results of this paper may lead to improved shareholder wealth maximization, improved managerial implementation of corporate diversification strategies and investors' investment strategies as well as enlightened public policy with respect to diversified firms.

As the Information Cost theory suggests, an internal capital market may loosen financing constraints and improve allocative efficiency across investments. An internal capital market reduces the under-investment costs by reducing the importance of information asymmetries between investors and firms. The evidence offered by both Lang and Stulz (1994) and Krishnaswami and Subramaniam (1998) strongly suggest that this may be the case. In fact, the Lang and Stulz evidence suggests that asymmetric information costs (proxied by the firm's non-dividend paying status), and so under-investment costs, are related to lower diversified firm values. The Krishnaswami and Subramaniam (1998) results suggest that the Information Cost theory may be important for diversified firms that face high information asymmetries. They provide evidence that is consistent with the hypothesis that diversified firms spin off divisions in an effort to decrease asymmetric information costs so that the firm can access external capital more cheaply.

Comment and Jarrell (1995) find no difference in external financing activity of diversified and single segment firms. While they find no difference in external financing activity, they did not control for the level of either firm cash flow nor investment opportunities. Billett and Mauer (1998) use a small sample to link "tracking stock" announcement returns to the value of the firm's internal capital market. Their announcement return results suggest that an internal capital market has a positive value.

This paper contributes to the literature by examining the efficiency of the internal capital market net of agency costs. First, an empirical proxy for the firm's internal capital market is developed and referred to as "Internal Finance". It measures the firm's ability to fund investment opportunities internally. Second, the differential impact of Internal Finance on firm value between diversified and single segment firms is examined. By focusing on only the differential impact of Internal Finance on diversified versus single-segment firms I avoid attributing value to the diversified firm's internal capital market if the internal financing proxy is related to firm value in the same way in both the single segment firm and the diversified firm.

While this work is motivated by the Information Cost and Free Cashflow theories discussed above, it is also motivated by two groups of results in a different stream of literature. These two results strongly suggest that the presence of an internal capital market may have a value-increasing effect on the firm. These results are as follows. First, MacKie-Mason (1990) and Lamont (1997) find that internal funds are important to the firm's ability to fund its investment projects. In fact, MacKie-Mason (1990) suggests that on average 75% of the firm's annual investment is funded internally. Therefore economy-wide, internal capital markets are an important and economically significant source of firm-level investment financing. This also suggests that an efficient internal capital market which Lamont suggests funds the majority of corporate investment has the real potential to increase firm value. This makes any positive impact on firm value economically significant. Second, the McCutcheon (1990) evidence suggests that the firm may diversify in an attempt to create an internal capital market.

My results suggest that, on average, the diversified firm's use of an internal capital market by the diversified firm is positively related to firm value, consistent with the Information Cost theory. Results hold while controlling for industry, profitability, firm size and investment opportunities. When firms are partitioned on the extent of the information asymmetries between firms and investors, the results change only for those firms which face the very highest information asymmetries. The results for those firms facing the highest information asymmetries are consistent with the "Free Cash Flow" theory.

The paper proceeds as follows. Section 1 presents the hypotheses. Section 2 presents the empirical model. Section 3 discusses the sample and descriptive statistics. Section 4 presents the empirical specification and results. Section 5 concludes.

1. Hypotheses

Portfolio theory suggests that there is no value-increasing effect of diversification at the firm level. This follows from a few critical assumptions. First, the investor can diversify for herself, so firm-level diversification only serves to reduce the state-space of payoffs for the investor. Portfolio theory assumes perfect capital markets. and so the absence of any information asymmetries between firms and investors with respect to the firm's investment opportunities. Given this assumption, all value enhancing projects will be financed by the external capital markets, making an internal capital market redundant and so of at most zero value.

Relaxing these assumptions and admitting capital market imperfections, Myers Majluf (1984) assert that there exist information asymmetries between the firm and the market with respect to the firm's investment opportunities. The Myers and Majluf theory has two implications which are relevant here. First, their theory suggests that firms prefer to fund investment with internally generated cash to avoid the Akerloff "lemons" problem when accessing the external capital markets. Second, due to the lemon's problem that makes access to external capital markets costly, firms may incur under-invest costs, by forgoing investment opportunities. It follows from the first implication that firms will want to build up financial resources to take advantage of investment opportunities without having to access the external capital market. As a result, the firm incurs the costs of building up internal cash until it needs it.

If we admit agency costs, and assume that manager's do not necessarily maximize firm value but rather prefer to maximize investment, then an internal capital market may create value in another way. Manager's may prefer to over-invest for a variety of reasons including the fact that perquisites are correlated with firm size even when the firm invests in negative net present value projects. If we admit agency costs then high cash flows realized by a single-segment firm are partially wasted. In what follows, I discuss how the diversified firm's internal capital market, by impacting the second moment of firm cash flows, may increase firm value by reducing agency costs. Stulz (1990) suggests that when two identical firms with imperfectly correlated cash flows are combined the value of the firm increases above the sum of the individual firm values. This results from the decline in cash flow volatility. A decrease in the dispersion of cash flow impacts firm value by reducing agency costs. It then follows that diversification across segments can increase shareholder wealth. Therefore diversification may reduce agency costs by reducing the volatility of firm cash flow. Reduced agency costs could potentially be a source of value to the firm as Denis, Denis and Sarin (1997), Lins and Servaes (1997), Berger and Ofek (1995), and Shin and Stulz (1998) find evidence of agency costs in diversified firms.

The presence of an internal capital market may increase firm value, as the Information Cost theory suggests that its value arises from the information advantage, with respect to outside investors, enjoyed by the manager. A firm that has an efficient internal capital market will increase firm value in at least two ways. First, the firm realizes the benefits of avoiding under-investment costs brought on by the "Lemons" problem that results from raising external financing with under-priced securities. The Lemons problem results from information asymmetries between firms and investors when the firm accesses the external capital market. Therefore, Internal Financing allows the firm to avoid the "Lemon's" problem and results in improved investment efficiency. The diversified firm also enjoys greater allocative efficiency because its investment opportunities are not confined to a single industry and the firm's management has superior information with respect to investment opportunities. Therefore, the diversified firm may fund the best investment opportunities across several business segments. This yields the following hypothesis.

H1: *Diversified firm value is increasing in the firm's use of internal financing.*

Jensen's (1986) Free Cashflow theory suggests that the diversified firm suffers from agency costs brought on by the presence of free cash flow. These costs of free cash flow include over-investment and prerequisites. Jensen claims that the diversified firm, due to its uncorrelated cash flows, is in a position to waste the easily accessible cash flow. The presence of an internal capital market increases the availability of cash which may be wasted. This yields the following hypothesis.

H2: *Diversified firm value is decreasing in the firm's use of internal financing.*

I test **H1** and **H2** using the empirical model that follows.

2. Empirical Model

A two-stage analysis is used here to analyze variations in firm value. In the first stage, the level of asymmetric information the firm would face if it were to raise capital externally is estimated. Next, each firm-year observation is categorized as facing either high or low information asymmetries. If the level of information asymmetries exceeds that of the year's sample median, the firm-year observation is considered to face high information asymmetries. Otherwise the firm-year observation is assumed to face low asymmetries. This dichotomous classification is used to control for the fact that the level of information asymmetries may not be linear in the proxies. The dichotomous classification is a coarse measure of asymmetries. The firm's use of internal financing is also estimated. The results of the first stage are used in the second stage of the analysis.

Estimating Information Asymmetries

Five different proxies are used for the information asymmetries between the firm and the market, with respect to the firm's investment opportunities. The five proxies are the analyst forecast error, standardized forecast error, dispersion in analyst forecast, the number of analysts following the firm and the fifth measure is whether or not the firm operates in a "science-based" industry.

Analyst earnings estimates from the Institutional Broker Estimate System (IBES) are used to estimate the analyst forecast error. Following Christie (1987), forecast error is measured as the absolute difference between the actual and forecast earnings per share. The mean earnings forecast for the final month of the fiscal year is defined to be the predicted analyst earnings. The work of Elton, Gruber and Gultekin (1984) supports the use of the forecast error as a measure of information asymmetries. Elton et al. found that over 80 percent of the forecast error in the final month prior to the end of the fiscal year may be attributed to mis-estimation of firm-specific factors, and not industry factors or the economy. This suggests that the analyst forecast error is a reasonable measure of information asymmetries between the firm and the external capital market. The value of the expected earnings varies with the firm's capital structure, number of shares outstanding and other factors unrelated to information asymmetry. As a result of these other sources of variation in the level of expected earnings, the analyst error may be correlated with the magnitude of expected earnings.

The second measure of information asymmetries is the standardization of forecast error. The forecast error is divided by the mean earnings estimate to control for any correlation between forecast errors and the magnitude of the earnings forecast. The size of the standardized forecast error varies with other factors which include firm leverage and risk management activity within the firm. As a result, the standardized forecast error does not control for all sources of variation in this proxy which are unrelated to information asymmetries.

The third measure of information asymmetries is the standard deviation, or dispersion, of analyst forecasts in the last month of the prior fiscal year. Healy, Palepu and Sweeny (1995) argue that as information asymmetries decline there is likely to be a higher consensus among financial analysts about the firm's prospects. This should lead to a decline in dispersion of analyst forecasts. As dispersion measures the divergence of analyst estimates, it indicates a lack of available information on the firm. The dispersion of analyst estimates includes uncertainty of two types. There is uncertainty in the analyst estimates with respect to the private information that the manager has with respect to investment opportunities. There is a second source of uncertainty, the uncertainty the manager has about future demand, cost structure and competition. Therefore the uncertainty that the dispersion in analyst estimates captures is uncertainty with respect to the manager's demand, cost structure and competition about which the manager does not know. Richardson (1998) also uses dispersion as a proxy for information asymmetries when examining the manager's ability to manipulate earnings.

The fourth proxy for the level of information asymmetries, follows Denis, Denis and Sarin (1997), and is the number of analysts following the firm. The number of analysts who provide an earnings estimate one-year prior to the end of the prior fiscal year is used for this purpose. Womack (1996) and Brennan et al. (1993) support the use of simple measure. Brennan et al. (1993) uses the number of analysts as a proxy for the level of informed trade. Womack finds that analyst reports contain information, therefore the level of information asymmetries is declining in the number of information producers (analysts). While Bhushan (1989) finds that the number of analysts is correlated with firm size, this problem is less important here as the diversified firms in the sample are all quite large, with average market equity in excess of one billion dollars per firm. Easley et al. (1998) find that the number of analysts may not be a good proxy for the level of information asymmetries.

The fifth proxy is a result of the work of Himmelberg and Petersen (1994) who suggest that small, high-tech firms face high information asymmetries that result in the restriction of their access to external capital markets. This follows as high-tech firms hold most of their value in growth opportunities and knowledge and have little tangible collateral. Such collateral could help overcome the adverse selection and moral hazard problems when accessing external capital markets. Therefore the firm's participation in one of four science-based industries, defined by SIC codes, is used as an indicator of high information asymmetries. These industries are: chemical and drugs, machinery, electrical equipment and communication, and instruments. This follows the Griliches and Mairsee (1984) definition of science-based firms as those firms that operate in one of the following SIC codes 28, 35, 36 and 38. This proxy may exclude other industries that face high information asymmetries. The inclusion of these industries may be correlated with other factors that are not explicitly controlled for here. This may result in biased estimates.

<u>Estimating the Firm's Use of an Internal Capital Market</u>

The proxy for the firm's use of an internal capital market is designed to capture the firm's ability to generate cash flow relative to its capital expenditures in excess of that of a portfolio of single segment industry-matched firms. In what follows I examine the relationship between the availability of internal cash to fund capital expenditures and firm value. The availability of internal financing is estimated using both firm cash flow and capital expenditures. The intuition behind controlling for capital expenditures and cash flow in a portfolio of single-segment industry matched firms follows. Because firm value is the sum of discounted expected future cash flows, it is important that I control for the median level of internal cash flow available in a firm that is not diversified. Without carefully controlling for the median internal cash flow available in a portfolio of single-segment firms, there is the potential for the regression coefficient estimate on Internal Financing to become confounded with the positive relationship between cash flow and firm value. In addition to these two controls, I add a third control variable. As a result of the potential correlation of cash flow and value, when I examine the impact of internal finance on firm value I separately control for the firm's profitability which serves as a proxy for cash flow. The firm's cash flow is estimated using earnings before extraordinary items, interest and taxes and adding back depreciation. Cash flow is divided by capital expenditures, yielding the variable "Unadjusted Internal Finance". This is really just cash flow per dollar of capital expenditures. If the diversified firm creates value by funding its capital expenditures with internally generated cash, then this should increase diversified firm value above that of a matching portfolio of stand-alone firms that do not have access to an internal capital market. A control for the level of internal financing is a portfolio of single-segment industry matched firms is constructed in the following manner. For each segment of the diversified firm the median Unadjusted Internal Financing ratio of all the single-segment firms that operate in that segment's industry is used as a benchmark level of internal financing. After the ratios have been collected for each segment of the firm, a weighted-average firm benchmark is calculated. The sales of each segment as a fraction of the firm's consolidated sales is used as the weight. Unadjusted financing benchmark is used as benchmark level of internal financing. A sales-weighted average Unadjusted Internal Financing benchmark ratio for the diversified firm is calculated and then this benchmark ratio is subtracted from the diversified firm's Unadjusted Internal Financing variable. This yields the Internal Finance Proxy used in the analysis. The Internal Financing proxy uses the Unadjusted Internal Financing ratio of other firms in the same industry to control for industry-wide investment opportunities. The value of *Internal Finance* for firm i in period t is written as follows

$$InternalFinance_{i,t} = \frac{Cashflow_{i,t}}{Capex_{i,t}} - Benchmark_{i,t}\frac{Cashflow}{Capex} \qquad (1)$$

where

Cashflow	= earnings before extraordinary items, interest and taxes plus depreciation,
Capex	=capital expenditures.
Benchmark	=the single-segment imputed ratio calculated using only firms which operate in a single industry.

The benchmark value in the above equation is calculated as follows for each segment j, of firm i in year t

$$Benchmark_{i,t}\frac{Cashflow}{Capex} = \frac{1}{\sum_{j=1}^{N} Sales_{i,j,t}}\left[\sum_{j=1}^{N} Sales_{i,j,t} \times (mdn\frac{Cashflow}{Capex})_{i,j,t}\right] \qquad (2)$$

$Sales_j$	=net sales of firm *i's* segment j,
$(mdn\frac{Cashflow}{Capex})$	= the median ratio of cash flow divided by capital expenditures, for the single-segment firms operating in segment *j's* industry,
N	=the number of segments in firm i.

A positive value of *Internal Finance* indicates that the availability of Internal Financing to fund investment projects in the diversified firms exceeds the availability of Internal Financing in a sales-weighted portfolio of industry matched single-segment firms. This paper examines the differential impact of Internal Financing on firm value for diversified and single segment firms, respectively.

The advantage of the Internal Financing proxy introduced here over that of Billett and Mauer (1998) is that this proxy measures the firm's access to an internal capital market, whereas the Billett and Mauer proxy examines the firm's realized ability to invest in excess of its cash flow. Therefore this paper defines an active capital market as one in which cash flow is available for the manager to waste or to invest in wealth-creating projects. This contrasts with Billett and Mauer's proxy, they define a firm with high investment as a firm with an active internal capital market. As a result, a firm that generates a high level of available Internal Financing, but wastes it, is identified as a firm with an active internal capital market in this paper but would be identified as a firm without an active internal capital market in the Mauer paper. As mentioned earlier, the Billett and Mauer proxy does not control for heterogeneity across industries in firm access to external capital markets. This access to Internal Financing may be critical to the value of diversification, and so I control for it.

<u>Estimating the relationship between the use of Internal Financing and Firm Value</u>

The relationship between Internal Finance and firm value is examined in the second stage of the analysis. Firm value is defined as total assets less the book value of common equity plus the market value of common equity. The Berger and Ofek (1995) benchmark Value is calculated for each firm-year observation to control for variation in firm value which is due to industry valuation differences. Benchmark firm value is calculated using the "chop-shop" approach. The "chop-shop" approach requires that the firm's benchmark value be calculated by simply adding together the benchmark values for all segments of the firm. The Berger and Ofek (1995) method uses only those single segment firm-year observation for single segment firms which operate in the same industry as the segment. The industry median firm value-to-sales ratio is used to calculate the segment's benchmark value. The segment's benchmark value is calculated by multiplying the industry median firm value-to-sales ratio by segment sales. The sum of all of the firm's segment benchmark values is defined as the firm's benchmark value.

The benchmark value controls for the value that the firm would have if it were simply valued as a portfolio of stand alone firms. The analysis is repeated, replacing sales with assets. However, following Rajan, Servaes and Zingales (1998) and Lins and Servaes (1998) the analysis focus on the results calculated using firm value to sales to control for variation in firm value. The sales multiple benchmark requires the fewest adjustments resulting from incomplete data and so sales-multiple results are highlighted, but the results from using firm-value-to-assets to calculate benchmark value are also reported. Again, the sales multiple is measured with less error because the sum of the firm's reported segment assets differs from the consolidated assets which the firm reports far more often than does the sum of the firm's reported segment sales differ from the firm's reported consolidated sales.

The firm's benchmark value is effectively the sales-weighted average of its segment benchmark values. As discussed immediately above, the benchmark value of firm *i* with its segments indexed on *j* may be written as follows.

$$BenchmarkValue_{i,t} = \sum_{j=1}^{N} Sales_{j,t} \times (mdnV/S)_{j,t} \quad (3)$$

where

Benchmark Value	=the sum of imputed values of firm *i*'s segments as stand-alone firms,
$Sales_j$	=segment *j's* sales,
mdn V/S	= median ratio of the sum of the market value of equity and the book value of debt divided by the firm's net sales, for single-segment firms in segment *j's* industry,
N	=the number of segments that make up firm *i*.

Industries are defined by SIC codes such that the most narrow industry definition which includes at least 5 single-segment firms that have at least $20 million in sales, and adequate data to compute the ratios, is used to calculate a segment benchmark value. Using this method yields 61% of segment benchmark values calculated at the 4-digit sic level, 21% at the 3-digit level and 18% at the 2-digit sic level. The calculation of benchmark values using asset multiples is executed in an analogous manner with assets replacing sales in equations (2) and (3).

Deviations of firm value from benchmark value are examined in what follows. Excess firm value is the percentage deviation of actual value from benchmark value. Excess value of firm *i* in year *t* is defined as the natural logarithm of the ratio of firm value to benchmark value, so

$$ExcessValue_{i,t} = \ln(FirmValue_{i,t} / BenchmarkValue_{i,t}).$$

A positive Excess value indicates that the firm's market value exceeds its single segment benchmark value. Imputed value using firm value-to-assets is found in a like manner. However, quite often the sum of segment assets is less than the firm's reported consolidated total assets for the firm. Berger and Ofek (1995) suggest that this is due to unallocated assets. The adjustment that they used is applied here. If the sum of segment assets deviates from the reported consolidated assets by more than 25%, the observation is excluded from the asset multiple analysis. If the absolute value of the deviation is less than 25% , the benchmark value is adjusted to account for the fact that the industry median firm value-to-assets ratio may have been multiplied by segment assets which are either too large or too small. Therefore the firm's imputed value is grossed up or down by the percentage deviation between the sum of the firm's segment assets and total firm assets.

Attention is focused in the analysis of the value of an internal capital market on the variation in excess value. Therefore excess value is used as the dependent variable in the regressions which examine the relationship between Internal Finance and excess firm value. Controls are used for other well-established sources of variation in firm value. The independent variables are discussed below.

Asymmetric information and the Use of Internal Financing

Each firm-year observation is identified as facing either high or low asymmetries. According to the Information Cost theory, firms facing high information asymmetries face a higher cost of accessing the external capital market than do firms facing low asymmetries. To fully test the Information Cost theory the interaction of high information asymmetries and the firm's use of internal financing is examined. However, to avoid confounding the interaction effects of information asymmetries and Internal Finance with the impact of Internal Finance, a separate indicator variable for high information asymmetries is used in the regressions. This specification, by controlling separately for high asymmetries, should reduce omitted variable bias. The concern with omitted variable bias arises from the fact that Lang and Stulz (1994) found that diversified firms that face high information asymmetries have lower values. As a result, firms that face high asymmetries will likely have lower values, and so the high information asymmetry indicator is entered separately in the regression. The information asymmetry indicator is also interacted with Internal Finance to examine the interaction effect. The Information Cost theory suggests that firms which face the highest information asymmetries have the most to gain from using Internal Finance.

Control Variables

Using control variables, the relationship between Internal Financing and firm value is examined without confounding the results with the effect of other well-known sources of variation in firm value. Controls include firm size, profitability, and investment opportunities. Berger and Ofek (1995) find firm size and excess values are positively related. Berger and Ofek (1995) and Hyland (1996) find that diversified firms are less profitable and face fewer investment opportunities even before they become diversified. Size is the natural logarithm of assets. Controlling for profitability also helps control for the fact that profitability and cash flow are high correlated. This control is relevant because the proxy for Internal Finance is a transformation of cash flow. Profitability is the sum of earnings before extraordinary items, depreciation and taxes, divided by net sales. Capital expenditures/Sales is used as a proxy for investment opportunities again following Berger and Ofek (1995), in the multi-variate regressions.

Sample and Descriptive Statistics

The Compustat business segment information tapes (CIS) are used to define business segments. A segment is defined for financial reporting purposes as a separate line of business activity that comprises at least 10% of the firm's consolidated sales or assets. This follows as SEC regulation S-K and FASB No.14 require firms to report limited business segment data for segments that contribute at least 10% to consolidated firm assets or sales.

Berger and Ofek (1995) suggest that diversified firms which report sales in two or more segments defined at the two-digit SIC code level are particularly susceptible to negative diversification synergies. However, if the cash flows and investment opportunities of each of firm's segments are uncorrelated, the diversified firm may realize the value – increasing effect of an internal capital market, as suggested by Stulz (1990). Therefore, only those firms which either operate in a single segment or which report sales in at least two or more segments defined at the two-digit SIC code level are included in the sample. I delete all other multi-segment firms, including those that report multiple segments all of which are within the same two-digit SIC code industry.

The sample consists of all firm-year observations for which the following two pieces of data are available. First, observations for which sufficient balance sheet, cash flow and capital expenditure variables are available on the annual and business segment Compustat files for any fiscal year end 1991 through 1996. Second, analyst forecasts must be available on the IBES data tape for the end of the prior fiscal year .
Following Berger and Ofek (1995) in an attempt to avoid distortions in valuation multiples, the following four requirement must be met for a firm-year observation to be included in the sample. First, data is obtained for only those firms which have net annual sales in excess of $20 million, and have no segments in the financial sector (SIC codes between 6000 and 6999). Second, firms with segments in the financial sector are eliminated because of their regulated status, the presence of deposit insurance, higher

leverage and their ability to securitize their assets. Third, to avoid data problems when using sales multiples to calculate the firm-year benchmark value, the sum of the segment sales on the Compustat segment tapes be within 1% of the reported firm's consolidated sales for the firm. Fourth, when using asset multiples the sum of the firm-year segment assets must be within 25% of the firm's total assets. If the sum of segment assets deviates from the reported total assets by less than 25%, then the firm-year benchmark value is grossed up by the percentage deviation of the sum of segment assets from total assets. This reduces the error in the benchmark values which would result from a deviation of reported consolidated assets from the sum of segment assets. These sample restrictions make the analysis comparable with the literature. Due to skewness in the distributions, and following the literature, the focus of the analysis is on median values and medians are used to calculate benchmark values as discussed above. Following Vogt (1994), firm-year observations are screened out for the years during which the firm made significant acquisitions or was financially distressed. Therefore, firm-year observations in which the firm made acquisitions in excess of 10% of its total assets, or defaulted on its debt were screened out. The financial distress screen is used to avoid mixing the impact of financial distress on decision-making.

The descriptive statistics for the firm-year observations are presented in Table 1. The sample is made up of 1645 firm-year observations on multi-segment firms and 3641 firm-year observations on single segment firms, for a total of 5286 observations. The median excess value for all firms is positive. This is true using both sales multiples to calculate benchmark values, 4.6%, or using asset multiples to calculate benchmark values, 2.6%. Again, excess value is conditional upon the industries in which the firm operates. These positive median values are not surprising, as financially distressed firm-year observations have been screened out. The median excess value for diversified firms is 0.8% and -0.5% using sales and asset multiples respectively. The diversified firm's excess value is well below that of the single segment firm whose excess values are 6.2% and 4.0%, using sales and asset multiples respectively. The excess value measures are quite similar regardless of whether sales or asset multiples are used to calculate benchmark values. The excess value measures, calculated using sales and asset multiple respectively, are significantly positively correlated, with a correlation coefficient of 0.62 (p-value < 0.01).

The Table 1 univariate statistics suggest that diversified firms can be characterized in a manner similar to that reported by Berger and Ofek (1995). Without conditioning on the industry in which the firm operates, the diversified firm has greater market value, fewer investment opportunities (measured using market-to-book as a proxy) and is less profitable than its single segment counterparts. The diversified firm's median market value of equity, market to book and profitability are $1.1 billion, 1.39 and 4.8% respectively. The corresponding values for the single segment firm are $0.5 billion, 1.53 and 6.0% respectively. The median number of segments reported by the diversified firm is 3, while it is of course one, by definition, for the single segment firm.

Without conditioning on the industries in which the firm operates, the level of Unadjusted Internal Financing generated by each type of firm is quite similar. The median cash flow divided by capital expenditures ratio is 1.67 for diversified and 1.68 for single segment firms. However, after controlling for the industries in which the firm operates, the level of industry-adjusted Internal Finance is -0.026 and 0.013 for diversified and single segment firms respectively. The multi-variate analysis attempts to disentangle the effects of Internal Financing from the type of firm in which the Internal Financing is generated, single segment or diversified.

The "Asymmetric Information" variables in Table 1 indicate that the diversified firm faces marginally higher information asymmetries, without conditioning on firm size. The forecast error and dispersion measures of 0.06 and 0.05 for the diversified firm exceed that of the single segment firm's 0.05 and 0.04, while the standardized forecast error is no different at 0.05. The mean numbers of analysts for the diversified firm and single segment firm are 9 and 6 respectively.

Table 2 indicates that the three measures of information asymmetries based on analyst forecasts the analyst forecast error, the standardized forecast error analyst (error divided by the mean analyst forecast) and the dispersion in analyst forecasts are all highly positively correlated with p-values not exceeding 0.05. The analyst forecast errors are either uncorrelated or negatively correlated with the number of analysts issuing forecasts, correlation coefficients appear in Table 2. The Science-based industry dummy variable is not correlated with the forecast error. Again, this science-based indicator variable is equal to one if at least one segment of the firm operates in one of the following SIC industries 28, 35, 36 or 38. Yet the science-based industry dummy is significantly positively correlated with the number of analysts, as indicated by the positive correlation of 0.05 (p-value < 0.00).

Table 3 presents the summary statistics by the level of information asymmetries for each quartile for all firms in the sample. The table suggests that excess value declines as asymmetries increase. In the case of the sales multiple, median excess value decline, from 11% to 0% as we move from the lowest to the highest asymmetric information quartile. In addition, firm size, investment opportunities and profitability all decline as information asymmetries increase from the lowest to highest quartiles of information asymmetries. The median market value of equity for the lowest asymmetry quartile is $1.2 billion and the highest quartile $0.3 billion. Market-to-book declines from 1.69 to 1.29, from the lowest to the highest asymmetry quartile. The Unadjusted Internal Financial proxy cash flow/capital expenditure ratio also declines from 1.87 to 1.48 from the lowest to highest asymmetry quartile. Internal Finance does not appear to be related to the level of asymmetries.

The Table 3 results suggest that excess value and information asymmetries are negatively related. As other important determinants of firm value (market-to-book, market value of equity and profitability) are related to asymmetric information, a multi-variate approach is used to control for the correlation in these variables. However, the fact that Internal Finance is not monotonically related to Information Asymmetries reduces the problem of inference, with respect to the relationship between Internal Finance and excess firm value.

Table 4 presents the means and quartile values for the four asymmetric information proxies that use analyst earning forecasts data. The quartile values indicate that analyst coverage varies widely, at 3 analysts and 14 analysts for the quartile 1 and quartile 3 values, respectively. The results are similar for analyst error and error divided by the mean forecast.

4. Empirical Specification and Results

H1 predicts that the firm's use of Internal Financing to fund investment projects is positively related to excess firm value. This prediction is tested by pooling firm-year observations for 1991 through 1996 and by using Ordinary Least Squares. The focus of this analysis is upon the difference in the Internal Finance coefficients for diversified and single segment firms, respectively. The specification is as follows.

$$\begin{aligned} \text{Excess value}_{i,t} = {} & b + b_1(\text{use of Internal Finance}_{i,t-1}) + b_2(\text{high information asymmetry dummy}_{i,t-1}) \\ & + b_3(\text{use of internal finance}_{i,t-1} * \text{high information asymmetry dummy}_{i,t-1}) \\ & + b_4(\text{diversification dummy}_{i,t}) \\ & + b_5(\text{use of internal finance}_{i,t-1} * \text{diversification dummy}_{i,t}) \\ & + b_6(\text{investment opportunities}_{i,t-1}) + b_7(\text{log size}_{i,t-1}) + b_8(\text{profitability}_{i,t-1}) + e \end{aligned} \quad (4)$$

Excess value is defined as the natural logarithm of the ratio of the firm's market value to its benchmark value. Benchmark value is the sum of the imputed values of all the firm's segments. The high information asymmetries dummy is an indicator variable set equal to one if the absolute value of the mean analyst earnings per share forecast less the actual earnings in the month prior to fiscal year end divided by the mean earning per share forecast exceeds the annual cross-sectional median. The diversification dummy is set equal to one if the firm operates in two or more segments, where a segment is defined at the two-digit SIC code level, otherwise this dummy variable is equal to zero. Investment opportunities are the firm's capital expenditures divided by firm sales[1,2]. Log size is the natural logarithm of total assets. Profitability is earnings before extraordinary items divided by net sales. The results have been corrected for heteroskedasticity using the procedures outlined by White (1980). Significance tests on coefficients are calculated using asymptotic tests.

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[1] Results do not change if an interaction term for the diversified firm dummy and investment opportunities is included in the regression.

[2] Using market to book equity as an alternative proxy for investment opportunities does not significantly change the results.

The empirical literature has established that diversified firms have a lower value than do single-segment firms. The hypotheses tested here suggest that the structure of the diversified firm enables it to allocate internal cash flow, via its internal capital market, to projects within the firm but in an unrelated industry—which is not possible in the single-segment firm. I first estimate the internal cash that the firm has available and, second, examine the effect the diversified firm's internal capital market has on firm value. Therefore, holding all else equal, I examine the differential impact that internal cash flow has on firm value in diversified and single-segment firm, respectively. I attribute the difference in the relationship between internal financing and firm value between the two types of firms to the diversified firm's internal capital market. The multi-variate tests are designed to test the differential impact internal financing has on diversified and single-segment firms.

The multi-variate results proceed as follows. Section A discusses the impact of Internal Finance on the value of the single segment firm and the diversified firm, respectively. Section B examines the impact of information asymmetries on the relationship of Internal Finance and the diversified firm's excess value. Section C examines results discussed in Section B but using alternative measures of asymmetric information. Section D takes an in-depth look at information asymmetries and the diversified firm value.

A. Internal Financing and the Value of the Firm

To examine the relation of Internal Finance and the value of the firm I estimate three regressions using two different dependent variables. The regressions discussed in this section are Regressions (1), (2) and (3) in Tables 5 and 6, in which I estimate equation (4), only the dependent variable is different in the two tables. The two different dependent variables are used for robustness. Panels A of Table 5 and Table 6 present the detailed regression results for multi-variate regressions of Excess Value on Internal Finance, while controlling for other determinants of firm value. Tables 5 & 6 present the results for the regressions using sales multiples and asset

Multiples, respectively, to compute an imputed benchmark value for each firm. In addition to the regression output which appears in Panels A of Table 5 and Table 6, the regression coefficients for diversified and single segment firms have been summarized in Panels B of Table 5 and Table 6. The results presented in Regressions (4) and (5) of Tables 5 and 6, are discussed in Section B.

Table 5 uses sales multiples to calculate benchmarks. Regressions (1) and (2) are the results of seperate regressions for single segment and diversified firms, respectively. Regression (3) is a pooled regression of diversified and single segment firm-year observations.

The single segment regression has 3641 observations, the diversified firm regression 1645, and the pooled regression 5286. Model p-values are at the 0.00 level. Adjusted R-squared values exceed 0.14 for all 3 specifications. The results indicate that firm size, investment opportunities and profitability are generally significant and positively related to excess value, at the 5% level, consistent with the prior literature (See Berger and Ofek, 1995).

Panel B summarizes the results of separate regressions for diversified and single-segment firm. Regression (1) results indicate that single segment firm value is not significantly related to Internal Finance, with a coefficient estimate of 0.001, p-value < 0.14. Regression (2) indicates that diversified firm value is positively related to Internal Finance, with coefficient 0.010, p-value < 0.03. This suggests that the relative value impact of an internal capital market is positive for diversified firms but not significant for single segment firms. The pooled regression enables a joint estimation of seperate coefficients on Internal Finance in Regression (3), results appear under the heading "Pooled Regressions". Again, in the pooled regression, the diversified firm indicator variable is equal to one for a diversified firm and zero otherwise. The indicator variable and the Internal Finance variable are interacted to estimate the relationship between Internal Finance and excess value for the diversified firm.

The results of the pooled regression (3) appears in Panel B of Table 5 and are no different than the results of the separate regressions discussed above. Internal Finance is unrelated to Excess Value for the single segment firm, coefficient 0.001, p-value < 0.14. However, for the diversified firm the Internal Finance coefficient is 0.011, p-value < 0.02. Therefore the results of the pooled regression are no different from those of the individual regressions. There is no relationship between Internal Finance and excess firm value for the single segment firm. The use of Internal Finance in the diversified firm is positively related to excess firm value. This is consistent with the hypothesis that the diversified firm realizes the value –increasing effect of Internal Finance. Table 5 results are consistent with the Information Cost theory, and inconsistent with the Free Cash Flow theory.

Table 6 reports the results of the same regression as discussed immediately above, but using asset multiples rather than sales multiples to estimate benchmark values used in the calculation of excess value. Again, Regressions (1) and (2) report the results for single segment and diversified firm-year observations respectively. Regression (3) reports the results for the pooled estimation using both single segment and diversified firm-year observation. Table 6 Regression results explain less of the variation in excess firm value, as evidenced by a lower R-squared than do the Table 5 results. Adjusted R-squareds exceed 0.10 in Table 6 and 0.14 in Table 5, respectively. Recall that in the "Empirical Model" section, when the sum of segment assets were within 25% of reported total assets, the firm's benchmark value was grossed up by the percentage difference. This adjustment results in a less efficient measure of excess firm value because of the error in the benchmark value. Table 6 results on the Internal Finance coefficient are similar in magnatude, but somewhat weaker. Panel B of Table 6, summarizes the results. The coefficient on Internal Finance is again not significant, for the single-segment firm, coefficient -0.0001, p-value < 0.83, while the coefficient is 0.010, p-value < 0.08 for diversified firms. The pooled regression yields a coefficient of -0.001 on Internal Finance for the single segment firm, p-value < 0.84, and for the diversified firm the coefficient is 0.010, p-value < 0.04.

These results are consistent with those in Table 5. Therefore, the use of Internal Finance by the diversified firm is positively related to excess value while there is no such relationship for single segment firms. The results are consistant with the Information Cost Theory and inconsistant with the Free Cash Flow Theory, while robust to the choice of value benchmark. The results reported in Tables 5 and 6 are the main results of this paper.

Section B: Internal Finance and Information Asymmetries

Regressions (4) and (5), returning to Panels A of Tables 5 and 6 , present the results for the regression of Excess Value on Internal Finance, a high information asymmetries indicator variable and the interaction of Internal Finance and the indicator variable. Again, the indicator variable is equal to one if the measure of information asymmetries exceeds the firm-year cross-sectional median (information asymmetries are high). The analyst forecast error divided by the mean analyst forecast is used as the base case proxy for information asymmetries. The summary results are reported in Panels B of Tables 5 and 6 under the title "Firms Facing High Information Asymmetries". Using sales multiples to calculate benchmark values, reported in Table 5, The coefficient for single segment firms, conditional upon high information asymmetries, is not significant, at -0.001, p-value < 0.16. Likewise, the coefficient for diversified firms is not significant at -0.0006 p-value < 0.94. These results are consistent with the hypothesis that for firms which face high information asymmetries, both single segment and diversified firms, there is no relation between Internal Finance and Excess firm value.

The results of replicating this analysis using asset multiples to calculate excess values appear in Panel B of Table 6, again under the heading "Conditional Upon High Information Asymmetries". The results are consistent with those in Table 5. The coefficients are -0.001 and 0.010, with p-values < 0.62 and < 0.28 for single segment and diversified firms, respectively. Results are consistent with the hypothessis that for firms facing high information anymmetries, single-segment or diversified, there is no relation between Internal Finance and firm value. These results suggest that the costs of high information asymmetries overwhelm the benefits of Internal Finance for these high asymmetry firms.

Section C: Robustness: Asymmetric Information and Excess Firm Value

For robustness I examine the interaction of high asymmetries and Internal Finance by using four additional measures of information asymmetries. However, I focus only on the diversified firm. The specification is as follows.

$$ExcessValue_{i,t} = \beta_0 + \beta_1 D_{ai,t-1} + \beta_2 InternalFinance_{i,t-1} + \beta_3 (D_{ai,t-1} \times InternalFinance_{i,t-1})$$

$$+ \beta_4 Size_{i,t-1} + \beta_5 InvOPPS_{i,t-1} + \beta_6 Profit_{i,t-1} + e_i \qquad (5)$$

where

ExcessValue =log(Actual firm value/benchmark firm value),
D_{ai} =1 if the firm's measure of asymmetric information is above the sample median, and 0 otherwise,
Internal Finance =the ratio of cash flow divided by capital expenditures less the benchmark ratiocalculated in (2),
Size = natural logarithm of total assets,
InvOPPs =Capital Expenditures/Net Sales,
Profit =earnings before extraordinary items/Net Sales,
and
e =a normally distributed error.

The results have been corrected for heteroskedasticity using the procedures outlined by White (1980). Significance tests on coefficients are calculated using asymptotic tests. These four measures of information asymmetries are the analyst forecast error, the dispersion in analyst forecasts, the number of analysts (as an inverse measure of information asymmetries) and participation in one of 4 science-based industries which face particularly high information asymmetries. These four measures are in addition to the base case information asymmetry measures—the analyst forecast error divided by the mean forecast, used in Tables 5 and 6.

The pooled Regression (3) in Table 5 is re-run, reporting the results in Table 7 for all five proxies for information asymmetry. Panel B of Table 7 summarizes the coefficients for low and high asymmetric information firms. Again, the results are consistent with those in Table 5. The coefficients on Internal Finance for the diversified firm facing low asymmetries are all a positive 0.010, with p-values < 0.05 regardless of which proxy is used for information asymmetries. Results are consistent with the Information Cost theory for firms facing low information asymmetries. Regardless of which asymmetric information measures is used, the diversified firm's use of Internal Finance is not related to firm value for those firm-year observations which face high asymmetries, as evidenced by the p-values on the high asymmetry coefficient, all but one of which exceeds 0.20. These results are consistent with the absence of any value relation between Internal Finance and excess value for diversified firms facing high information asymmetries. Results for firms facing high information asymmetries are consistent with the Free Cash Flow theory.

Section D: Asymmetric Information and the Diversified Firm

To further examine why Table 5 , 6 and 7 results suggest that the positive relationship between the excess value and Internal Finance dissolves when asymmetric information are high, additional analyses are completed. The results appear in Table 8. The asymmetric information indicator variable is replaced with four indicator variables to better understand where the relationship of excess value and Internal Finance dissolves. Beginning with Regression (2) in Table (5), indicator variables for the four quartiles of asymmetric information are used in the regression. Each of the four quartile indicator variables is interacted with the Internal Finance variable, and include three of the four indicators in the regression. Three different asymmetry measures are used to examine this relationship. The three proxies are analyst error, the error divided by the mean analyst forecast and the dispersion in analyst forecast. Results are no different when the other two asymmetric information proxies are used, as a result they are not reported. Results are reported in Table 8.

Examination of the interaction of Internal Finance and the quartile indicators finds that the results are robust to the choice of asymmetric information proxy. The signs on the interaction of the quartile indicators and Internal Finance are positive for each of the three lowest asymmetry quartiles. Yet they are not often significant. The coefficients on the interactions of the indicator variable for the highest asymmetries, Q4, are negative, but not significant for each specification. Results suggest that the relationship between Internal Finance and excess value reverses, although not at traditional levels of statistical significance, for those firms which face the highest information asymmetries.

To better understand why the relation between Internal Finance and diversified firm value reverses at the highest level of asymmetries we return to Table 3. Table 3 results indicate that firms in the highest asymmetry quartile, Q4, are smaller, have fewer investment opportunities and are less profitable. Therefore, the methods employed here may not be able to disentangle the impact of Internal Finance from poor firm performance and perhaps distress. Perhaps this relationship is more complex.

5. Conclusion

The results suggest that, on average, the use of an internal capital market is positively related to firm value, consistent with the Information Cost theory. Results hold while controlling for industry, profitability, firm size and investment opportunities. When firms are partitioned on the extent of the information asymmetries between firms and investors, the results change only for those firms which face the very highest information asymmetries. The results for those firms facing the highest information asymmetries are consistent with the "Free Cash Flow" theory. Therefore my results suggest that diversified firms which face high information asymmetries do not realize the value of an internal capital market, but that agency costs dominate for these firms.

The results of this work are consistent with both Billett and Mauer (1998) and Krishnaswami and Subramaniam (1998). Billett and Mauer find a positive relationship between the value of an internal capital market and firm value using a modest sample of "tracking stock" announcement returns. In a pooled regression of 5286 firm-year observations from 1991-1996 I use a methodology introduced by Berger and Ofek (1995) to measure firm value in excess of a benchmark value. I find that firm value is positively related to Internal Financing for diversified firms. Krishnaswami and Subramaniam find evidence consistent with the hypothesis that high levels of information asymmetries lead to lower value for some diversified firms. This is consistent with my results for high information asymmetry firms, which are consistent with high agency costs of Free Cash Flow for these firms.

More generally, the results of this paper support the work that suggests that diversified firms can increase their value by focusing. While that the value of the diversified firm which faces low-to-moderate levels of information asymmetries is positively related to the use of Internal Financing by these firms, the net impact of diversification is still negative. This is evidenced by differences in median excess values of diversified and single-segment firms. The negative net impact of diversification is consistent with the work of Lang and Stulz (1994), Berger and Ofek (1995) and others. This suggests that while an internal capital market adds value to the diversified firm, diversified firms still have lower values even after controlling for industry, and firm profitability, investment opportunities and firm size.

It is possible that a change in the corporate control market in the early 1980s with the advent of leveraged financing may have reduced waste of Free Cashflow by managers of diversified firms and yielding the positive relationship between Internal Finance and Diversified firm value in my sample. Nonetheless, the agency costs of Free Cashflow appear to be dominate the value-increasing effect of an internal capital market only for the firms which face the highest information asymmetries. Perhaps a shift in corporate control has increased the importance of Internal Finance in the modern diversified firm. It is not clear whether diversified firms use an internal capital market to increase their value or if firms that use internal capital markets efficiently tend to diversify. This is a topic for future research.

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Table 1: Sample Means and Medians for All, Diversified and Single-segment firms

Diversified firms are defined for purposes of this table as a firm that reports sales in more than one business industry. Where industries are defined at the two-digit SIC code level. All values are for a fiscal year ended 1991-1996. Excess value is the log of the ratio of the market value of the firm to the imputed benchmark firm value. Market value is defined as Total Assets less Common equity plus the market value of common equity. The imputed value is the sum of the imputed values of the firms divisions. The imputed value of each division is calculated as follows. The imputed value of a firm segment is the median ratio of the market value divided by either net sales or total assets of all single segment firms in the industry in which the segment operates times net sales of that segment of the firm. EBEI is the annual earnings before extraordinary items and interest. Profitability is EBEI/Net Sales. The "segments" is the number of business segments that the firm reports. Unadjusted IF is the unadjusted internal finance ratio of (EBEI + Depreciation)/Capital Expenditures. This is unadjusted measure of the availability of internal financing to fund capital expenditures. Internal Finance is the cash flow/capex ratio less an industry control. I control for industry by subtracting the firm's sales-weighted average single-segment industry median cash flow/capex from the firm's Cash flow/Capex. Forecast error is the absolute value of the difference between the mean analyst earnings per share forecast in the month prior to fiscal year end and actual earnings. Stdzd Forecast error is the forecast error divided by the mean analyst estimate. Forecast dispersion is the standard deviation of analyst earnings forecasts. Analysts are the number of analyst estimates available on IBES in the month preceding the fiscal year end.

	Firm Type					
	All Firms (Obs=5286)		Diversified (Obs=1645)		Single-segment (Obs=3641)	
	Mean	Median	Mean	Median	Mean	Median
Excess Value						
Using Sales multiple	8.1%	4.6%	2.5%	0.8%	10.6%	6.2%
Using Asset multiple	8.2%	2.6%	2.2%	-0.5%	10.9%	4.0%
Market Value Equity	$2,561	$610	$3,521	$1104	$2,126	$487
Market-to-book	1.80	1.47	1.59	1.39	1.90	1.53
Profitability	7.0%	5.6%	5.7%	4.8%	7.6%	6.0%
Segments	1.7	1	3.2	3	1	1
Internal Capital Markets						
Unadjusted IF	2.60	1.67	2.07	1.67	2.83	1.68
Internal Finance	0.648	0.001	0.260	-0.026	0.823	0.013
Asymmetric Information						
Forecast error	0.15	0.06	0.17	0.06	0.14	0.05
Stdzd Forecast error	0.14	0.05	0.09	0.05	0.16	0.05
Forecast Dispersion	0.08	0.04	0.09	0.05	0.07	0.04
Analysts	9.5	7	10.9	9	8.9	6

Table 2: Correlation among Measures of Asymmetric Information
P-values of the test of equality of the correlation coefficient to zero is reported in parenthesis.

	Analyst Forecast Error	Analyst Forecast Error over Mean	Dispersion Of Analyst Estimates	Number of Analysts	Science-based Industries Dummy
Analyst Forecast Error		0.07** (0.00)	0.53** (0.00)	-0.09** (0.00)	0.02 (0.21)
Analyst Forecast Error over mean			0.03** (0.03)	-0.05** (0.00)	-0.02 (0.13)
Dispersion of analyst estimates				0.003 (0.82)	0.02 (0.17)
Number of analysts					0.05** (0.00)

** significant at the 5% level, * significant at the 10% level

Table 3: Summary Statistics by Asymmetric Information Quartile
Asymmetric information quartiles are calculated using the Standardized Analyst Forecast Error. Standardized analyst forecast error is the difference between the mean analyst earnings per share forecast and the actual earnings per share divided by the mean earnings per share forecast. Quartile values are calculated annually. Analyst forecasts are from the month preceding the end of the fiscal year. Mn. Designates the mean, mdn. designates median and s.d. designates the standard deviation. Market equity is in millions of dollars. A total of 5286 observations.

	Asymmetric Information Quartile											
	Low			Low/Med.			Med./High			High		
	Mn.	Mdn.	s.d.	Mn.	Mdn.	s.d.	Mn.	Mdn.	s.d.	Mn.	Mdn.	s.d.
Excess Value												
Sales Multiples	15%	11%	45%	11%	7%	45%	6%	3%	43%	-1%	0%	46%
Asset Multiples	14%	7%	39%	13%	6%	38%	7%	2%	34%	-2%	-4%	34%
Market Equity	4131	1164	8413	2791	867	6232	1933	526	5569	1360	259	4963
Market-to-book	2.00	1.69	1.09	1.93	1.55	1.17	1.74	1.44	1.03	1.54	1.29	0.87
Profitability	7.7%	6.4%	5.5%	8.1%	6.5%	6.4%	7.0%	5.5%	5.9%	5.2%	3.5%	5.2%
Segments	1.8	1	1.3	1.7	1	1.2	1.7	1	1.2	1.7	1	1.3
Unadjusted IF	2.75	1.87	8.46	2.44	1.74	5.08	2.76	1.61	10.96	2.43	1.48	5.89
Internal Finance	0.72	0.08	3.60	0.51	0.03	5.01	0.76	0.00	10.12	0.60	0.00	5.30

Table 4: Summary Statistics on Measures of Information Asymmetry for Diversified Firms

The number of analysts is the number of analysts issuing earnings per share forecasts for the fiscal year. The number of analysts issuing forecasts is measured during the month preceding the end of the fiscal year. Analyst forecast error is the absolute value of the difference between the mean analyst earnings per share forecast and the actual earnings per share. Analyst forecast error/mean is the analyst forecast error divided by the mean earnings per share forecast. Analyst forecasts are from the month preceding the end of the fiscal year. Dispersion of analyst forecast is the standard deviation of the analyst earnings per share forecast. Science-based industry is an indicator variable equal to one if the firm reports sales in one of four industries defined by two-digit SIC codes. The industries are chemicals and drugs, machinery, electrical equipment and communication, and instruments. This follows the Griliches and Mairsee (1984) definition of science-based industries.

	Number of Analysts	Analyst Error	Analyst Error/ Mean Forecast	Dispersion of Analyst Forecast
Mean	9.7	0.15	0.14	0.08
Std. Dev.	8.4	0.31	0.85	0.12
Quartile 1	3	0.02	0.02	0.02
Median	7	0.06	0.05	0.04
Quartile 3	14	0.15	0.15	0.09

Table 5: Regression of Excess Value (using Sales Multiples) on Internal Finance

Panel A: Regression of Excess Firm Value on Internal Financing for Single Segment and Diversified firms

$$\text{Excess value}_{i,t} = b + b_1(\text{use of Internal Finance}_{i,t-1}) + b_2(\text{high information asymmetry dummy}_{i,t-1}) + b_3(\text{use of internal finance}_{i,t-1} * \text{high information asymmetry dummy}_{i,t-1}) + b_4(\text{diversification dummy}_{i,t}) + b_5(\text{use of internal finance}_{i,t-1} * \text{diversification dummy}_{i,t}) + b_6(\text{investment opportunities}_{i,t-1}) + b_7(\text{log size}_{i,t-1}) + b_8(\text{profitability}_{i,t-1}) + e_{i,t}$$

Excess value is the natural logarithm of the ratio of actual market value to its benchmark value. Benchmark value is the sum of the imputed values of the diversified firm's segments. Imputed values are calculated using the single segment industry median market value-to-sales multiple. Use of internal finance the ratio of firm cash flow divided by capital expenditures less the sales-weighted single-segment industry median ratio. The high information asymmetries dummy is an indicator variable set equal to one if the mean analyst earnings per share forecast divided by the average forecast exceeds the annual sample median. Diversification dummy is set equal to one if the firm operates in two or more segments, where a segment is defined as a two-digit SIC code. Investment opportunities is the firm's capital expenditures divided by the firm's sales. Log size is the natural logarithm of total assets. Profitability is the earnings before extraordinary items divided by net sales. The regression is estimated using dummy variables for year effects, but results are not reported. Two-tailed P-values for the hypothesis that the coefficient is equal to zero are listed in parenthesis below the coefficient estimate.

	Single Seg	Diversified	Single Seg & Diversified	Single Seg	Diversified
	(1)	(2)	(3)	(4)	(5)
Intercept	-0.23	-0.64	-0.32	-0.16	-0.65
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Use of Internal Finance	0.001	0.01**	0.001	0.002	0.01**
	(0.14)	(0.03)	(0.14)	(0.12)	(0.00)
High Information Asymmetry Dummy (D1)				-0.07**	0.02
				(0.00)	(0.41)
(Use of Internal Finance)*D1				-0.001	-0.02*
				(0.42)	(0.08)
Two-digit SIC Diversification (D2)			-0.05**		
			(0.00)		
(Use of Internal Finance)*D2			0.01**		
			(0.05)		
Control Variables					
Investment Opportunities	0.05	0.40**	0.08**	0.06**	0.39**
	(0.12)	(0.00)	(0.01)	(0.05)	(0.00)
Logarithm of Size	0.01**	0.05**	0.02**	0.01*	0.05**
	(0.01)	(0.00)	(0.00)	(0.10)	(0.00)
Profitability	2.66**	3.50**	2.79**	2.56**	3.55**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Model p-value	0.00	0.00	0.00	0.00	0.00
Adjusted R-squared	0.15	0.20	0.16	0.15	0.20
Sample Size	3641	1645	5286	3641	1645

** significant at the 5% level, * significant at the 10% level

Table 5 [continued] Regression of Excess Value (using Sales Multiples) on Internal Finance

Panel B: Summary of Coefficient estimates on Internal Finance for Single Segment and Diversified Firms

The following Panel summarizes the regression coefficients for Single Segment and Diversified firms. A firm is diversified for purposes of this table if it reports sales in two or more segments, where a segment is defined at the two-digit SIC code level. The table below indicates the regression coefficient constructed, as needed, from the coefficients in Panel A. "Regress Number" is the number of the regression in which the coefficient values appear in Panel A and the two-tailed p-value for the test statistic that the coefficient is equal to zero.

Unconditional Results

Separate Regressions		Regress Number	Coefficient	p-value
Single Segment	b_1	1	0.001	(0.14)
Diversified	b_1	2	0.010**	(0.03)
Pooled Regressions				
Single Segment	b_1	3	0.001	(0.14)
Diversified	$b_1 + b_5$	3	0.011**	(0.02)

Firms Facing High Information Asymmetries

Single Segment	b_1+b_3	4	-0.001	(0.16)
Diversified	b_1+b_3	5	-0.0006	(0.94)

** significant at the 5% level, * significant at the 10% level

Table 6: Regression of Excess Value (using Asset Multiples) on Internal Finance

Panel A: Regression of Excess Firm Value on Internal Financing for Single Segment and Diversified

$$\text{Excess value}_{i,t} = b + b_1(\text{use of Internal Finance}_{i,t-1}) + b_2(\text{high information asymmetry dummy}_{i,t-1}) + b_3(\text{use of internal finance}_{i,t-1} * \text{high information asymmetry dummy}_{i,t-1}) + b_4(\text{diversification dummy}_{i,t}) + b_5(\text{use of internal finance}_{i,t-1} * \text{diversification dummy}_{i,t}) + b_6(\text{investment opportunities}_{i,t-1}) + b_7(\text{log size}_{i,t-1}) + b_8(\text{profitability}_{i,t-1}) + e_{i,t}$$

Excess value is the natural logarithm of the ratio of actual market value to its benchmark value. Benchmark value is the sum of the imputed values of the diversified firm's segments. Imputed values are calculated using the single segment industry median market value-to-sales multiple. Use of internal finance is the ratio of firm cash flow divided by capital expenditures less the sales-weighted single-segment industry median ratio. The high information asymmetries dummy is an indicator variable set equal to one if the mean analyst earnings per share forecast divided by the average forecast exceeds the annual sample median. Diversification dummy is set equal to one if the firm operates in two or more segments, where a segment is defined as a two-digit SIC code. Investment opportunities is the firm's capital expenditures divided by the firm's sales. Log size is the natural logarithm of total assets. Profitability is the earnings before extraordinary items divided by net sales. The regression is estimated using dummy variables for year effects, but results are not reported. Two tailed P-values for the hypothesis that the coefficient is equal to zero are listed in parenthesis below the coefficient estimate.

	Single Seg (1)	Diversified (2)	Single Seg & Diversified (3)	Single Seg (4)	Diversified (5)
Intercept	0.13	-0.12	0.08	0.21	-0.04
	(0.00)	(0.00)	(0.00)	(0.00)	(0.29)
Use of Internal Finance	-0.0001	0.01*	-0.0001	0.001	0.02**
	(0.83)	(0.08)	(0.84)	(0.32)	(0.00)
High Information Asymmetry Dummy (D1)				-0.08**	-0.09**
				(0.00)	(0.00)
(Use of Internal Finance)*D1				-0.002	-0.02**
				(0.27)	(0.01)
Two-digit SIC Diversification (D2)			-0.05**		
			(0.00)		
(Use of Internal Finance)*D2			0.01**		
			(0.04)		
Control Variables					
Investment Opportunities	-0.20**	-0.14**	-0.20**	-0.18**	-0.11*
	(0.00)	(0.01)	(0.00)	(0.00)	(0.06)
Logarithm of Size	-0.02**	0.0009	-0.02**	-0.03**	-0.004
	(0.00)	(0.85)	(0.00)	(0.00)	(0.42)
Profitability	1.94**	2.59**	2.03**	1.84**	2.44**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Model p-value	0.00	0.00	0.00	0.00	0.00
Adjusted R-squared	0.10	0.12	0.12	0.11	0.14
Sample Size	3657	1630	5287	3657	1630

** significant at the 5% level, * significant at the 10% level

Table 6 [continued] Regression of Excess Value (using Asset Multiples) on Internal Finance

Panel B: Summary of Coefficient estimates on Internal Finance for Single Segment and Diversified Firms

The following Panel summarizes the regression coefficients for Single Segment and Diversified firms. A firm is diversified for purposes of this table if it reports sales in two or more segments, where a segment is defined at the two-digit SIC code level. The table below indicates the regression coefficient constructed, as needed, from the coefficients in Panel A. "Regress Number" is the number of the regression in which the coefficient values appear in Panel A and the two-tailed p-value for the test statistic that the coefficient is equal to zero.

Unconditional Results

Separate Regressions		Regress Number	Coefficient	p-value
Single Segment	b_1	1	-0.0001	(0.83)
Diversified	b_1	2	0.010*	(0.08)
Pooled Regressions				
Single Segment	b_1	3	-0.001	(0.84)
Diversified	b_1+b_5	3	0.010**	(0.04)

Firms Facing High Information Asymmetries

Single Segment	b_1+b_3	4	-0.001	(0.62)
Diversified	b_1+b_3	5	0.010	(0.28)

** significant at the 5% level, * significant at the 10% level

Table 7: Regression of excess firm value (using sales multiples)on the Diversified firm's Internal Finance: Low and High Information Asymmetries

Pooled cross-sectional time-series regression of the excess value measure at fiscal year end for the observations on diversified firms available on Compustat from 1991-1996. Firms are considered diversified if they operate business segments in more than one industry, where industries are defined at the two digit SIC code level. To be included in the sample the following data must be available: Balance sheets and income statements must be available for the fiscal year end. Business segment data must be available and the sum of the firm's segment sales must be within one percent of firm sales on the Annual tape. Forecasted and actual analyst earnings per share forecasts for the fiscal year must be available on IBES. Benchmark value is the sum of the imputed values of the diversified firm's segments. Imputed values are calculated using the single segment industry median market value-to-sales multiple. Annual indicator variables are used to control for year effects in the regression, however I do not report results for these control variables. Two-tailed P-values of the t-test of equality of the coefficient to zero are reported in parenthesis. The results have been corrected for heteroskedasticity using the procedures outlined by White (1980). Regression is as follows.

$$ExcessValue_{i,t} = \beta_0 + \beta_1 D_{ai,t-1} + \beta_2 InternalFinance_{i,t-1} + \beta_3 (D_{ai,t-1} \times InternalFinance_{i,t-1})$$

$$+ \beta_4 Size_{i,t-1} + \beta_5 InvOPPS_{i,t-1} + \beta_6 Profit_{i,t-1} + e_{i,t}$$

where

ExcessValue	=log(Actual Market Value/benchmark value),
D_{ai}	=1 if the firm's measure of asymmetric information is above the cross-sectional median for that fiscal year, and 0 otherwise,
Internal Finance	=the ratio of firm cashflow divided by capital expenditures less the sales-weighted average single-segment industry median ratio,
Size	= natural logarithm of total assets,
InvOPPs	=Capital Expenditures/Net Sales,
Profit	=earnings before extraordinary items/Net Sales,
and *e*	=a normally distributed error.

The regression results are run using five different measures of information asymmetries. The following indicates which measure was used for each regression.

Regression	Measure of Information Asymmetries
1	Analyst Forecast Error
2	Standardized Forecast Error
3	Standard Deviation of Analyst Forecast
4	Number of analysts providing earnings forecasts
5	Participation in a science-based industry (sic codes 28, 35, 36 or 38).

[Table is continued on the following page.]

Table 7: [continued] Regression of excess firm value (using sales multiple)on the Diversified firm's Internal Finance: Low and High Information Asymmetries

	1	2	3	4	5
Intercept	-0.63	-0.65	-0.64	-0.48	-0.72
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Internal Finance	0.01**	0.01**	0.01**	0.01**	0.01**
	(0.00)	(0.00)	(0.02)	(0.03)	(0.00)
High Information Asymmetry Dummy (D1)	-0.01				
	(0.55)				
(Use of Internal Finance)*D1	-0.01*				
	(0.08)				
High Information Asymmetry Dummy (D2)		0.02			
		(0.41)			
(Use of Internal Finance)*D2		-0.02*			
		(0.08)			
High Information Asymmetry Dummy (D3)			-0.07**		
			(0.00)		
(Use of Internal Finance)*D3			-0.01		
			(0.19)		
High Information Asymmetry Dummy (D4)				-0.08**	
				(0.00)	
(Use of Internal Finance)*D4				0.004	
				(0.71)	
High Information Asymmetry Dummy (D5)					0.05**
					(0.04)
(Use of Internal Finance)*D5					0.02
					(0.18)
Investment Opportunities	0.40**	0.39**	0.42**	0.38**	0.57**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Logarithm of Size	0.05**	0.05**	0.06**	0.04**	0.05**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Profitability	3.51**	3.55**	3.46**	3.44**	3.33**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Model p-value	0.00	0.00	0.00	0.00	0.00
Adjusted R-squared	0.20	0.20	0.21	0.21	0.20
Sample Size	1645	1645	1645	1645	1004

** significant at the 5% level, * significant at the 10% level

Table 7 [continued] Regression of excess firm value (using sales multiples) on the Diversified firm's Internal Finance: Low and High Information Asymmetries
Panel B: Summary of Coefficient estimates on Internal Finance for Diversified Firms

The following Panel summarizes the regression coefficients for Single Segment and Diversified firms. A firm is diversified for purposes of this table if it reports sales in two or more segments, where a segment is defined at the two-digit SIC code level. The table below indicates the regression coefficient constructed, as needed, from the coefficients in Panel A. "Regress Number" is the number of the regression in which the coefficient values appear in Panel A and the two-tailed p-value for the test statistic that the coefficient is equal to zero. "AI" refers to asymmetric information.

Firm Type		Regression 1	Regression 2	Regression 3	Regression 4	Regression 5
Low AI	β_2	0.01**	0.01**	0.01**	0.01**	0.01**
		(0.00)	(0.00)	(0.02)	(0.03)	(0.00)
High AI	$\beta_2 + \beta_3$	0.0005	-0.0006	0.0015	0.0112	0.0289**
		(0.93)	(0.94)	(0.80)	(0.23)	(0.04)

** significant at the 5% level, * significant at the 10% level

Table 8: Regression of excess firm value (using sales multiples) on asymmetric information quartile indicator variables and their interaction with Internal Financing.

Sales multiples are used to calculate firm benchmark values. Q1-Q4 are indicator variables. Q1 is equal to one if the level of information asymmetries lies within the lowest cross-sectional quartile for that year. Q2-Q4 are defined in a similar manner. The coefficients on the interaction of Internal Financing and the quartile indicator variables appear first. The coefficients for the indicator variables follow. The results for three different regressions appear below. Each regression uses a different estimate of information asymmetries, as indicated by the column heading. Year dummies are estimated but are not reported below. Two-tailed p-value for the test statistic that the coefficient is equal to zero appears in parenthesis. The results have been adjusted according to the procedures in White (1980).

$$
\begin{aligned}
\text{Excess value}_{i,t} = {} & b + b_1(\text{Internal Finance}_{i,t-1})^*Q1_{i,t-1} + b_2(\text{Internal Finance}_{i,t-1})^*Q2_{i,t-1} \\
& + b_3(\text{Internal Finance}_{i,t-1})^*Q3_{i,t-1} + b_4(\text{Internal Finance}_{i,t-1})^*Q4_{i,t-1} \\
& + b_5 Q2_{i,t-1} + b_6 Q3_{i,t-1} + b_7 Q4_{i,t-1} \\
& + b_8(\text{investment opportunities}_{i,t-1}) + b_9(\text{log size}_{i,t-1}) + b_{10}(\text{profitability}_{i,t-1}) + e_{i,t}
\end{aligned}
$$

	Analyst Error		Analyst Error/ mean forecast		Standard Deviation of Analyst Error	
	(1)		(2)		(3)	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
(Internal Finance)*Q1	0.02**	(0.02)	0.02**	(0.00)	0.01	(0.43)
(Internal Finance)*Q2	0.01*	(0.06)	0.01	(0.25)	0.02**	(0.03)
(Internal Finance)*Q3	0.01	(0.17)	0.02**	(0.02)	0.02	(0.14)
(Internal Finance)*Q4	-0.01	(0.24)	-0.02	(0.16)	-0.01	(0.29)
Q2	-0.01	(0.74)	-0.01	(0.70)	-0.03	(0.32)
Q3	-0.03	(0.33)	-0.02	(0.46)	-0.08**	(0.00)
Q4	-0.01	(0.87)	0.04	(0.16)	-0.08**	(0.00)

** significant at the 5% level, * significant at the 10% level

Corporate Investment Myopia: a Horserace of the Theories

Leonard L. Lundstrum

Department of Finance
Kelley School of Business
Indiana University
Bloomington, IN 47405-1701

and

Department of Business Management
College of Management
North Carolina State University
Raleigh, NC 27695-7229

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Abstract

This paper jointly tests three theories of corporate investment myopia which predict a distortion in investment policy with respect to the standard net present value rule. Myopia results in a distortion in investment policy in favor of projects that realize cash flows early and away from those projects that realize their cash flows later. I confront the theories with the empirical evidence, allowing the theories to compete to explain investment behavior. The "Holdup Losses" hypothesis predicts a negative relationship between long-term investment and the age of the manager, while the "Wage Distortion" hypothesis predicts a positive relationship. The "Inflated Earnings" hypothesis predicts a negative relationship between long-term investment and the sensitivity of the firm's shares price to an earnings surprise.

I use the level of the firm's research and development expenses as a measure of the firm's long-term investment, and find that research and development expense is decreasing in the age of the Chief Executive Officer. On average, a ten-year difference in the age of the CEO, holding all else equal, is associated with as much as a 10 percent decline in the level of R&D spending. Results are robust to three different industry adjustments for R&D level, and the inclusion of control variables for investment opportunities and year effects and controlling for variation in the average age of the manager by industry. The results of this paper suggest that the firm under-invests in long-term projects as a result of shareholder efforts to reduce future "Holdup Losses" to the manager. The shareholders impose a myopic policy to prevent the manager from making long-term investments which require his continued employment with the firm, and then threatening to leave if his compensation is not increased. Results are consistent with the Noe and Rebello (1997) "Holdup Losses" theory, inconsistent with the Narayanan (1985) "Wage Distortion" theory and also inconsistent with the Stein (1989) "Inflated Earnings" theory.

Preliminary and Incomplete—comments welcome.

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Introduction

The popular press suggests that U.S. firms do not pursue an optimal investment policy but rather that they invest myopically, selecting projects which pay off quickly over those projects that maximize firm value. The assertion that U.S. firms invest myopically has important implications for both the creation of wealth by firms and for public policy. These policy implications include restrictions on institutional investment, shareholder rights and corporate governance activities. Michael Jacobs, former Director of the Corporate Finance Group at the U.S. Treasury, details the most commonly cited causes of corporate investment myopia in his 1991 book. He cites the only modest economy-wide year-to-year increases in Research and Development expenses as evidence of such myopia. The book implicates both high information asymmetries between investors and firms, and disengaged shareholders as important causes of myopia. The empirical evidence on the cause of myopia is inconclusive, to date. This paper takes corporate investment myopia as a stylized fact and examines whether the empirical evidence is consistent with any of three prominent myopia theories.

I contribute to the literature in two ways. First, by confronting three theories with the data and allowing the theories to compete to explain investment behavior. Second, I contribute to the literature on managerial career concerns by examining evidence on the relationship between the age of the manager and his corporate investment decision. Results suggest that younger managers make greater long-term investments. The results are consistent with the hypothesis that myopia results from the shareholders' efforts to reduce potential "holdup" losses to the manager. These "holdup losses" result from the manager's preference for long-term investments which make his retention essential to the project's success. The manager prefers these long-term investments so that he can "hold the firm up" by threatening to leave before the project's cash flows are realized if his compensation is not increased.

My results offer an explanation for the prevalence of short-term earnings-based CEO incentive contracts, which have until now remained largely an unexplained phenomenon. The results of this paper are consistent with the hypothesis that managerial compensation contracts, which focus on short-term accounting performance, may be a manifestation of the shareholder's efforts to impose a myopic investment policy, to minimize "holdup losses".

The academic literature offers a number of competing theories of investment myopia, two of which have already been tested. This paper uses a unified framework to investigate empirically three other leading theories. These theories suggest that the type of investment distortions discussed above are driven by either a conflict of interest between the firm's manager and the shareholders, or by information problems in capital or labor markets, respectively. The paper attempts to determine which effects dominate. The "Wage Distortion", "Holdup Losses" and the "Inflated Earnings" hypotheses compete here to explain corporate investment behavior. Each theory tested here assumes that the firm's annual cash flow contains a stochastic term as discussed below. The stochastic term makes inference of managerial skill or expected future cash flows difficult.

The first theory suggests that it is information problems in the labor market that drive myopia. The manager selects short-term projects in an attempt to inflate the labor market's perception of his value. The Narayanan (1985) "Wage Distortion" theory asserts that the manager tries to inflate the labor market's perception of his value before the market's uncertainty with respect to his value has been resolved. The manager attempts to inflate the perception by selecting sub-optimal short-term projects which generate high near term cash flows in an effort to fool the labor market into attributing the high cash flows to his skill managing long-term investments. While short-term projects have high near-term cash flows, their net present value is inferior to that of longer-term projects. As the manager becomes more seasoned, the labor market is able to estimate the manager's skill with greater precision, reducing the manager's incentive to invest short-term. The "Wage Distortion" hypothesis implies that investment myopia is decreasing in managerial seasoning.

The Noe and Rebello (1997) "Holdup Losses" theory relies upon the Shliefer and Vishny (1989) assertion that the manager prefers long-term projects to short-term projects. The manager prefers long-term projects because it enables him to become entrenched and then "hold up" the firm by threatening to leave if his contract is not renegotiated. "Holdup losses" increase in the seasoning of the manager because the manager's value to the firm is increasing in his seasoning. As a result, shareholders want the manager to invest in short-term projects to mitigate the "Holdup Losses" that they will suffer if the manager invests in long-term projects that require his continued employment and then threatens to leave if his compensation is not increased. The shareholders attempt to control investment policy by designing a compensation contract for the manager which is tied to short-term earnings. Investment in short-term projects minimizes the average time until the project pays off and so reduces the "holdup losses" that the firm will incur if the manager leaves. Because holdup losses are increasing in managerial seasoning, the shareholder's incentive to impose a myopic policy also increases in the seasoning of the manager. The "Holdup Losses" hypothesis implies that investment myopia increases in managerial seasoning.

Given the conflicting hypotheses with respect to the manager's investment choice there is no clear theoretical consensus as to the relationship between the seasoning of the manager and his preference for long- or short- term projects. The dominant effect remains an empirical question. Age is used here as an empirical proxy for managerial seasoning. Under the null hypothesis the age of the chief executive officer and the firm's long-term investment are unrelated. Alternatively, if the age of the chief executive officer and the firm's long-term investment are positively related, the evidence is consistent with the "Wage Distortion" theory. The second alternative is that the age of the chief executive officer and the firm's long-term investment are negatively related, in which case the evidence is consistent with the "Holdup Losses" theory.

In addition to testing the "Wage Distortion" and "Holdup Losses" theories, this paper tests a third competing theory, the "Inflated Earnings" theory. The Stein (1989) "Inflated Earnings" theory asserts that information asymmetries between the investor and the firm, with respect to the firm's expected future cash flows, result in the market conditioning its estimate of firm value on all available information. The market conditions its expectation of future cash flows on the firm's current earnings, because they may be correlated with future cash flows. This admits the potential for the firm to manipulate investor expectations by investing myopically in projects that do not maximize present value but do generate high current earnings.

The manager pursues a myopic investment policy to increase current share price. If the market conditions its expectation on the current inflated earnings it will be fooled into over-estimating the value of the firm. The "Inflated Earnings" theory implies that firms whose share price is highly sensitive to current performance announcements have the greatest incentive to invest myopically.

The Earnings Response Coefficient, introduced by Hagerman et al. (1984), is used as a proxy for the sensitivity of the stock price to earnings surprises. Under the null hypothesis the Earnings Response Coefficient and long-term investment are positively related. Under the alternative hypothesis, the earnings response coefficient and long-term investment are negatively related, consistent with the "Inflated Earnings" theory.

Research and development expense is used here as a proxy for the firm's long-term investment. I examine the relationship between the firm-level annual Research and Development expense and the variables that the theories predict will explain long-term investment. All else equal, a myopic firm will have lower Research and Development expense.

The results of this paper suggest that the firm under-invests, relative to a standard net present value rule, in long-term projects because of shareholder efforts to reduce future "Holdup Losses" to a manager who may become entrenched. I find that research and development expense decreases in the age of the chief executive officer. Results are robust to the inclusion of a control variable for investment opportunities, three different types of industry adjustments to long-term investment, controlling for industry average CEO age, and year effects. The results are consistent with the Noe and

Rebello (1997) "Holdup Losses" hypothesis and inconsistent with both the Narayanan (1985) "Wage Distortion" hypothesis and the Stein (1989) "Inflated Earnings" hypothesis.

The paper proceeds as follows. Section 1 discusses the three hypotheses to be tested. Section 2 presents the model. Section 3 describes the sample and descriptive statistics. Section 4 presents the empirical specification and results. Section 5 concludes.

1. Hypotheses

The extant empirical investment myopia literature examines the empirical evidence on two hypotheses: the "Takeover" threat and "Ownership Structure". The three studies that are discussed below examine this evidence using the firm's R&D expense as a proxy for the firm's long term investment. While the evidence is mixed, it is at least partially consistent with each hypothesis.

The Knoeber (1986) and Stein (1988) "Takeover" theories assert that the threat of a hostile takeover and subsequent dismissal of management leads to myopic investment. Knoeber's theory implies that a "golden parachute" for the CEO acts as a bonding mechanism so that the chief executive officer will invest optimally in long-term projects and not worry about the potential for a takeover and dismissal. Knoeber's (1986) cross-sectional empirical results are consistent with his "Takeover" hypothesis, R&D is positively related to the presence of a "golden parachute".

The Stein (1988) "Takeover" theory suggests that takeover firms seek out takeover candidates with high levels of R&D expenditures, acquire the candidate firm, and then cut R&D to use the cash flow to meet high debt service. This theory implies that R&D spending declines subsequent to a takeover. Meulbrock et al. (1990) test the theory, and their results are inconsistent with the "Takeover" hypothesis.

The "Ownership Structure" hypothesis suggests that share ownership by investors who pursue a "buy and hold" strategy mitigates the firm's investment myopia. Bushee (1998) finds that the probability that the firm cuts R&D in response to an earnings decline is decreasing in the fraction of shares held by "low turnover" institutional investors. Low turnover investors are defined as institutions that experience low portfolio turnover during the year. Results are consistent with the "Ownership Structure" hypothesis.

In summary, the empirical evidence on the "Takeover Threat" hypothesis is mixed while the empirical evidence is consistent with the "Ownership Structure" hypothesis. A related study by Dechow and Sloan (1991) examines long-term corporate investment in the chief executive officer's last year prior to retirement and finds that R&D declines in that year. They test the hypothesis that CEOs cut long-term investment in order to artificially inflate current earnings in their final year, to boost their current earnings-based compensation. The results are consistent with the inability of contracting procedures to eliminate opportunistic managerial behavior.

Dechow and Sloan found that the firm cuts long-term investment in the last year of the CEO's tenure, consistent with the hypothesis that CEOs cut long-term investment in order to artificially inflate current earnings. Their results, consistent with the hypothesis, suggest that deferred compensation packages were not inducing an optimal policy. Their results did not examine the relationship between CEO age and R&D across the range of CEO age, they simply examine investment in the CEO's final year of tenure. I take a broader look, including observations on CEOs age 26 to 85 and examine investment across age.

Boards of directors will, of course, try to reduce managerial investment distortions, through the use of contracting mechanisms. While boards can use a variety of mechanisms, including complex compensation contracts to try and control myopic managerial behavior, these contracting mechanisms are expensive to employ. This paper assumes that the cost of myopic investment is simply a part of the total cost in a cost-minimizing contracting equilibrium. In particular, the cost of myopic investment includes the incremental net present value of long-term projects forgone when suboptimal short-term projects are selected. The key predictions of each of the three theories are tested empirically in what follows.

1.1. Narayanan's (1985) "Wage Distortion" theory

The manager's wage next period is based on the market's assessment of his value in the absence of the availability of complete information on the manager's true value and his investment choices. The manager has an incentive to choose an inferior, short-term projects in an effort to artificially inflate current firm performance and enjoy a higher wage next period. The theory assumes that firm cash flows are a function of both the manager's value and his choice of a long- or short- term project. Each project generates a cash flow in each of two consecutive periods, an element of which is stochastic. A critical assumption is that while a short-term project has, on average, higher near-term cash flows, the net present value of the long-term project exceeds that of the short-term project. The manager has an incentive to select the short-term project when the manager's project choice is not observable to the labor market. When the manager's project choice is not observable, the labor market must draw inference on the manager's choice of project, when assessing the manager's value, yet it only observes stochastic project cash flows.

The manager prefers an early positive revision in the labor market's assessment of his value to a revision which occurs later. This follows as the precision of the labor market's estimate of the manager's productivity is increasing in the number of observations of the manager's performance. Therefore, given that the firm experiences a high cash flow, a greater fraction of the cash flow will be attributed to the value of the manager when the precision of the market's estimate of the manager's value is low—which is when the manager is relatively unseasoned.

The manager has an incentive to behave myopically and select the inferior short-term project hoping the market will infer that he has chosen a long-term investment and attribute the high current term cash flows to high manager value. The manager is willing to impose some loss of net present value upon the firm in an attempt to enjoy an inflated wage early in his tenure. As a result, managerial investment myopia declines as the manager becomes more seasoned. This yields the testable hypothesis.

H1: *Myopia is decreasing in managerial seasoning.*

1.2. Noe and Rebello's (1997) "Holdup Losses" theory

Noe and Rebello's (1997) "Holdup Losses" theory predicts that shareholders choose a myopic investment policy to reduce future "Holdup Losses" to the manager who threatens to leave before cash flows are realized if his compensation is not increased. The manager prefers long-term projects for which his continued presence is essential to the realization of future cash flows. The shareholders choose to impose a myopic investment policy because the cost of imposing such a policy is less than the "Holdup Losses" which the firm will suffer if the manager selects long-term projects and then proceeds to "holdup" the firm.

The manager develops firm-specific human capital over time, and so the value of the manager to the firm grows to exceed the value of a replacement manager. The incremental value the firm realizes by the continued retention of the current manager is the "rent" the firm realizes by the continued pressure of the current mangers. The "rent" leads to the entrenchment of the manager and admits a 'holdup' problem.

The shareholders use compensation contracts which minimize "Holdup Losses" by rewarding the manager for high short-term earnings. As the managers' firm-specific value increases as time passes, the manager prefers projects which payoff later, because his firm-specific value will be greater then, and he will be able to extract more from the firm by threatening to leave. He is able to extract more of the "rent" when his firm-specific value is high because the firm has more to lose if he were to leave. The shareholders try to induce a myopic investment policy to minimize holdup losses. A myopic policy translates into a series of short-term projects, each of which quickly yields its terminal cash flow. This series of short-term projects realize their cash flows, on average, when the manager's less firm-specific value is lower.

Therefore, shareholders prefer investments that generate near term cash flows which have a lower present value precisely because the cash flows of these projects are less subject to holdup losses, because they are quickly realized. Shareholders use their power to impose a myopic investment policy and thereby reduce the expected level of holdup losses. Because the manager's firm-specific value is increasing his seasoning, the manager's ability to hold up the firm also increases in his seasoning.

H2: *Myopia is increasing in managerial seasoning.*

1.3. Stein (1989), the "Inflated Earnings" theory

Stein assumes that current earnings are made up of two components: a natural and a transitory component. As a result of information asymmetries, the market can not discern natural from transitory earnings. Earnings announcements are important to the market as they contain information about the economic performance of the firm and because they are correlated with future firm cash flows. Because an efficient capital market uses current earnings to forecast future cash flows, cash flow forecasts are sensitive to earning's surprises. Therefore the firm's stock price is sensitive to earning's surprises.

If market expectations of future firm cash flows are sensitive to an earning's surprise, any deviation of current earnings from the market's expectation will result in a re-valuation of the firm's stock price. The manager cares about not only the future market price of the firm but also the current market price. As a result, he tries to inflate the firm's stock price by investing myopically to overstate current earnings, hoping that a positive earnings surprise will result in an upward revaluation of the firm's current stock price. As the market's sensitivity to deviations from expected earnings increases, the manager's myopia becomes exacerbated.

The extent of the investment myopia problem depends upon the degree to which firm value is sensitive to an earning's surprise. Therefore, the greater the sensitivity of the firm's stock price to an "earning's surprise" the greater the myopia.

***H3**: Myopia is increasing in the sensitivity of the firm's stock price to an earnings surprise.*

2. Empirical Model

An empirical model of the firm's long-term investment is used to test the hypotheses, controlling for firm size, industry effects, investment opportunities and year effects.

Long-term investment

I employ the literature's empirical proxy for long-term investment: Research and Development expense. I use the level of Research and Development expenses as a proxy for long-term investment for the following three reasons. First, the use of Research and Development expense to measure the firm's long-term investment is explicitly suggested by the following theoretical work on corporate long-term investment: Stein (1989), Noe and Rebello (1997) and Bebchuk and Stole (1993). Second, the use of Research and Development expenses to examine long-term investment follows the empirical work of Meulbrock et al. (1990), Knoeber (1986), Bushee (1998) and Dechow and Sloan (1991), each of which uses R&D as proxy for long-term investment. Third, the lag between the investment in R&D and the future revenues that the R&D investment generates. The U.S. accounting standards require that R&D be expensed immediately. However, these standards do not allow the associated future revenues to be recognized until they are actually realized.

The choice of R&D rather than capital expenditures as a proxy for long-term investment is also driven by three other reasons. First, an equivalent amount spent on capital expenditures is recognized as an expense over multiple years, via depreciation, and so it has a smaller impact on current earnings than does R&D. Second, the firm may depend upon internal financing to fund R&D to a greater extent than it does for capital expenditures, as discussed by Himmelberg and Peterson (1994). This follows from the proprietary nature of R&D and the absence of a collateralizable asset as well as greater information and agency problems associated with R&D investment. External financing for capital expenditures is generally available via debentures, collateralizable bonds, mortgages, etc. In contrast to the financing of capital expenditures, to obtain external financing for R&D, the firm may have to share enough information with capital providers to allow for outsiders to replicate the firm's proprietary process/product. This may result in a potentially heightened reliance upon internal financing for R&D expenditures. If so, R&D has a greater impact on the firm's cash position than does an equivalent cash outlay on capital expenditures. Investment in R&D is also illiquid, unlike expenditures on capital equipment. If the R&D expenditure is not profitable it is unlikely that the firm can recover its costs by selling the intangible asset.

To investigate the theories of corporate investment myopia, an inverse measure of the firm's myopia is constructed and called R&D/Sales. R&D/sales is annual research and development expenses divided by the prior year's sales. All else equal, myopic firms have a lower level of R&D/Sales. The analysis is performed in three ways. First, without controlling for the level of R&D/Sales in industry in which the firm operates. Second, after controlling for the firm's industry-median R&D/sales, where industry is defined at the 4-digit SIC code level. Third, after controlling for the firm's industry-median R&D/sales defined at the 3-digit SIC code level. Results are robust to the choice of the second and third method, therefore I only report the results using the first and second methods.

The firms in the sample have an economically significant level of Research and Development expenses. Meulbrock et al. found that Research and Development expenses increase at an average annual compound rate in excess of 9% during the 1980-87 period. R&D grows at an average annual compounded rate of 12.0% in the current sample during the 1990-93 period. This admits the opportunity for the manager to under-invest in long-term assets by failing to increase Research and Development expenditures at the rate at which competitors do. This is important because of the size of the average annual increase in research and development expenses relative to earnings. Median R&D expenses are approximately 175% of median earnings before interest and extraordinary items. The large average annual increase, as discussed immediately above, has a significant impact on current earnings. As a result of a myopic investment policy, the firm may fail to increase R&D at the industry-wide rate and to inflate current earnings and improve current cash flow, at the expense of value maximization.

Meulbrock et al. found that the research and development ratio varies widely by industry, as defined by SIC code. Therefore an industry control is used as follows. Firms are grouped by SIC code such that the most narrow industry definition which includes at least 5 firms that have at least $20 million in sales, and adequate data to compute R&D is used to calculate the industry control. I assume a homogeneous optimal intra-industry level of R&D/sales, for each year. The use of this method to calculate an industry adjustment follows the methodology used by Berger and Ofek

(1995) to calculate firm value in excess of an SIC industry control. The median R&D/sales of all firms in the industry in which the firm operates is defined as the firm's industry-adjustment to R&D/sales. If there is sufficient industry data, the industry median is computed at the four-digit SIC code level. If there is inadequate industry data at the four-digit level the firm's industry is defined at the three-digit SIC code level, if sufficient data is available. Otherwise the firm's industry is defined at the two-digit SIC code level. The firm's industry-adjusted R&D/sales is calculated by subtracting the industry median R&D/sales from the firm's R&D/sales.

R&D/sales is the dependent variable in the regressions which follow. A negative industry-adjusted R&D/sales suggests that the firm's R&D expense is low. Therefore, as investment myopia increases, R&D/sales decreases. A myopic investment policy, all else equal, results in a lower R&D/sales ratio.

Managerial Seasoning

The "Wage Distortion" and "Holdup Losses" hypotheses tested here predict that managerial seasoning is related to investment policy distortions. The age of the chief executive officer is used as the measure of managerial seasoning, following Chevalier and Ellison (1998). Chevalier and Ellison find that the reporting of the manager's tenure has far greater measurement error than does the reporting of the manager's age. This motivates the use of the less-problematic manager's age, rather than tenure, as a proxy for managerial seasoning. The age of the chief executive officer (hereafter CEO) is used, as I assume that it is his or her own biases, which are most likely to impact the firm's investment policy.

Earnings Response Coefficient (ERC)

The "Inflated Earnings" hypothesis predicts that the manager's incentive to invest myopically in an effort to inflate the current market price of the firm's stock price is increasing in the sensitivity of the firm's stock price to an earnings surprise. The market's expectation of future firm cash flows is sensitive to an earnings surprise, any deviation of current earnings from the market's expectation will result in a re-valuation of the firm's stock price. Therefore, I measure the sensitivity of the response of the firm's stock price to an "earnings surprise" by estimating the firm's Earnings Response Coefficient. The Earnings Response Coefficient is an estimate of the share price change associated with a deviation of earnings from the market's expectations. The "Inflated Earnings" theory implies that the Earnings Response Coefficient (hereafter ERC) is negatively related to long-term investment.

Investment Opportunities

The Q-theory of investment suggests that in some cases investment opportunities are sufficient to explain all investment activity (Hayashi 1982). The use of market-to-book to control for variation in firm-year investment follows the Kaplan and Zingales (1995) suggestion that market-to-book equity is a good proxy for investment opportunities. Himmelberg and Peterson (1994) use market-to-book to control for investment opportunities in their examination of R&D and this work follows using market-to-book. Market equity-to-book equity is used as a proxy for the firm's investment opportunities.

Year Effects

Two indicator variables are used to control for year effects. The two indicator variables are for 1992 and 1993 firm-year observations, respectively.

3. Sample and Descriptive Statistics

3.1 Sample

The sample is drawn from the population of firms for which the age of the chief executive is available on the CD Disclosure database. The Earnings Response Coefficient is estimated for each firm-year observation using the prior 16 quarterly earnings. Firms must have quarterly earnings information available on Compustat for four years ended the prior fiscal year to be included in the Earnings Response Coefficient sample. The sample is restricted to firms for which stock returns are available on the CRSP tape for the 210 trading days preceding the first quarterly earnings announcement noted immediately previous, through the end of the prior fiscal year. All balance sheet, earnings data and earnings announcement dates are from Compustat. Following the analysis of Research and Development Expenses by Himmelberg and Petersen (1994) and Dechow and Sloan (1991) only manufacturing firms are included in the sample. These firms operate in any industry defined by SIC codes 2000 to 4000. This avoids the inclusion of financial firms and utilities both of which face greater regulation and oversight that likely to effect the firm's investment decisions. To avoid distortions in ratios, I obtain data for only those manufacturing firm-year observations with sales in excess of $20 million, following Berger and Ofek (1995). The firm's R&D expense must not have increased more than 100% over the prior year's level. This screen is designed to filter out data errors and firm-year observations for which the firm made large acquisitions so that scaling the current year's R&D by the prior year's sales is not meaningful.

To test the "Inflated Earnings" theory, the firm's Earnings Response Coefficient is estimated over the 16 quarters ended the previous fiscal year. The method used here to estimate the coefficient was first employed by Hagerman et al. (1984) who found a positive and significant relationship between the magnitude of the earnings surprise and the stock market price reaction. Hagerman et al. assume that quarterly earnings per share follow a seasonal random walk. I estimate the relationship by first calculating the quarterly seasonal earnings surprise, and scaling it to control for stock price as:

$$UE_{j,q} = (E_{j,q} - E_{j,q-4}) / P_{q-4} \qquad (1)$$

where $E_{j,q}$ is the fully diluted earnings per share excluding extraordinary items reported by Compustat for firm j in quarter q, and $E_{j,q-4}$ is the same variable for the same quarter of the previous year. The surprise is scaled by the prior quarter's closing price, P_{q-4}. $UE_{j,q}$ is the scaled surprise in earnings of firm j in quarter q.

Easton and Zmijewski (1989) examine the cross-sectional variation in firm-level earnings response coefficients using an estimation which is similar to that employed here. The main difference between their work and this analysis is two-fold. First, they use the firm's 20 previous quarterly earnings announcements, whereas only the prior 16 quarterly announcements are used here. Requiring only 16 previous announcements here increases the size of the sample. Second, Easton and Zmijewski use analyst forecast earnings per share to calculate the earnings surprise, whereas this paper assumes that quarterly earnings follow a seasonal random walk. The decision not to use analyst earnings forecasts to calculate the earnings surprise here is motivated by the availability and completeness of analyst forecast data on the IBES files. If analyst forecast earnings were used here to calculate the earnings innovation, the sample size would have been reduced significantly.

The estimate of the market's response to the earnings surprise controls for market risk and is discussed below. The cumulative abnormal return of firm j's stock in quarter q is defined as the sum of the daily abnormal returns over a three-day window which includes the date of the announcement of quarter q's earnings and the two days preceding the announcement, as $CAR_{j,q}$. The three-day cumulative abnormal announcement returns is computed as the sum of the market model residuals with model parameters estimated over a (-210,-10) window, t=0 is defined as the announcement date of quarter q's earnings for firm j. The abnormal announcement return, $AR_{j,t}$ for firm j on day t is calculated as

$$AR_{jt} = R_{jt} - \left(\hat{a}_j - \hat{b}_j R_{mt}\right) \qquad (2)$$

where R_{jt} is the daily percentage return on common stock of firm j on day t. R_{mt} is the daily percentage return on an equally-weighted market index on day t, and $\hat{a}_j$ and $\hat{b}_j$ are the ordinary least-squares estimates of the firm's market model parameters.

The cumulative abnormal return, $CAR_{j,q}$, estimate and the earnings surprise $UE_{j,q}$ are used in what follows to estimate the firm's Earnings Response Coefficient. The Earnings Response Coefficient, γ_j, for each firm j, is an estimate of the sensitivity of firm j's stock returns to earnings announcement surprises. The Earnings Response Coefficient is estimated using the following firm-level OLS regressions for each firm-year observation,

$$CAR_{j,q} = \alpha_j + \gamma_j UE_{j,q} + \eta \qquad (3)$$

where q indexes the quarter relative to the first quarter of the current fiscal year which is quarter zero, and where η is a normally distributed error term. The regression is estimated, for each annual firm-year observation, using the 16 quarterly earnings announcements through the end of the prior fiscal year. The Earnings Response Coefficient, $\hat{\gamma}_i$, estimates the sensitivity of the firm's market value to the information conveyed by the earnings surprise. The $\hat{\gamma}_i$ s are used in equation (4).

3.2 Descriptive Statistics

The sample includes all firm-year observations during 1991, 1992 or 1993 for which sufficient data is available. The choice of years is dictated by the availability of chief executive officer age data on the CD Disclosure database on the Bloomington, Indiana campus. The analysis focuses on industries in which the ratio of Research and Development expenses to sales is significant, following Dechow and Sloan (1991). Therefore only those firm-year observations in industries defined at the 4-digit SIC code level, in which the cross-sectional mean firm level R&D/Sales is at least 3.0% are included in the sample. This 3% requirement is less restrictive and so results in a far larger sample than does the 5% requirement used by Dechow and Sloan. Dechow and Sloan test whether, on average, the CEO reduces R&D expenses in his or her final year with the firm. My 3% requirement means only that the level of Research and Development expenditures are significant in the industry-year which corresponds to the firm-year observation. The procedures outlined above result in a sample of 997 observations. Table 1 presents the distribution of observations over time and industries. Descriptive statistics are presented in Table 2. Due to the skewness in the distributions of the variables, the analysis focuses on medians and uses them to calculate industry-year adjustments.

The firm-year observations are distributed as shown in Panel A of Table 1, 320 in 1991, 294 in 1992 and 383 in 1993. In the sample, data is available to calculate 185 firm-year ERC estimates in 1991, 160 in 1992 and 242 in 1993, a total of 587 or 59% of the age sample. Observations are drawn from 33 industries defined at the three-digit SIC code level, as shown in Panel B. Over one-half of the observations come from just four industries. Because the industry selection criteria, or 3% rule, apply to 4-digit industries, but industry data presented in Panel B is only for 1997 data pooled at the 3-digit SIC code level, some industries appear to have R&D/Sales less than 3%. This is a result of my parsimonious presentation in which industry data is pooled at the 3-digit level. The industries are Drugs (SIC 283), Computer and Office Equipment (SIC 357), Laboratory Applications, Optics, Measurement and Control Instruments (SIC 382) and Electronic Components and Accessories (SIC 367). The Drug and the Computer and Office Equipment industries are characterized by the highest median ratios of R&D divided by sales, at 9.73% and 9.10% respectively.

The multivariate regressions which follow present regression results using two different dependent variables, the dependent variables are firm-year R&D/Sales and firm-year R&D/Sales adjusted for industry. The industry adjustment is made by subtracting the industry-year median R&D/Sales from the firm-year R&D/Sales. Descriptive statistics appear in Table 2. The median level of research and development expenses is $7.5 million or 7.8% of the prior year's sales. The median number of firm-year observations used to calculate the industry adjustment is 16. The level at which the

R&D industry adjustment is calculated is driven by the availability of five firm-year-observations with adequate data within the industry-year defined by the SIC code. The median chief executive officer age, 53, does not appear to be skewed in the sample, and ranges from 26 to 85 years.

While firm size is positively skewed, the firms in the sample are not particularly large. Median sales and market value of equity are $122 million and $109 million respectively, means are $1,154 million and $1,183 million respectively. Median market-to-book equity at prior year-end is 1.80 and is positively skewed, with mean 2.76. Median earnings before extraordinary items and interest are only $4.28 million. Therefore a firm could increase its current earnings about 17% just by cutting research and development expense by 10%. Therefore the level of research and development expense significantly impacts the firm's current earnings. The mean Earnings Response Coefficient is 0.585 and is significantly different from zero (two-tailed test of the hypothesis that the ERC is equal to zero has a p-value<0.01.

The correlation between the two dependent variables used in the multi-variate regression analyses is presented in Table 3. The two measures are significantly related to each other at the 1% level. The correlation between the unadjusted R&D/Sales and the industry-adjusted R&D/sales is 0.89 (p-value < 0.01). The uni-variate correlations indicate that CEO age and R&D/Sales are negatively correlated, correlation coefficient is -0.17 (p-value < 0.01). The negative correlation between R&D/Sales and the age of the CEO persists after an industry-adjustment is made to R&D/Sales, correlation coefficient –0.12 (p-value<0.01), while the correlation is somewhat smaller in magnitude. Investment opportunities are positively correlated with R&D/Sales.

coefficient 0.12 (p-value < 0.01), and negatively correlated with CEO age, coefficient –0.07 (p-value < 0.02). These results suggest that to properly examine the relationship between R&D/Sales and age, controls are needed for industry and investment opportunities. The multi-variate regressions presented below control for industry, investment opportunities and year effects.

4. Empirical Specification and Results

H1 and **H2** imply that investment myopia is related to managerial seasoning while **H3** implies that myopia is related to the sensitivity of the market price of the firm's stock to earning's announcement surprises. To test **H1**, **H2** and **H3** simultaneously, I estimate the following regression using the firm-year observations which have been pooled for the years 1991 through 1993.

$$R\&D/Sales = \alpha + \beta_1 CEOage_{t-1} + \beta_2 \hat{\gamma}_{t-1} + \beta_3 InvOpp_{t-1} + \beta_4 D92 + \beta_5 D93 + \varepsilon_t \quad (4)$$

where

R&D / Sales	= Research and Development expense in year *t* divided by Sales in year t-1,
CEOage	= age of the Chief Executive,
$\hat{\gamma}$	= earnings response coefficient, as estimated in equation (3)
InvOpp	= firm's market-to-book equity as proxy for investment opportunities,
D92	= indicator variable=1 if the observation is from 1992 and 0 otherwise,
D93	= indicator variable=1 if the observation is from 1993 and 0 otherwise,

and ε_t is a normally distributed error term and *t* and where *t-1* denote the observation year. The standard errors are corrected using White's (1980) procedure. The results of the multi-variate regression results appear in Table 4, 5, 6 and 7. Significance tests on coefficients are calculated using asymptotic t-tests.

H1 predicts that myopia is decreasing in seasoning, and so older managers invest more in long-term projects. Therefore ***H1*** implies that the cross-sectional average R&D/Sales is positively related to manager's age, or $\beta_1 > 0$. ***H2*** implies that myopia is increasing in the seasoning of the manager, and older managers invest less in long-term projects. ***H2*** implies that the cross-sectional average R&D/Sales is negatively related to the manager's age, and so $\beta_1 < 0$. Therefore ***H1*** and ***H2*** have conflliciting implications. **H3** predicts that myopia is increasing in the sensitivity of the market price of the firm's stock to earning's surprises. Therefore the manager's propensity to choose long-term investments decreases in the firm-year earnings response coefficient. ***H3*** predicts that the cross-sectional average R&D/Sales is negatively related to the Earnings Response Coefficient, and so $\beta_2 < 0$.

Section A: Regression of R&D/Sales on the Chief Executive Officer's Age

The results of the test of **H1** are presented first, using the largest sample available. Table 4 presents the results with and without an industry adjustment, using all available observations. Columns (1) and (2) present the results of the regression on the industry-adjusted change in R&D, and columns (3) and (4) present the unadjusted results.

In a simple regression, using the industry-adjusted dependent variable, which appears in column (1), on an intercept and CEOage, the ceo's age is significantly negatively related to R&D, $\beta_1 = -0.0012$ (p-value<0.01). After controlling for investment opportunities, using market-to-book equity as a proxy for investment opportunities, in column (2), the coefficient and p-value remain unchanged. The results are also robust to an alternative industry adjustment[2] and to the inclusion of a control variable for investment opportunities. Columns (3) and (4) present the regressions without an industry-adjustment to the dependent variable. The coefficient on CEO age is negative (p-value<0.01), β_1=-0.0020, and significant in both (3) and (4).

The presentation above indicates that the results are robust to the inclusion of an industry-adjustment to R&D/Sales, and the inclusion of a control for investment opportunities[3]. Overall the results are inconsistent with **H1**, and consistent with **H2**, the prediction of the "Holdup Losses" theory.

Section B: Regression of R&D/Sales on the Earnings Response Coefficient

H3 is first tested by itself, Table 5 presents the results. Results are presented with and without the inclusion of an industry adjustment to R&D/Sales, for all observations. Results are robust to the inclusion of an additional control variable for investment opportunities and the industry adjustment to the dependent variable.

The earnings response coefficient is not related to R&D. Columns (1) and (2) present the results of the regression on the industry-adjusted change in R&D. In a multi-variate regression of an intercept, the earnings response coefficient and year dummies, column (1), the Earnings Response Coefficient is unrelated to R&D, β_2=0.0005 (p-value<0.72). After controlling for investment opportunities using the coefficient on the Earnings response coefficient is again not significant, β_2=0.0007 (p-value<0.63), results appear in column (2).

Columns (3) and (4) present the regressions on the unadjusted dependent variable. The coefficient on the Earnings Response Coefficient is again not significant, results are in column (3), β_2=-0.0013 (p-value<0.09). The coefficient is again not

[2] Results are robust to a 3-digit industry adjustment to R&D/Sales and also to adjusting age for industry median CEO age by subtracting the industry median CEO age from the firm-year observation to compute an industry-adjusted CEO age.

[3] The results do not change if observations are not pooled across years but rather are run annually.

significant after controlling for investment opportunities, results appear in column (4) β_2=-0.0011 (p-value=0.22).

Section C: Regression of R&D on both the CEO's age and the Earnings Response Coefficient

Table 6 presents a simultaneous test of all these hypotheses, allowing the theories to compete to explain the variation in R&D/Sales. Results are presented with and without an industry adjustment, for all observations for which both CEO age and the Earnings Response Coefficient are available. Columns (1) and (2) present the results of the regression on the industry-adjusted change in R&D. In column (1), the coefficient on CEO age, β_1<-0.0013 (p-value<0.01) is significant and the earnings response coefficient β_2=0.006 (p-value=0.65) is not significant. Therefore while CEO age is significantly and negatively related to R&D, the earnings response coefficient is not related to R&D. The results of the regression on the un-adjusted R&D/Sales yield similar results. In (2) the coefficient on CEO age, β_1<-0.0020 (p-value<0.01) is significant and negatively related to R&D. The earnings response coefficient, β_2=-0.0011 (p-value<0.19) is again not statistically significant. The results are inconsistent with **H1** and **H3** but are consistent with **H2**, and therefore are consistent with the prediction of the "Holdup Losses" theory.

Section D: Robustness Check--Piecewise Linear Regression of R&D/Sales on CEO age

A piece-wise linear regression is used to implement a robustness test. I test the hypothesis that the relationship between the CEO's age and R&D changes over the range of CEO age. Regression is as follows.

$$R\&D/Sales = \alpha + \beta_1 CEOage_{t-1} + \beta_2 Q2 \times CEOage_{t-1} + \beta_3 Q3 \times CEOage_{t-1} + \beta_4 Q4 \times CEOage_{t-1} + \beta_5 InvOpp_{t-1} + \beta_6 D92 + \beta_7 D93 + \varepsilon_t \quad (5)$$

where *R&D/Sales* is Research and Development expense in year t divided by sales in year t-1. *CEOage* is the age of the Chief Executive at the end of the prior year, *InvOpp* is the firm's market-to-book equity as proxy for investment opportunities, *D92*=1 if the observation is from 1992 and 0 otherwise, *D93*=1 if the observation is from 1993 and 0 otherwise, Q2=1 if the manager's age lies within the second quartile of CEO age in the sample and Q3 and Q4 are the indicator variables defined in a similar manner, and where ε is a normally distributed error term. The results have been corrected for heteroskedasticity using the procedures outlined by White (1980). Significance tests on the coefficient are calculated using asymptotic t-tests.

If the relationship between CEO age and R&D changes over the range of CEO age, then we can reject the hypothesis **H4** :$\beta_2+\beta_3+\beta_4=0$. The p-value of the Chi-square test of **H4** is greater than 0.28, for column (1). The p-value for the test of **H4** using the unadjusted scaled change as the dependent variable in the regression which is presented in Column (2) is greater than 0.33. The results are inconsistent with the hypothesis that the relationship changes over the range of CEO age. I fail to reject **H4**.

Section E: Summary of Multi-variate Regression Results

The results are consistent with the hypothesis **H2**, the long-term investment is decreasing in CEO age, the relationship persists across the range of CEO age. Results are consistent with the "Holdup Losses" theory and inconsistent with both the "Wage Distortion" theory and the "Inflated Earnings" theory.

Conclusion

This paper uses a unified framework to investigate empirically three leading theories of myopic corporate investment. These theories suggest that myopic investment distortions result from either a conflict of interest between the firm's manager and the shareholders or by information problems in capital or labor markets, respectively. This paper contributes to the literature by improving our understanding of the relative importance of potential causes of myopic investment distortions. I am the first to allow potential causes of investment myopia to compete to explain investment behavior.
I find that the firm's Research and Development expense is decreasing in the age of the Chief Executive Officer and that this relationship persists across the range of CEO age. Results are robust to the inclusion of control variables for industry effects with respect to both median levels of R&D/Sales and CEO age, investment opportunities and year effects.

The results are consistent with the hypothesis that firms under-invest, relative to a standard net present value rule, in long-term projects as a result of shareholder efforts to reduce future "Holdup Losses" to a manager. Shareholders take action to minimize future "Holdup Losses" to the CEO who may become entrenched and then threaten to leave if his compensation is not increased. Therefore, ceteris paribus, the results support the importance of agency problems and the costs of contracting to firms that rely upon long-term investment. Contracting problems dominate information problems in labor and capital markets when explaining myopic distortions in the sample.

Results are inconsistent with the "Wage Distortion" hypothesis that myopia results from the efforts of the younger manager to distort the labor market's perception of his value. Results are also inconsistent with the "Inflated Earnings" hypothesis that myopia results from firm efforts to inflate current stock price.

Therefore, the costs of a myopic investment policy are only part of the total cost in a cost-minimizing, contracting equilibrium between shareholder's and their CEOs. Shareholders maximize their wealth by minimizing the sum of "holdup losses" plus the costs of myopic investment. The cost of myopic investment is the incremental net present value of long-term projects forgone as a result of a distortion of investment policy towards the short-term. Total contracting costs are lower when the firm invests myopically rather than follow a standard net present value rule and incur the large "holdup losses" which result.

Dechow and Sloan (1991) found that CEOs cut long-term investment in the last year of their tenure. Their results suggest that deferred compensation packages do not induce an optimal investment policy. I extend their work in a much more general setting by taking a broader look at CEO age and long-term investment and finding that investment distortions towards the short term are simply a product of a cost-minimizing contracting equilibrium. I examine investment by CEOs that range in age from 26 to 85, and find that long-term investment declines with age over a manager's career, not simply in the CEO's last year with the firm.

Chevalier and Ellison (1998) indicate that there is not any other direct empirical evidence which links the manager's career concerns to managerial decision making.

My paper now provides evidence of the linkage between the CEO's age and investment distortions.

In summary, the shareholders' attempts to control holdup losses to an entrenched manager are more important when explaining investment distortions than are either the manager's attempts to inflate the labor market's perception of his value or the firm's attempt to inflate its current stock price. The results offer an explanation for the prevalence of short-term earnings-based CEO incentive contracts, which have until now remained largely an unexplained phenomenon. The results of this paper are consistent with the hypothesis that managerial compensation contracts, which focus on short-term. accounting performance, may be a manifestation of the shareholders' efforts to minimize contracting costs by imposing a myopic investment policy.

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Table 1: Distribution of the Sample over Years and Industries
Panel A: Firm-year observations by year

The following panel shows the number of firm-year observations for which Chief Executive Officer age data is available. the number of these observations for which sufficient data is available to estimate the Earning Response Coefficient and the corresponding percentage of the sample for which sufficient data is available to estimate the Earnings Response Coefficient.

Observation Year	Total	ERC Estimates	Percentage of annual age Sample for which data is available to estimate ERC
1991	320	185	58%
1992	294	160	54%
1993	383	242	63%
Total	997	587	59%

Table 1: The Distribution of the Sample over Years and Industries [Continued]

Panel B: Firm year observations and Median Research and Development expenses/Sales by Industries defined at the 3-digit SIC code level, for 1997

SIC Code is the three-digit SIC code. Number of firms in the sample is the number of observations for which there is sufficient data to include in the sample. Median R&D/Sales is the median ratio of Research and Development expenses divided by the prior year's sales for the industry which was used to calculate an industry adjustment across all firms in the 3-digit SIC code which appears in the first column. Median Change in R&D/sales is the median ratio of Research and Development expense divided by the prior year's sales.

Table 1

Panel B:[Continued] Firm year observations and Median Research and Development expenses/Sales by Industries defined at the 3-digit SIC code level, for 1997

SIC Code	Observations in firm-year Sample	Median R&D/Sales (%)
220	11	3.47%
221	1	2.83%
222	1	3.30%
225	3	1.97%
280	4	2.24%
281	4	1.25%
282	12	3.59%
283	86	9.73%
285	10	3.53%
287	5	7.86%
289	17	2.93%
351	7	0.91%
352	6	2.42%
353	7	3.13%
355	60	8.42%
356	16	4.20%
357	168	9.10%
360	3	2.43%
361	9	1.55%
362	9	4.63%
363	3	0.93%
365	23	3.84%
366	116	8.28%
367	138	7.39%
369	1	9.07%
371	7	1.67%
372	12	3.89%
381	8	2.99%
382	124	9.08%
384	93	7.08%
385	4	3.87%
386	21	5.35%
399	9	4.14%
Total	997	

Table 2: Descriptive Statistics

Sample statistics are for 997 firm-year observations, which were available over the 1991-1993 time period, except for the Earnings Response Coefficient for which only 587 estimates are available for the sample. Research and development expenses and sales are for the fiscal year end and the prior fiscal year-end respectively. Balance sheet and income statement values are from the annual Compustat files, chief executive officer age data is from CD Disclosure. The firm's industry is defined as narrowly as possible. To calculate the industry adjustment for the firm the median ratio of all firms in the firm's 4-digit SIC code is issued only if there are at least five such observations. If there are not five such observations in the 4-digit industry then the firm's 3-digit SIC code industry is used. The 2-digit industry is only used if there are not enough firms in the 3-digit industry. Market-to-book equity is the market value of common equity divided by book value of equity. Chief Executive Officer age is the age of the chief executive officer at the end of prior year. IQR is the inter-quartile range. Dollars are in millions.

Variables	Mean	Median	IQR
Research and Development Expense	$71.3	$7.5	$21.7
Research and Development Expenses/Sales	9.09%	7.80%	8.30%
Number of Observations used to calculate industry adjustments	23.4	16	16
Sales	$1,154	$122	$344
Earnings before extraordinary items and interest	$62.4	$4.28	$16.47
Market value of equity	$1,183	$109	$418
Market-to-book equity	2.76	1.80	2.28
Age of Chief Executive Officer in years	54.1	53	11
Earnings response coefficient	0.585	0.279	1.581

Table 3: Correlation coefficients for the two proxies for the annual change in annual R&D/Sales.

Variables described in previous tables. The p-value for the test of the hypothesis that the correlation coefficient is equal to zero appears in parenthesis.

	R&D/Sales	Industry -adjusted R&D/sales	Age	Market-to-book Equity
R&D/Sales	1.00**	0.89**	-0.17**	0.12**
	(0.00)	(0.00)	(0.00)	(0.00)
Industry-adjusted R&D/Sales		1.00**	-0.12**	0.11**
		(0.00)	(0.00)	(0.00)
CEO age			1.00**	-0.07**
			(0.00)	(0.02)
Market-to-book equity				1.00**
				(0.00)

** Significant at the 5% level, * significant at the 10% level

Table 4: Regression of Research and Development Expense on the age of the Chief Executive Officer

Firm-year observations are pooled for 1991 through 1993. The results have been corrected for heteroskedasticity using the procedures outlined by White (1980). Regression is as follow.

$$R\&D/Sales_{i,t} = \alpha + \beta_1 CEOage_{i,t-1} + \beta_3 InvOpp_{i,t-1} + \beta_4 D92_{i,t} + \beta_5 D93_{i,t} + \varepsilon_{i,t}$$

where *R&D/Sales* = research and Development expense in year *t* divided by sales in year *t-1*,
CEOage = age of the Chief Executive,
InvOpp = market-to-book equity as proxy for investment opportunities,
D92 = indicator variable =1 if the observation is from 1992 and 0 otherwise,
D93 = indicator variable=1 if the observation is from 1993 and 0 otherwise,

where $\varepsilon_{i,t}$ is a normally distributed error term, and *t* and *t-1* denote the observation year.

The column title "Adjusted by 4 Digit Industry" indicates that the 4-digit industry-year median *R&D/Sales* has been subtracted from the firm-year *R&D/Sales* to compute an industry-adjusted dependent variable.

	Adjusted by 4 Digit Industry		Unadjusted	
	(1)	(2)	(3)	(4)
Intercept	0.0746**	0.0700**	0.1999**	0.1909**
	(0.00)	(0.00)	(0.00)	(0.00)
CEOage	-0.0012**	-0.0012**	-0.0020**	-0.0020**
	(0.00)	(0.00)	(0.00)	(0.00)
Market-to-book equity		0.0019**		0.0023**
		(0.00)		(0.00)
D92	-0.0034	-0.0051	-0.0031	-0.0050
	(0.60)	(0.43)	(0.70)	(0.52)
D93	0.0011	-0.0013	0.0052	-0.0024
	(0.86)	(0.84)	(0.48)	(0.74)
Model p-value	0.00	0.00	0.00	0.00
Sample Size	997	997	997	997

** significant at the 5% level, * significant at the 10% level

Table 5: Regression of the year-to-year change in Research and Development expense on the Earnings Response Coefficient

Firm-year observations are pooled for 1991 through 1993. The results have been corrected for heteroskedasticity using the procedures outlined by White (1980). Regression is as follows.

$$R\&D/Sales_{i,t} = \alpha + \beta_2\hat{\gamma}_{i,t-1} + \beta_3 InvOpp_{i,t-1} + \beta_4 D92_{i,t} + \beta_5 D93_{i,t} + \varepsilon_{i,t}$$

where

R&D/Sales	= research and Development expense in year *t* divided by sales in year *t-1*,
$\hat{\gamma}$	= the earnings response coefficient, as estimated in equation (3)
InvOpp	= the firm's market-to-book equity as proxy for investment opportunities.
D92	=1 if the observation is from 1992 and 0 otherwise,
D93	=1 if the observation is from 1993 and 0 otherwise,

where $\varepsilon_{i,t}$ is a normally distributed error term.

The column title "Adjusted by 4 Digit Industry" indicates that the 4-digit industry-year median *R&D/Sales* has been subtracted from the firm-year *R&D/Sales* to compute an industry-adjusted dependent variable.

	Adjusted by 4 Digit Industry		Unadjusted	
	(1)	(2)	(3)	(4)
Intercept	0.0011	-0.0050	0.0814**	0.0729**
	(0.85)	(0.45)	(0.00)	(0.00)
Earnings Response Coefficient	0.0005	0.0007	-0.0013*	-0.0011
	(0.72)	(0.63)	(0.09)	(0.22)
Market-to-book equity		0.0033		0.0046*
		(0.12)		(0.07)
D92	-0.0034	-0.0039	0.0015	0.0009
	(0.68)	(0.63)	(0.87)	(0.92)
D93	0.0037	0.0007	0.0082	0.0041
	(0.59)	(0.92)	(0.28)	(0.59)
Model p-value	0.76	0.32	0.41	0.41
Sample Size	**587**	**587**	**587**	**587**

** significant at the 5% level, * significant at the 10% level

Table 6: Regression of the year-to-year change in Research and Development expense on the age of the Chief executive officer and the Earnings Response Coefficient
Firm-year observations are pooled for 1991 through 1993. The results have been corrected for heteroskedasticity using the procedures outlined by White (1980). Regression is as follows.

$$R\&D/Sales_{i,t} = \alpha + \beta_1 CEOage_{i,t-1} + \beta_2 \hat{\gamma}_{i,t-1} + \beta_3 InvOpp_{i,t-1} + \beta_4 D92_{i,t} + \beta_5 D93_{i,t} + e_{i,t}$$

where *R&D/Sales* is Research and Development expense in year *t* divided by sales in year *t-1*. *CEOage* is the age of the CEO, $\hat{\gamma}_{t-1}$ is the earnings response coefficient, as estimated in equation (3). *InvOpp* is the firm's market-to-book equity as proxy for investment opportunities. *D92*=1 if the observation is from 1992 and 0 otherwise, *D93*=1 if the observation is from 1993 and 0 otherwise, where $\varepsilon_{i,t}$ is a normally distributed error term.

The column title "Adjusted by 4 Digit Industry" indicates that the 4-digit industry-year median *R&D/Sales* has been subtracted from the firm-year *R&D/Sales* to compute and industry-adjusted dependent variable.

	Adjusted by 4 Digit Industry	Unadjusted
	(1)	(2)
Intercept	0.0652**	0.1832**
	(0.00)	(0.00)
CEOage	-0.0013**	-0.0020**
	(0.00)	(0.00)
Earnings Response Coefficient	0.0006	-0.0011
	(0.65)	(0.19)
Market-to-book equity	0.0034	0.0047*
	(0.11)	(0.06)
D92	-0.0046	-0.0003
	(0.56)	(0.97)
D93	0.0001	0.0031
	(0.99)	(0.67)
Model p-value	0.01	0.00
Sample Size	587	587

** significant at the 5% level, * significant at the 10% level

Table 7: Piecewise Linear Regression of the year-to-year change in Research and Development expense on the age of the Chief executive

The results have been corrected for heteroskedasticity using the White (1980) procedures.

$$R\&D/Sales_{i,t} = \alpha + \beta_1 CEOage_{i,t-1} + \beta_2 Q2 \times CEOage_{i,t-1} + \beta_3 Q3 \times CEOage_{i,t-1}$$

$$\beta_4 Q4 \times CEOage_{i,t-1} + \beta_5 InvOpp_{i,t-1} + \beta_6 D92_{i,t} + \beta_7 D93_{i,t} + \varepsilon_{i,t}$$

where *R&D/Sales* is Research and Development expenses divided by the prior year's sales. *CEOage* is the age of the Chief Executive, $\hat{\gamma}_{i,t}$ is the earnings response coefficient, as estimated in equation (3) *InvOpp* is the firm's market-to-book equity as proxy for investment opportunities,*D92*=1 if the observation is from 1992 and 0 otherwise, *D93*=1 if the observation is from 1993 and 0 otherwise, Q2=1 if the manager's age lies within the second quartile of CEO age in the sample and Q3 and Q4 are the indicator variables defined in a similar manner, and where $\varepsilon_{i,t}$ is a normally distributed error term.

The column title "Adjusted by 4 Digit Industry" indicates that the 4-digit industry-year median *R&D/Sales* has been subtracted from the firm-year *R&D/Sales* to compute an industry-adjusted dependent variable.

	Adjusted by 4 Digit Industry	Unadjusted
	(1)	(2)
Intercept	0.0101	0.1258**
	(0.80)	(0.01)
CEOage	0.0001	-0.0005
	(0.93)	(0.55)
CEO age*Q2	0.0004	-0.0027
	(0.98)	(0.92)
CEOage*Q3	-0.0192	-0.0309
	(0.39)	(0.24)
CEOage*Q4	-0.0451	-0.0510
	(0.12)	(0.13)
Market-to-book equity	0.0020**	0.0023**
	(0.00)	(0.00)
D92	-0.0055	-0.0055
	(0.39)	(0.48)
D93	-0.0016	0.0022
	(0.80)	(0.76)
Model p-value	0.00	0.00
Sample Size	997	997

** significant at the 5% level, * significant at the 10% level

Does Costly Long-Term Informed Trading Cause Under-investment in Projects with Long-term Cash Flows?

An Empirical Test of the Theory

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Leonard L. Lundstrum

Department of Finance
Kelley School of Business
Indiana University
Bloomington, IN 47405-1701

and

Department of Business Management
College of Management
North Carolina State University
Raleigh, NC 27695-7229

Abstract

The Shleifer and Vishny (1990) "Costly Trade" theory predicts that the firm under-invests in projects with long-term cash flows as a result of the cost differential between informed trading on long-term and short-term information. In equilibrium, traders collect less long-term information because the cost of trading on it exceeds the cost of trading on short-term information. Higher trading costs make informed trade on long-term information less profitable. Therefore, less long-term information is collected and impounded into price, resulting in greater mispricing of firms that invest in projects with long-term cash flows. Shleifer and Vishny develop a model in which the combination of mispricing of firms with long-term cash flows and the manager's desire to avoid under-pricing of the firm's current stock price result in under-investment in projects with long-term cash flows.

Prior theoretical and empirical literatures on the introduction of option trade are consistent with the introduction effecting a decrease in the cost of informed trade. The decrease in cost results in an increase in the amount and precision of information collected and impounded into the current market value per share. By reducing the cost of trade on long-term information, the introduction of exchange trading of a long-term option on the firm should result in less mis-pricing of firms that invest in projects with long-term cash flows. A decrease in mispricing effects an increase in investment in long-term projects. I test the hypothesis that corporate investment in long-term projects increases around the introduction of exchange trade of a long-term option. I find evidence that the firm increases investment as much as 9%, on average, around the introduction. The empirical results are consistent with the "Costly Trade" theory, and suggest that a significant increase in long-term investment is associated with the introduction of exchange trade of options on the firm. Results imply that capital market imperfections play a significant role in deterring firms from pursuing projects with long-term cash flows. The implications of this result for shareholders, boards and policymakers are discussed.

Preliminary and Incomplete – comments welcome

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Introduction

Theory implies that when an organized exchange introduces trading of a long-term option on the firm, the firm realizes positive externalities in its investment policy. Yet, the evidence has not been examined in detail until now. The empirical literature on option introduction is consistent with the hypothesis that the introduction of option trade increases the firm's stock price efficiency by effecting an increase in information gathering and informed trade. Increased informed trade results in an increase in the precision and quantity of information impounded into option prices. The introduction has this effect because option trade is less costly than is stock trade, and so the increased trade of the profit-maximizing informed trader impounds more information on firm value into option prices. Informed trade of options increases stock price efficiency as arbitrageurs force the underlying stock price to rapidly adjust to the increased precision and quantity of information which is impounded into option prices.

An increase in informed trading is generally associated with more efficient market prices. Yet the private costs and benefits of informed stock trading lead to a clustering of stock trade on short-term information. Clustering increases the amount and precision of short-term information relative to long-term information that is impounded in the current stock price. The corporate manager, whose compensation is a function of current and future stock price, avoids projects with long-term cash flows in an attempt to minimize the potential under-pricing of the firm's current stock price that results from the low level and precision of long-term information impounded into current stock price.

This argument, espoused by Sheifer and Vishny's (1990) "Costly Trade" theory, assumes that the private costs of informed stock trading result from imperfections in the capital market. Imperfections are in the form of information problems between informed traders and those that provide them with their capital. The trader has information that their capital provider does not have, about their trading ability and the level of risk that they take. This information problem makes perfect risk sharing between these two parties impossible (in other words the informed trader can not credibly commit to pay the capital provider a risk-adjusted rate of return). The provider reacts to this problem by imposing a credit constraint on the trader. The constraint is costly to the informed trader because it restricts him from trading on all securities that he knows to be mispriced. The results of this paper imply that capital market imperfection play a significant role in deterring firms from pursuing projects with long-term cash flows.

Mispricing of stocks results from the market's uncertainty as to the security's expected future cash flows. Uncertainty may be resolved, and mispricing corrected, by either an increase in the number of traders choosing to collect information on the project's expected future cash flows and trading on the information, or by the realization of the project's cash flows over time.

The cost of the credit constraint is the opportunity cost of the forgone trading profits on alternative investments. The informed trader maximizes his profits subject to the credit constraint by selecting only the most profitable trades. The constraint makes trade on long-term information relatively more costly than trade on short-term information. By trading on short-term information upon which mispricing is soon corrected, the informed is able to quickly realize trading profits and reinvest their capital in other mispriced securities. When there is limited informed trade on long-term information, more time passes, on average, before information about the asset's true value is impounded into share price (mispricing corrected).

Theoretical and empirical evidence suggest that trade in options is less costly than is trade in the underlying asset. It follows that when option trade is introduced on the firm, the cost wedge between trade on long-and-short-term information shrinks and the informed are less likely to cluster their information gathering and trade on short-term information. The cost wedge shrinks because the introduction results in an increase in the amount and precision of information about long-term project cash flows that is impounded into the current stock price, resulting in an increase in stock price efficiency with respect to long-term information. Trade on long-term information increases as a result of increased stock price efficiency, which shortens the expected length of time that an investment must be held until mispricing is corrected. Increased efficiency reduces the chance that a firm which invests heavily in projects with long-term cash flows will experience significant under-pricing.

Short-term information relates to expected cash flows which are soon realized and related mispricing corrected even in the absence of long-term option trade. By using a long-term option, the informed trader can, using a small amount of capital, trade on long-term information. By tying up little capital, the long-term option effectively lowers the cost of long-term trade (waiting for mispricing be corrected and profits realized). The key attribute of an option that makes trade less costly is the reduced cost of the credit constraint on the informed trader. This paper isolates the decrease in only the cost of trade on long-term information, not short-term information. Each firm in the introduction sample examined here already enjoys ordinary option trade, therefore the introduction of the long-term option does not impact the cost of trade on short-term information, only the cost of trade on long-term information.

This paper contributes to the literature by confronting the "Costly Trade" theory with the data. The empirical evidence is examined as follows. If the theory is correct, a firm should increase its investment in projects with long-term cash flows when a long-term option is introduced on the firm's stock. I test the hypothesis that firm-level corporate investment in projects with long-term cash flows increases around the introduction of long-term option trade on the firm's stock. Under the null hypothesis, the firm's investment in projects with long-term cash flows is negatively related to the introduction of a long-term option. The alternative hypothesis is that the firm's investment in projects with long-term cash flows increases when a long-term option is introduced, consistent with the "Costly Trade Theory". If the introduction of a long-term option impacts the firm's investment policy, then the results of this test have important implications for shareholders, boards and policy makers. Implications may include the board encouraging third parties to introduce long-term options, shareholders conditioning forecasts of firm cash flows on the trade of long-term options and policymakers considering the benefit of long-term options when drafting policies which impact the taxes and other costs borne by option traders. The results of this paper are statistically and economically significant, consistent with the Costly Trade theory. The paper provides empirical evidence that firms increase R&D when LEAPs trade is introduced on the firm. The results support the theory.

The paper proceeds as follows. Section 1 discusses the Costly Trade theory to be tested. Section 2 discusses the introduction of LEAPS trade. Section 3 presents the empirical specification. Section 4 presents the Sample and Descriptive Statistics. Section 5 discusses the results of the Hypothesis Testing. Section 6 concludes.

1. The "Costly Trade" Theory

Shleifer and Vishny develop a model in which the combination of mis-pricing of long-term cash flows and the manager's desire to avoid under-pricing of the firm's current stock price result in the firm's under-investment in projects with long-term cash flows. The problem is that the manager can not credibly signal the value of the long-term project. As a result, some firms with projects that have long-term cash flows are overpriced while others are underpriced. The introduction of exchange trading of a long-term option on the firm's equity results in reduced mis-pricing on long-term information and leads to an increase of corporate investment in projects with long-term cash flows. The long-term option introduction effects a decline in stock mispricing by reducing the cost of trade on long-term information. A decline in the cost increases the quantity of information that informed traders are willing to collect and results in an increase in the quantity and precision of the information that is impounded into the current stock price.

Some of the firm's cash flows are generated by long-term projects while other cash flows are generated by short-term projects. The market may have little or imprecise information about long-term project cash flows, making them difficult to value. The long- or short- term nature of the information refers to the expected time until the value of future cash flows is revealed and mispricing corrected. The informed trader pays to learn about expected future cash flows from long-term projects. Therefore, if the cost of trade on long-term information declines, then the market expects greater informed trader efforts to gather information on the firm's long-term cash flows. This translates into a greater quantity and precision of the information impounded into today's price. So, all else equal, mis-pricing on the firm's equity declines with the cost of trade on long-term information. The mechanism for this linkage between mis-pricing and the cost of trade is the fact that, in equilibrium, the expected trading profits on short- and long- term information must be equal, net of trading costs. Therefore, when costs of trade on long-term information decline, trade on long-term information will become more profitable. Increased profitability results in an increase in the quantity and precision of information uncovered on long-term cash flows and impounded into stock price and so fewer pricing errors (greater stock price efficiency.)

The Manaster and Rendleman (1982) results imply that the introduction of a long-term option would result in an increase in the quantity of precision about long-term information impounded into price. They suggest that the benefits of trading options include leverage, lower transactions costs, and fewer short-sale restrictions. They test the hypothesis that the informed trader prefers trading options on stocks to trading stocks, results are consistent with the hypothesis. They find that option price changes help predict stock price changes, consistent with the hypothesis that arbitrageurs force the firm's stock price to rapidly adjust to information, which is first impounded into option prices.

Further evidence suggests that the introduction of option trade increases the incentive to invest in information about expected project cash flows. Jennings and Starks (1986) find that market prices adjust more rapidly to new information for firms that have exchange-listed options than for those firms without option trade. Damodaran and Lim (1991) find that prices adjust more rapidly to new information after options are listed. Skinner (1989) finds that the reaction to earnings reports is smaller after options are listed. All of these findings are consistent with the hypothesis that option trade increases the incentive to invest in information about the firm. In total, this evidence is consistent with the hypothesis that the introduction of trade on a long-term option should increase the efficiency of stock price with respect to long-term information. The increase in price efficiency, which results from the introduction of a long-term option, reduces the chance of underpricing and induces the manager to increase investment in projects with long-term cash flows.

The introduction of a long-term option increases the amount and/or the precision of information that is impounded into current stock prices about long-term project cash flows (long-term information). The introduction of trading of a long-term option on an exchange results in improved stock price efficiency by reducing the wedge in costs between trade on long- and short- term information. The wedge, which results from credit constraints on the informed trader, declines because the introduction of a long-term option reduces the cost of trade on long-term information by reducing the importance of the credit constraint. A reduction in the cost wedge leads to a shift of informed trade away from short-term information and towards long-term information. The shift results in increased price efficiency on long-term information. The increased stock price efficiency, by reducing potential mispricing, increases the manager's willingness to invest in projects with long-term cash flows.

The theory makes a standard assumption (like that made in signaling models) that the manager has an asymmetric concern with respect to mis-pricing of his firm's stock. The manager's asymmetric concern results from the fact that the cost to the manager of under-pricing is larger than the benefit that he realizes from over-pricing of the same magnitude. Therefore, the manager under-invests in projects with long-term cash flows to avoid underpricing of equal magnitude.

2. LEAPS trade

Prior to the initial exchange listing of options at the Chicago Board Options Exchange (CBOE) in 1973, options traded in the Over-the-Counter market. Seventeen years later, in 1990, the CBOE introduced long-term options on individual stocks, these long-term options were referred to as Long Term Equity Appreciation Securities, or LEAPS. They are American-style, standardized, exchange-listed options on individual stocks. They are similar in every way to short-term options with the exception of their maximum time to maturity (39 months) which may be up to four times greater than the maximum for an ordinary exchange-listed option. At the time that these contracts began to trade, the CBOE claimed that their introduction would result in lower trade costs because of the leverage that LEAPS offer and suggested that LEAPS would appeal to investors with longer horizons[1]. To date, LEAPS have only been introduced on firms upon which exchange-listed options were currently trading. Since LEAPS were first introduced, the number of stocks and American Depository Receipts (ADRs) upon which LEAPS trade had increased to at least 248 by January, 1998.

While it has always been possible to buy customized, long-term options on individual stocks prior to the introduction of LEAPS, the trading of these standardized exchange-listed contracts should be less costly than trading a similar, private contract. By reducing the private costs of informed trade on long-term information LEAPS, via the leverage and transaction cost savings they offer have positive externalities realized at the firm level. They result in an increase in investment in long-term projects. For LEAPS to increase the efficiency of stock price of firms with long-term cash flows, they need only reduce the trade cost differential between short- and long-term information enough so that the informed trader can realize an increase in their profits by trading long-term information.

The introduction of LEAPS trade may be thought of largely as an exogenous shock. Kim and Young (1991) note that the decision to introduce an option or LEAPS on the exchange is not made by the manager of the firm on which the option trades. Therefore the introduction of option trade is not the result of a firm attempting to 'signal' to the financial markets. Furthermore, Jennings and Starks (1986) note that the introduction of option trade is not random, but rather the decision to introduce ordinary option trade depends upon investor interest, stock trading activity and stock price volatility. Because the data used in the decision to introduce option trade is publicly available, it is not surprising that Kim and Young (1991) as well as Holland and Wingender (1997) did not find any abnormal announcement return to ordinary option and LEAPS introductions, respectively.

While long-term options can be replicated with a complex combination of stock options and money-market securities, Choie and Novomestky (1989) found that such

[1] The Financial Times, September 12, 1990, p.31.

replication is costly. This finding is inconsistent with the Black and Scholes (1973) assertion that options are redundant securities. The introduction of long-term options may have a real effect on the market by increasing the state space of payoffs available to the investor.

Subsequent to the introduction of ordinary exchange-listed options, these listings were criticized by some for changing the distributional properties of the price of the underlying, calling the efficiency of such listings into question. The Whiteside, Dukes and Dunne (1983) and the Hayes and Tennenbaum (1979) evidence on the impact of ordinary option introduction on trading volume in the underlying is mixed. While the Klemkosky and Mann (1980) empirical evidence is inconsistent with the hypothesis that option listings impact stock price volatility.

In summary, the literature suggests that the introduction of an option can be treated as an exogenous shock, reduces the cost of informed trade and increases the incentive to collect information. It also suggests that long-term options are costly to replicate.

The introduction of LEAPs, by increasing stock price efficiency, combined with the manager's preference to avoid under-pricing, should result in an increase in corporate investment in projects with long-term cash flows.

H1: The firm's investment in projects with long-term cash flows increases when LEAPS are introduced on the firm's stock.

3. Empirical Specification

Following the initial introduction of LEAPS trade on a limited number of stocks in 1990, LEAPS were introduced on additional stocks in the years that followed. A sample of firms upon which LEAPS were introduced is collected and referred to as the "Introduction Sample". The change in the firm's annual long-term investment is examined around the year in which LEAPs trade was introduced.

Research and Development expense is used as the empirical proxy for investment in projects with long-term cash flows for three reasons. First, the use of Research and Development expense to measure the firm's annual investment in projects with long term cash flows is explicitly suggested by leading theoretical work on corporate long-term investment: Stein (1989), Noe and Rebello (1997) and Bebchuk and Stole (1993). Second, the use of Research and development expenses to examine corporate investment in projects with long term cash flows follows the empirical work of Meulbrock et al. (1990), Knoeber (1986), Bushee (1998) and Dechow and Sloan (1992). Third, because the time lag between the investment decision and the associated returns may be non-trivial for Research and Development expenditures, the long-term nature of R&D investment makes it a good proxy for investment in projects with long-term cash flows.

The percentage change in the firm's annual R&D/Sales in the years surrounding the introduction of LEAPS trade proxies for the change in investment in projects with long term cash flows. R&D is divided by sales to control for size effects, R&D/Sales is referred to as the "R&D Intensity" in what follows. The hypothesis, **H1**, that R&D intensity increases after LEAPS trade is introduced on the firm is tested using a one-tailed T-test. The one-tailed nature of the test follows from the predicted positive sign on the change in R&D intensity. To hold market effects constant, the tests are repeated using the market-adjusted percentage change in R&D intensity. The market-adjusted change is calculated using the method employed by Meulbrock et al. (1990) in the examination of the percentage change in R&D/Sales surrounding the board's passage of a shark repellant. For each year, the market change in R&D intensity is computed using data from only those firms on COMPUSTAT which report annual R&D expenses in excess of $10,000 in that year. The market change is calculated by computing the year-to-year change in the ratio of the sum of the annual R&D expenses of the firms to the sales of the same firms. The annual percentage change in this ratio is the annual market-adjustment.

The year in which the LEAP is introduced is referred to as year zero. A (-1,1) window is used to measure the change in intensity from one year prior to the introduction to the year following the introduction to examine the percentage change in R&D intensity. As firms may be slow to adjust R&D intensity in response to an introduction, two alternative windows are also used to measure the percentage change around year 0. Therefore, a (-1,2) window and a (-1,3) window, each measuring the change in R&D intensity from the year preceding the introduction to the second and third years following the introduction, respectively, are also used to measure the change in R&D intensity.

4. Sample and Descriptive Statistics

The sample of LEAPS introductions is drawn from the period that begins with the first introduction of LEAPS in October 1990 and ends in December 1997. The sample period ends in 1997 to allow for the examination of the change in R&D/Sales in the subsequent years. Using a listing of LEAPS obtained from the Chicago Board

Options Exchange, dated January 27, 1998, the introduction date is located on either Lexus-Nexus or Dow Jones Interactive.

Table 1 presents the distribution of firms over two-digit Standard Industrial Code industries in 1997. The table includes the ranking of industries by median R&D/Sales. The intensity of R&D varies widely by industry and R&D/Sales appears to be related to the choice of firm upon which LEAPS are introduced. This is evidenced by the fact that only 18 percent of the 7116 firms operate in a two-digit industry in which industry-average R&D intensity exceeds 3 percent. However, of the 74 observations in my sample, 36 percent operate in industries in which the average R&D intensity exceeds 3 percent. Given that LEAPs have been introduced on a firm, the probability that the firm operates in an industry in which the R&D intensity exceeds 3 percent is twice the unconditional probability.

The analysis excludes firms that report no R&D expenditures in the sample period. Table 1 suggests that the introduction of LEAPS is concentrated in three industries: 18 in Chemicals and Allied Products (SIC 28), 13 in Electronics and Other Equipment (SIC 36) and 12 in Industrial Machines and Equipment (SIC 35). A total of 43 of the 74 sample observations are from these three industries.

Table 2, Panel A presents the sample. Of the 248 LEAPS introductions over this period, there is sufficient data to test 74 of the introductions. Data losses include 8 introductions on ADRs. As R&D data is not available on ADRs, they are excluded from the sample. Contacts at the exchanges and efforts to find introduction dates in Lexus-Nexus and Dow Jones Interactive produced introduction dates for 74 LEAPS. The balance of the data losses were due to either missing Compustat data or to firms which report no R&D expenses. Panel B of Table 2 presents the distribution of introductions over time. The distribution of LEAPS introductions is: 9 in 1990, 4 in 1991, 10 in 1992, 14 in 1993, 0 in 1994, 12 in 1995, 10 in 1996 and 15 in 1997. Panel B also displays the annual percentage change in market R&D/Sales in each year. During the time period examined here, the annual percentage change in market R&D/Sales is volatile and increases from –0.07 percent, in 1990, to 6.41 percent in 1997.

The introduction sample median volume far exceeds the market median volume that increases from 4.44 million to 13.45 million over the same period. The introduction sample median volume climbs from 146 to 640 million over the 1990 to 1997 period. Panel C of Table 2 displays the descriptive statistics for year 0 for the LEAPS sample. Because the sample statistics are positively skewed, the discussion focuses on medians rather than means as a measure of central tendency. The firms in the sample may be characterized as large, profitable and research-intensive firms with high-market-to book and with heavy share trade volume. Median sales are $5.7 billion, market equity $7.0 billion, and $169.5 million of earnings before extraordinary items and taxes. The sample firms spend a median $180.7 million annually, or 3.17% of median sales on R&D and have a Market-to-book of 3.37 with 240 million shares traded annually.

5. Hypothesis Testing Results

I examine the average percentage change in R&D/Sales over three windows surrounding year 0. The three windows are denoted as (-1,1), (-1,2) and (-1,3). The (-1,1) window measures the percentage change in the firm's annual R&D/Sales from the year prior to the introduction to the year immediately subsequent to the introduction.

The first row of Table 3 presents the mean percentage changes across all sample firms for each of the three windows. The Costly Trade hypothesis predicts that the change in annual R&D/Sales around the introduction of LEAPS will be positive. The one-tailed p-values referenced in what follows are for the test of the hypothesis that the percentage change in R&D/Sales is equal to zero. The unadjusted percentage change in R&D/Sales is statistically different from zero at traditional levels of significance for only one of the three windows. R&D/Sales increases 1.45 percent (p-value <0.35) in the (-1,1) window, 13.56 percent (p-value <0.08) in the (-1,2) window and 4.34 percent (p-value < 0.30) in the (-1,3) window. The unadjusted results are weakly consistent with the Costly Trade theory.

The unadjusted results presented above indicate that the increase in R&D/Sales persists for the two years subsequent to the introduction before falling in the third year, as unadjusted R&D intensity appears to decrease from year 2 to year 3, (from 13.56% to 4.34%). However, the reason for this seeming decline is that the unadjusted results do not control for the low market-wide increase in R&D intensity during the years subsequent to the year in which the largest number of introductions occurred in the sample. The second largest number of introductions occurred in 1993, and two of the three subsequent years to 1993 saw the lowest market-wide changes in R&D intensity of all years subsequent to any of the introductions in the sample. In fact, Table 2, Panel B column (1) indicates that the market-wide year-to-year change in R&D/Sales does not appear to be constant over time, ranging from a low of -0.07% to a high of 6.41%. As a result, the decline in R&D intensity from (-1,2) to (-1,3) is that the change in unadjusted R&D intensity does not control for the market-wide annual change in intensity.

Therefore, while the R&D intensity seems to decrease from year 2 to year 3, after controlling for the market-wide change it actually increases.

The test is repeated holding constant the annual market-wide change in R&D/Sales. The second row presents the market-adjusted percentage change in R&D/Sales. The efficiency of the tests increases when we control for variation in R&D/sales which is unrelated to the introduction, by controlling for market-wide changes in R&D/sales. On average, the LEAPS sample firms significantly increase their R&D/Sales relative to the marketwide change. Market-adjusted R&D/Sales increases 5.49 percent (p-value <0.01) in the (-1,1) window, 8.18 percent (p-value <0.01) in the (-1,2) window and 9.56 percent (p-value <0.01) in the (-1,3) window. Results are consistent with the Costly Trade hypothesis ***H1***.

R&D/Sales intensity increases in each window (-1,1), (-1,2) and (-1,3), 5.49%, 8.18% and 9.56% respectively. The market-adjusted results are highly significant, the control for the market-wide change is important. The results imply that R&D/Sales increase 5.49% in the first year subsequent to the introduction and then 2.69% and 1.38% in the two following years, respectively. Therefore, the cumulative change over the three years subsequent to the introduction is years 1, 2 and 3 in excess of 9%. T-tests of the year-to-year and the cumulative market-adjusted percentage change in R&D/Sales are presented in Table 4, and appear in Figure 1. Results are for the nine years proceeding the introduction year through the seven years which followed, due to data availability. Generally, the year-to-year changes are trivial in the early years and don't become positive and significant at traditional levels until two years after the introduction. The cumulative market-adjusted percentage change results are similar. To further examine the change in R&D/Sales around these introductions, I examine the relationship between share volume and the change in R&D/Sales. If the level of mis-pricing of the firm's shares varies systematically with volume, the impact of the introduction may be different for low and high share volume firms. Firms which suffer proportionally more under-pricing as a result of a low level of informed trade would benefit the most from an increase in stock price efficiency with respect to long-term information, and experience the largest increase in R&D as a result if the share volume is correlated with the level of informed trading. The percent change in R&D intensity is examined by the level of volume.

Panel B of Table 2 suggests that share volume increases dramatically over the sample period for both the market and the Introduction sample, making necessary a control for the drift in share volume. To control for the difference in volume across years, first share volume is standardized by dividing the firm's annual volume in year 0 by the LEAPS sample median share volume in that year. The standardized volumes are pooled and volume quartile values calculated. Each firm in the introduction sample is assigned to the appropriate standardized volume quartile. The percentage change in R&D/Sales is calculated for each of the windows. No discernable pattern is apparent, the results are not presented.

To examine whether the change in R&D varies by the firm's prior level of R&D, the samples is partitioned into quartiles based on the level of R&D/Sales in the firm's introduction year. The first, second, and third quartile values for R&D/sales in the introduction year, are 2.8%, 6.6% and 11.2%. Results appear in Table 5. The market- adjusted change in R&D/Sales does not seem to vary systematically by the level of R&D/Sales. For example, the change ranges in magnitude from 4.85% to 5.96% for the (-1,1) period. The results for the (-1,2) period range from 7.79% to 8.59% and for the (-1,3) period range from 8.50% to 9.72%. These results do not imply a relationship between the change in long-term investment and the prior level of R&D.

6. Conclusion

Shliefer and Vishny develop a model in which the combination of mispricing of the shares of a firm which invest in projects with long-term cash flows combined with the firm's manager's desire to avoid under-pricing of the firm's current stock price result in under-investment in projects with long-term cash flows. By reducing the cost of trade on long-term information, the introduction of exchange-trading of a long-term stock option on the firm should result in less mis-pricing of long-term information and a corresponding increase of corporate investment in projects with long-term cash flows. This paper tests the hypothesis that corporate investment in projects with long-term cash flows increases around the introduction of trade on a long-term stock option. The results of this paper are consistent with the hypothesis that the firm increases investment in projects with long-term cash flows when a long-term stock option is introduced on the firm.

The market-wide R&D/Sales change varies from year-to-year, and is an important source of variation in the change in R&D/Sales. After controlling for market-wide year effects, the results are highly significant and indicate that R&D/Sales increases as much as 9.6% in the three years subsequent to the introduction of a long-term stock option. This implies that capital market imperfections may play a significant role in deterring firms from pursuing projects with long term cash flows. This highlights the importance of the costs of collecting and trading on long-term information, and suggests that the level of information problems in capital markets have a deterrent effect on long-term investment.

The results here suggest that understanding the positive externalities associated with the introduction of option trade is crucial to identifying all of the important costs and benefits of option trade. The positive impact of the introduction of these derivatives includes their effect on firm investment behavior. While the trade of options improves the choice set of payoffs available to the investor, it also reduces barriers to long-term investment at the firm level. The benefit of the reduction in barriers to long-term investment is not fully captured by the exchange that introduces the option but by the firm's shareholders and stakeholders throughout the economy. This implies a role for public policy in managing the level of economy-wide private, long-term investment.

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Table 1: Distribution of Long-term Option Introductions across Industries
R&D/Sales is ratio of the sum of the annual R&D expenses of those firms reporting annual R&D in excess of $10,000 by the sum of annual sales for the same firms. Number of firms in industry is the number of firms operating in the industry defined by the two digits SIC code. Number of firms in LEAPS sample is the number of firms in the sample of LEAPS introductions, which operate in the industry. Data is for 1997.

SIC Code	R&D/ Sales (%)	Number of Firms In Industry	Number of Firms in LEAPS Sample
28	8.55	381	18
73	5.53	418	5
38	10.53	386	4
36	0.90	370	13
62	4.56	5	0
35	0.88	379	12
87	24.16	50	0
48	0.05	24	2
64	1.41	5	0
22	0.24	12	0
82	5.70	1	0
49	4.30	10	0
39	0.59	42	1
60	5.37	1	0
37	0.01	90	0
30	0.62	42	0
13	0.06	20	3
32	0.22	26	1
14	0.11	5	0
78	0.70	11	0
10	0.50	4	0
25	0.06	15	0
27	3.56	13	0
34	0.09	40	0
20	0.07	34	3
33	0.07	37	1
26	0.47	31	0
8	0.27	1	0
7	1.00	1	0
15	1.90	1	0
29	0.10	21	3
21	0.00	3	0
24	0.04	8	6
17	0.54	3	0
63	0.00	3	0
16	0.03	2	0
Others			4
Total		7116	74

Table 2: Descriptive Statistics

Panel A: LEAPS Introduction Sample

LEAPS introductions 1990-1997	248
Less: ADR LEAPS Introductions	8
Less: Introduction date not available	76
Less: Missing balance-sheet data or no R&D expense reported on Compustat	90
Introduction Sample Size	74

Panel B: Distribution of Observations over time

Market percentage change in R&D/Sales is calculated by dividing the year-to-year change in the ratio of the sum of the annual R&D expenses of those firms reporting annual R&D in excess of $10,000 by the sum of the annual sales of the same firms. Annual introductions for the LEAPS sample is the annual number of LEAPS introductions. Sample R&D/Sales is the sum of research and development expense divided by the sum of annual sales for firms for which LEAPS were introduced in that year. Median volume is the median annual common stock share trade volume. Observations in Introduction Sample are the number of observations on share volume available on the introduction sample.

			Median Share Trade Volume		
Year	Market % change in R&D/Sales	Sample Annual Introductions	Market	Introduction Sample	Observations on Introduction Sample
	(1)	(2)	(3)	(4)	(5)
1990	-0.07	9	4.44	146	49
1991	5.84	4	6.30	165	50
1992	3.33	10	7.84	184	53
1993	2.80	14	8.35	239	54
1994	1.14	0	8.05	275	54
1995	2.56	12	10.44	388	59
1996	1.79	10	12.52	505	63
1997	6.41	15	13.45	640	55

Table 2 [continued]

Panel C: Market Values and Volume, Balance Sheet and Market-to-Book ratio
Sample statistics are for the introduction year (year 0) for the 74 sample firms on which Long-term Equity Appreciation Securities (LEAPS) were introduced during the 1990-1997 period. R&D is the firm's annual Research and Development expense, and sales are annual sales dollars. R&D/Sales is the firm's R&D divided by sales. Annual share volume is the annual common stock trade volume in millions. EBET is earnings before extraordinary items and taxes. Market value equity is market value of common stock at year-end. Market-to-book is the ratio of the market value of common stock to book value of common stock. All values, with the exception of the change in R&D are for the year immediately prior to the introduction of LEAPS securities on the firm's equity. SD is the standard deviation, IQR is the inter-quartile range. All values are cross-sectional sample statistics. R&D, Sales, Assets, EBET and Market Value Equity are in millions of dollars. Share Volume is in millions of common shares traded annually.

Variables	Mean	SD	Median	IQR
R&D	587.4	1000.6	180.7	675.3
Sales	13070.1	23546.4	5701.5	12513.4
R&D/sales	0.1165	0.1772	0.0707	0.0970
Annual Share Trade Volume	305.7	268.8	239.6	250.0
EBET	539.3	1195.2	169.5	714.7
Market Value Equity	12933.5	15891.7	6978.9	17884.8
Market-to-book	5.20	4.80	3.37	4.48

Table 3: Percentage Change In Firm-Level R&D/Sales Around The Introduction of Exchange Trading Of A Long-Term Option

Percentage change in annual R&D/Sales around the year of the introduction of LEAPS trade. Three windows are used to examine the change in the annual ratio around the year in which the LEAPS were introduced, the year 0. The (-1,1) window measures the change in the ratio from one year prior to introduction to the year following the introduction. The (-1,2) and (-1,3) windows measure the change from the proceeding year to the second and third years following the introduction, respectively. The number of firms is the number of firms in the Introduction sample for which data was available to calculate the percentage change. The market-adjusted change is the percentage change in firm R&D/Sales less the market-wide percentage change in R&D/Sales in that year. One-tailed p-values for the test of the hypothesis that the percentage change is equal to zero appear in parentheses.

	Window		
	(-1,1)	(-1,2)	(-1,3)
Percentage Change unadjusted	1.45 (0.35)	13.56 (0.08)	4.34 (0.30)
Number of firms	59	49	37
Market-adjusted percentage change	5.49 (0.00)	8.18 (0.00)	9.56 (0.00)
Number of firms	60	49	38

Table 4: Market-Adjusted Percentage Change In The Firm's Research And Development Expenses Around The Introduction of Exchange Trading of A Long-Term Options for the Introduction Sample.

The market-adjusted change is the percentage change in firm R&D/Sales less the market-wide percentage change in R&D/Sales in that year. Results have been pooled across firm-year. Year refers to the year number, where year zero is the year in which the LEAPs trade was introduced on the firm. Average is the average annual change in the market-adjusted R&D/Sales for the sample. T-$stat_{ann}$ is the t-statistic for the test of the hypothesis that the annual change in R&D/Sales is equal to zero. Cumulative is the cumulative change in market adjusted R&D/Sales since year –9. T-Stat is the t-statistic for the test of the hypothesis that the change in R&D/Sales is equal to zero. Annual Obs is the number of firms in the introduction sample for which data was available to calculate the percentage change.

Year	Average	t-$stat_{annual}$	Cumulative	t-$stat_{cumulative}$	Annual Obs
-9	-2.27	-1.76	-2.28	-5.28	9
-8	-0.51	-0.27	-2.79	-4.57	16
-7	-0.25	-0.10	-3.04	-4.07	24
-6	2.31	0.79	-0.73	-0.84	26
-5	0.98	0.29	0.26	0.27	40
-4	1.86	0.71	2.12	2.01	52
-3	1.03	0.59	3.16	2.77	60
-2	1.81	0.66	4.98	4.08	74
-1	2.45	1.42	7.43	5.74	77
0	3.07	1.38	10.50	7.70	76
1	3.31	1.58	13.82	10.14	60
2	3.27	1.86	17.10	11.96	49
3	2.17	3.82	19.27	12.90	38
4	3.30	1.40	22.58	14.52	37
5	3.97	1.94	26.55	16.46	25
6	2.77	1.41	29.33	17.57	14
7	6.41	0.00	35.74	20.73	11

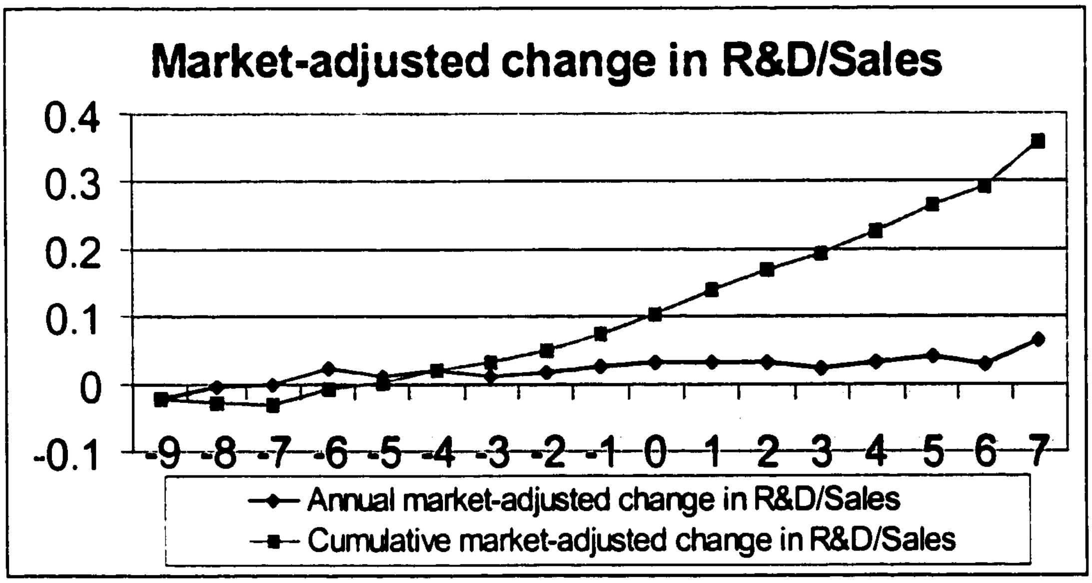
Table 5: Percentage Change In Firm-Level R&D/Sales Around The Introduction Of Exchange Trade Of A Long-Term Option – Partitioned On The Prior level of Firm R&D/Sales.

The market-adjusted change is the percentage change in firm R&D/Sales less the market-wide percentage change in R&D/Sales in that year. Results have been pooled across firm-year. Year refers to the year number, where year zero is the year in which the LEAPs trade was introduced on the firm. Average is the average annual change in the market-adjusted R&D/Sales for the sample. $T\text{-stat}_{ann}$ is the t-statistic for the test of the hypothesis that the annual change in R&D/Sales is equal to zero. Cumulative is the cumulative change in market adjusted R&D/Sales since year –9. T-Stat is the t-statistic for the test of the hypothesis that the change in R&D/Sales is equal to zero. Obs is the number of firms in the introduction sample for which data was available to calculate the percentage change. The lowest R&D/Sales quartile firms had R&D/Sales less than 2.8%, the median quartile was 6.6% and the highest quartile values exceeded 11.2%.

R&D/Sales Level Quartile	Market Adjusted Change					
	Window					
	(-1,1)		(-1,2)		(-1,3)	
	Mean	P-Value	Mean	P-Value	Mean	P-value
Lowest	5.49	(0.01)	7.87	(0.01)	9.68	(0.01)
Q2	5.62	(0.01)	8.59	(0.01)	9.55	(0.01)
Q3	4.85	(0.01)	7.79	(0.01)	9.72	(0.01)
Highest	5.96	(0.01)	8.46	(0.01)	8.50	(0.01)

Figure 1: Market-adjusted percentage change in R&D/Sales

The market-adjusted change is the percentage change in firm R&D/Sales less the market-wide percentage change in R&D/Sales in that year. Results have been pooled across firm-year. Year refers to the year number, where year zero is the year in which the LEAPs trade was introduced on the firm. Cumulative is the cumulative change in market adjusted R&D/Sales since year -9.



VITA

Leonard L. Lundstrum

College of Management
North Carolina State University
Raleigh, NC 27695

EDUCATION:

B.S. Finance and Accounting Northern Illinois University, 1989

M.S. Finance University of Illinois at Urbana-Champaign, 1994

ACADEMIC APPOINTMENT:

College of Management, 1999 to present
North Carolina State University
Assistant Professor of Finance