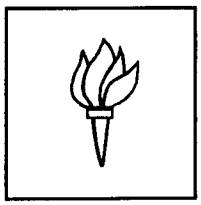

NEW YORK UNIVERSITY
STERN SCHOOL OF BUSINESS
FINANCE DEPARTMENT

Working Paper Series, 1994

Investor Valuation of the Abandonment Option

Philip G. Berger, Eli Ofek, and Itzhak Swary

FD-94-14

Investor Valuation of the Abandonment Option

Philip G. Berger[1]
Wharton School
University of Pennsylvania
2433 SH-DH
Philadelphia, PA 19104-6365
(215) 898-7125

Eli Ofek
Stern School of Business
New York University
40 West Fourth Street, #908
New York, NY 10003
(212) 998-0356

Itzhak Swary
Tel Aviv University
Faculty of Management
Ramat Aviv, Israel 69978
(972) 3-413-979

January, 1995

[1]Berger acknowledges the financial support of Coopers & Lybrand. We appreciate helpful comments from Andrew Alford, Jacob Boudoukh, Paul Fischer, Kose John, Anthony Lynch, Josh Ronen, Robert Whitelaw, and workshop participants at University of Pennsylvania. We gratefully acknowledge the contribution of I/B/E/S Inc. for providing earnings per share forecast data, available through the Institutional Brokers Estimate System.

ABSTRACT

We investigate whether investors price the real option to abandon the firm for its liquidation value. Theory prices this real option as an American put with both a stochastic strike price (liquidation value) and a stochastic value of the underlying security (the value of cash flows). The major empirical implications are that firm value increases in liquidation value, after controlling for expected going-concern cash flows, and that more generalizable assets produce more abandonment option value. We use both discounted analysts' forecasts of future earnings and industry-median cash flow multipliers to proxy for expected going-concern cash flows, and we rely on prior literature to categorize assets as more or less specialized. Using these measures, we find strong support for the major empirical predictions of abandonment put option theory.

1. Introduction

We investigate whether investors use information about the liquidation prices of the firm's assets to value their option to abandon the continuing business in exchange for the assets' liquidation value. As uncertainty about future cash flows is resolved, investors may wish to exercise their option to abandon the firm for its liquidation value. This abandonment option is like owning an insurance policy that pays off if the firm performs below expectations. The option thus has value, and information about the liquidation value of the firm's assets should affect its market value.

One area our study contributes to is the real options literature. This body of research recognizes that investment decisions often involve choices about a variety of control opportunities, such as when to invest (McDonald and Siegel (1986), Majd and Pindyck (1987), Lee (1988), and Pindyck (1988)), how to modify operating plans during a project's life (Stulz (1982), Johnson (1987), Kensinger (1988), and Triantis and Hodder (1990)), and whether to abandon an investment in midstream (Robichek and Van Horne (1967), Bonini (1977), Kensinger (1980), and Myers and Majd (1990)). Despite the theoretical development of real option-pricing models for these and other embedded options, almost no research has examined the models' empirical implications. Two exeptions are Paddock, Siegel, and Smith (1988), and Quigg (1993), which both examine the effect of the option to wait on the price of a specific capital investment (offshore oil leases or land). In contrast, our paper tests empirical implications of abandonment option-pricing models on the price of the entire firm.

Our paper also contributes to the large body of accounting research that aims to identify value-relevant accounting attributes in order to enhance our understanding of, and suggest possible improvements to, financial statement analysis. Most of this research has explored the relation between income statement disclosures and stock prices. Relatively little evidence exists, however, on the role played by the balance sheet in assessing firm value. Foster (1986,

p.446) states that "one area of equity valuation where important unresolved questions exist is the link between the level of equity security prices and the values of the individual assets and liabilities owned or controlled by the firm." Recently, a number of theoretical and empirical papers have addressed the valuation effects of balance sheet items. Most of these papers examine the potential for balance sheet disclosures to provide incremental information about the expected level of future cash flows (see, for example, Ohlson (1991), and Penman (1992)). Our examination of the abandonment option's effect on firm value differs from these papers by assessing the extent to which balance sheet information affects firm value **given** the level of expected cash flows.

The abandonment option is equivalent to an "American" put option on a dividend-paying stock. Our analysis of this option leads to predictions about how liquidation value affects firm value. All else equal, the abandonment option results in firms with a greater liquidation value being worth more to investors. We therefore predict that market value is positively related to liquidation value, **after** the relation of market value to the present value of expected cash flows (PVCF) is controlled for.

Liquidation values for going concerns are generally unobservable. Moreover, we are interested in the association between balance sheet information and the abandonment option's value. Therefore, we estimate the relation between book value and liquidation value for major asset classes by using the discontinued operations footnotes of 157 firms with sufficiently detailed information. We find that a dollar's book value produces, on average, 72 cents of liquidation value for receivables, 55 cents for inventory, and 54 cents for fixed assets. Applying these estimates to the balance sheet disclosures of each firm in the full sample provides us with estimated liquidation values.

We use discounted analysts' forecasts of future earnings and industry-median cash flow as proxies for PVCF. Kaplan and Ruback (1995) find that, for a sample of 52 highly levered

transactions, firm value estimates based on discounted cash flow forecasts consistently outperform those based on industry-median cash flow multipliers. Our main tests are based on the analyst forecast proxy, with the cash flow multiplier proxy providing a robustness check on our results.

We find a positive and highly significant relation between market value and estimated liquidation value after controlling for PVCF using either the analyst forecast proxy or the cash flow multiplier proxy. In addition, the strong, positive relation between estimated liquidation value and market value holds across each year in the 1984-1990 sample period and after controlling for factors that affect market value and that may not be completely captured by the PVCF proxies.

Option pricing theory suggests that the abandonment option's value is increased more by less specialized assets, because their value is less correlated with PVCF. Thus, if PVCF becomes disappointing, the value of the firm's generalizable assets will not decline as much as the value of its specialized assets will. This implication of option pricing is consistent with previous arguments about the effect of asset specialization on liquidation values (see, for example, Ronen and Sorter (1973), Williamson (1988), and Shleifer and Vishny (1992)). We follow previous literature in classifying current assets as less specialized than fixed assets, non-inventory current assets as less specialized than inventory, and land as less specialized than other fixed assets. We examine whether a dollar of book value enhances firm market value by more if the asset is less specialized. The results support the prediction that less specialized assets produce more abandonment option value. We find that a dollar's book value of current assets adds more market value than a dollar's book value of fixed assets. Noninventory current assets create more value than inventory and land enhances the option's value more than other fixed assets.

Finally, the probability of the abandonment option being exercised may be a function of

variables other than PVCF and liquidation value, such as the probability of financial distress and the level of agency problems between the firm's investors (who hold the abandonment option) and its managers (who control the option's exercise). For given levels of PVCF and liquidation value, market value will be more sensitive to variation in liquidation value when the probability of the option being exercised is higher. Consistent with this prediction, we find that firms with financial distress probabilities in the bottom quartile of the population (as measured by Altman's (1968) Z-score) have market values that are more sensitive to variation in estimated liquidation values. Similarly, we find that an increase in estimated liquidation value enhances market value by more in firms that are about to liquidate substantial portions of their assets. Assuming that investors ex-ante identify the managers of such firms as having a low probability of delaying liquidation past the time that is optimal for investors, this result is consistent with agency problems affecting the value that investors attach to the abandonment put option.

Section 2 describes abandonment put option theory and develops our predictions. Section 3 describes the estimation of liquidation values, discusses the advantages and disadvantages of the two PVCF measures, and presents the sample selection and description. Section 4 describes the empirical tests and results, and section 5 provides our summary and conclusions. The appendix presents additional details on our empirical approach and variable construction.

2. Theory and Predictions

In the capital budgeting literature, the abandonment option has been discussed for over 25 years.[1] Robichek and VanHorne (1967) include it as a contingency in the forecast of cash flows used for calculating the net present value or internal rate of return of an investment project.

[1]The option to liquidate has recently received attention in the accounting literature as well. Burgstahler and Dichev (1994) and Hayn (1994) address how the likelihood of liquidations or other redeployments of firm assets may affect the relation between accounting numbers and firm value.

Their contingency approach (as corrected by Dyl and Long (1969)) does not, however, provide a practical procedure for calculating the abandonment option's value, motivating attempts to model the option's value directly. Kensinger (1980) does this, but his analysis assumes the option is "European" and has a nonstochastic exercise price. Myers and Majd (1990) improve on Kensinger's approach by recognizing that the abandonment option is equivalent to a complex "American" put with both an uncertain underlying stock value (the cash flows) and an uncertain exercise price (the liquidation value).

Beginning with the intuition provided by Myers and Majd, we develop our hypotheses on the relation between firm value and the firm characteristics that determine the abandonment option's value. The hypotheses are explained with reference to the following equations:

$$\text{VALUE} = \text{PVCF} + \text{P}\ (\ \text{PVCF, SALVAGE, SDEV}) \tag{1}$$

$$(\frac{\text{VALUE}}{\text{PVCF}} - 1) = \text{P}\ (\ 1, \frac{\text{SALVAGE}}{\text{PVCF}}, \text{SDEV}) \tag{2}$$

where:

VALUE	=	the firm's market value
PVCF	=	the present value of the firm's expected operating cash flows
P	=	an operator representing an American put option
SALVAGE	=	the liquidation value of the firm's assets
SDEV	=	the standard deviation of the ratio of PVCF over SALVAGE

Equation ?? shows that the firm's market value equals the sum of the value of its expected operating cash flows plus the value of the abandonment option. Note that the abandonment option need not represent liquidation of the entire firm. The option to liquidate subsets of the firm's assets, such as lines of business, is also of value to investors.[2] When we divide each term of equation ?? by PVCF and rearrange terms in equation ??, the result is an expression of **excess firm value** (the percentage by which firm value exceeds PVCF) as

[2]The additive form of equation ?? is strictly appropriate only when the abandonment option involves the choice of liquidating the entire firm. With partial liquidations, proceeds may be reinvested in the firm to produce operating cash flow, creating an interaction between PVCF and the put's value.

a function of the abandonment put option. We present the relation in this form because it both facilitates hypothesis development and corresponds to the functional form used to conduct the empirical tests. As Myers and Majd point out, a general specification of the abandonment option does not allow a closed-form solution. The empirical tests therefore address only the relations suggested by equation ??, rather than an exact functional form.

The value of the option is a function of the ratio of SALVAGE to PVCF, which we call **excess liquidation value**. Equation ?? shows that excess liquidation value may be viewed as the stochastic strike price of a put option with a normalized value of one on its underlying stock. Thus, when excess liquidation value equals one (i.e., liquidation value equals the value of expected cash flows), the abandonment option is at the money. As the liquidation value increases, the option moves further into the money, while as the value of expected cash flow increases, the option moves further out of the money. Thus, excess liquidation value, because it is positively related to the abandonment option's value, is positively related to excess firm value.

Abandonment option theory gives rise to the prediction that, for a given current value of assets, more abandonment option value is created when the assets are less specialized. Ronen and Sorter (1973) and Williamson (1988) argue that, when the firm's cash flows become disappointing, redeployable assets can be liquidated for relatively high values. Shleifer and Vishny (1992) contend that the reason specialized assets are more likely to drop in value is because, when the seller's cash flows are disappointing, potential buyers are themselves likely to be experiencing problems.

Myers and Majd (1990) use an example to clarify this point. Consider two firms that differ only in the nature of their assets: firm A's are standard and have an active secondary market, whereas firm B's are custom-built and have no secondary market. If both firms have the same PVCF and are certain to continue operating until their assets are completely

worn out, investors are indifferent between them. When the possibility arises that investors may sell the firm's assets if cash flows are disappointing, firm A is preferred to firm B because the higher exit value of firm A's assets provides greater risk protection. Stated in terms of equation ??, SDEV is higher for firm A because the correlation between PVCF and SALVAGE is lower for firm A's more generalizable assets. Since option pricing theory shows that the option's value is increasing in SDEV, more generalizable assets enhance the option's value by more.

This analysis implies that, given current asset value and PVCF, market value decreases with asset specialization. The current value of the firm's assets is unobservable, and we are interested in how investors use book values to price their abandonment option. We therefore test whether market value decreases with asset specialization after holding constant PVCF and *book value* of assets. The potential effects on our inferences of using book values to proxy current values are discussed with the empirical results. To categorize assets by degree of specialization, we follow Ronen and Sorter (1973) in classifying current assets as less specialized than fixed assets, non-inventory current assets as less specialized than inventory, and land as less specialized than other fixed assets. These classifications enjoy wide acceptance in both the literature on liquidation values and in financial accounting.[3]

Abandonment option theory shows that, for given levels of PVCF and liquidation value, market value is more sensitive to variation in liquidation value when the probability of the option being exercised is higher. We propose two factors that could affect investors' assessment of the probability of exercise: the likelihood of financial distress, and the level of agency problems between investors and managers. Financial distress can force liquidation of the firm. We therefore predict that firm's with higher financial distress probabilities have

[3]For example, Shleifer and Vishny (1992) note that whereas "commercial land can be used for many different purposes," fixed assets often "have no reasonable uses other than the one they are destined for." Moreover, financial accounting classifies cash, current marketable securities, and current accounts receivable as liquid assets, but excludes inventory, which is viewed as more illiquid (Stickney and Weil, 1994).

market values that are more sensitive to variation in estimated liquidation values.

Rational holders of American put options follow an optimal exercise policy if they control exercise of the option. Investors hold the abandonment put option, but they may be unable to effect exercise when they desire due to agency problems with the managers who control the abandonment decision. For example, Ofek (1993) finds results consistent with entrenched managers being more likely to avoid taking actions such as discontinuing operations when the firm becomes distressed. If variation in agency problems results in some managers being more likely to delay liquidation past the optimal time for investors, investors will value the option more highly when the probability of delayed exercise is lower. We therefore predict that, for a given excess liquidation value, firm value is more sensitive to variation in excess liquidation value when investors attach a higher probability to timely exercise of the option.

Our final predictions are for the bounds of the relation between excess liquidation value and excess firm value. If there is no probability that the abandonment option will be exercised, information about liquidation value has no effect on firm value and the slope of the relation is at its lower bound of zero. At the other extreme, when the abandonment option is certain to be exercised, an extra dollar of liquidation value increases firm value by one dollar.

3. Empirical Approach

3.1 Estimating Liquidation Values

We cannot observe the salvage value of a firm's assets, instead only the book value is observable. We therefore use firms with discontinued operations to estimate how many cents per dollar of book value each of three major asset classifications produces when liquidated. We then apply these estimates to all sample firms in order to construct the excess liquidation value variable.

We obtain the information about discontinued operations from the NAARS library of Lexis/Nexis using the search "discop w/seg (write-down or write-off)" for the years 1984-93, which produces 1,043 observations. The phrases write-down and write-off are used in an attempt to restrict the liquidations identified to cases in which the motive for sale is to abandon operations whose cash flows have become disappointing. Observations are retained if information is available on the discontinued segment's book value, its liquidation value, and the proportion of its book value in noninventory current assets, inventory, and fixed assets. In addition, the assets of the discontinued line of business must be sold to unrelated parties. These requirements result in a sample of 157 observations.

The regression we perform on this sample and the estimation results are as follows:

$$LIQBOOK_i = 0.715\ NONINV_i + 0.547\ INV_i + 0.535\ FIXED_i$$

t-values	(12.25)	(8.07)	(15.52)

Adjusted $R^2 = 85\%$

where:

$LIQBOOK_i$	=	the ratio of liquidation value to book value for firm i's discontinued operations
$NONINV_i$	=	the proportion of book value in noninventory current assets for firm i's discontinued operations
INV_i	=	the proportion of book value in inventory for firm i's discontinued operations
$FIXED_i$	=	the proportion of book value in fixed assets for firm i's discontinued operations

The regression is performed with no intercept because, by construction, the independent variables sum to one. The estimates show how many cents per dollar of book value each asset category produces in liquidation. Noninventory current assets are liquidated for 72 cents on the dollar, inventory for 55 cents, and fixed assets for 54 cents. Book value of equity is transformed into estimated liquidation value of equity as follows. For each sample firm, we

multiply each of the three components of book value (non-inventory current assets, inventory, and fixed assets) by the estimated liquidation value per dollar of book value, and subtract the book values of payables and long-term debt. Note that the cash and short-term marketable securities components within the non-inventory current assets category are multiplied by one rather than by 0.72. Book value of total assets is transformed into liquidation value of total assets using the same calculation, except that the book value of long-term debt is not subtracted.

3.2 Proxies for the Present Value of Cash Flows

The analyst forecast approach, detailed in the appendix, uses three components to proxy for the present value of after-interest cash flows. First, expected equity cash flows based on actual earnings forecasts are discounted and summed. These forecasts are available for at least two years for all sample firms. The second term projects expected equity cash flows for the period from the last forecast earnings through year five using the consensus forecast of five-year earnings growth, then discounts and sums these expected inflows. The third term calculates the present value of the perpetuity for the equity cash flows from year six forward by assuming a constant 4% nominal terminal growth rate applies for all observations.[4]

Using earnings forecasts to approximate after-interest cash flows creates the possibility that the present value of after-interest cash flows is systematically over- or underestimated. For example, in an inflationary environment in which the average firm is not shrinking in real terms, capital expenditures will exceed straight line depreciation. In this environment, the present value of earnings will exceed the present value of cash flows. To control for the measurement error in PVCF introduced by the fact that analysts are trying to predict

[4]Kaplan and Ruback (1995) calculate terminal values of management cash flow forecasts from 52 highly levered transactions made during 1983-1989 by assuming that the cash flow in the last year of the projections will grow at a constant nominal rate in perpetuity. They present results using nominal growth rates of 4%, 2%, and 0%, but state that they feel "the 4% rate is economically the most appropriate."

earnings rather than cash flows, we control in our regressions for the level of capital expenditures and for the level of capital expenditures minus depreciation. In addition, we assess the sensitivity of our results to the sample-wide shifts in estimated cash flow value which result from assuming 0%, 2%, or 6% terminal growth in place of the 4% rate used in the reported results, and find that none of our inferences are sensitive to the terminal growth rate used.[5] Finally, we examine whether the analyst approach produces results consistent with those of the cash flow multiplier approach.

The cash flow multiplier approach, detailed in the appendix, multiplies an industry-median capital-to-cash flow multiplier by the firm's cash flow. The product of this multiplication is the total value (i.e., PVCF + abandonment value) the firm would have if its cash flow were capitalized at the rate of the median firm in its industry (see Kaplan and Ruback (1995) and Berger and Ofek (1995) for applications of industry-median cash flow multipliers in imputing firm value). Therefore, while we use the multiplier method to approximate the firm's present value of before-interest cash flows, the resulting estimate also includes the abandonment option value that the **median** firm in the industry would have if its cash flow were equal to those of the firm in question. The multiplier-based tests still allow us to examine the effect of liquidation value on the abandonment option, however, because each firm has the median-based value of the abandonment option (rather than its own value) built into the before-interest cash flow estimate.

The before-interest cash flow is approximated using EBIT, which incorporates the effect of investment on cash flows by deducting depreciation. Investment's effect on cash flows is smoothed by deducting depreciation rather than actual investment spending. EBIT is thus preferred to EBITD, which does not incorporate investment, and to (EBITD − capital

[5] We also assess the sensitivity of the results to our use of a constant cross-sectional growth term from year six forward. We effectively average the firm-specific growth rate of years one to five with the 4% terminal growth rate for year six and after. We find that the reported results are insensitive to the time at which growth is assumed to reach a cross-sectionally constant terminal level.

expenditures), which contains more transitory shocks from unusual levels of capital spending.

Table 1 summarizes the complementarities of the two approaches. Because the analyst approach is based on after-interest earnings, it approximates the value to which the firm's equity holders are entitled. The assessment of the abandonment option under the analyst approach therefore examines how the net assets of the firm provide option value to the firm's equity investors. Under the multiplier approach, earnings are measured before interest, allowing examination of the relation between the liquidation value of the firm's gross assets and the firm's total capital.

The approaches also differ in their risk adjustments, growth estimates, and sensitivities to transitory shocks. The analyst approach discounts future cash flows using the expected return implied by the CAPM. The discount rate therefore reflects each firm's systematic risk, but does not incorporate industry risk factors omitted from the CAPM. In contrast, the industry-based cash flow multiplier approach controls for industry factors, but not for firm risk factors. Growth in future cash flows is estimated under the analyst approach by forecasts and an assumed terminal growth term, whereas the multiplier approach relies on the market's anticipated growth for the industry-median firm. Finally, transitory shocks will introduce measurement error with the multiplier approach, which capitalizes a single year's cash flow. Such shocks should not introduce measurement error under the analyst approach, which is based on multiyear forecasts. The optimism in analysts' forecasts, however, does introduce measurement error.[6]

3.3 Sample Selection and Description

For the analyst approach, we obtain data for firms covered by the Institutional Brokers Estimate System (IBES) that have forecasts of earnings for at least two years ahead and

[6]See, for example, Philbrick and Ricks (1991), Freeman and Tse (1992) and, for a summary of the evidence, Schipper (1991).

forecasts of five-year earnings growth. Each observation's first earnings forecast must be made at least six months before the firm's fiscal year-end. All available IBES observations with sales above $20 million, and available *Compustat* and CRSP data, are included in the sample. The minimum sales requirement is imposed to reduce the frequency of observations with only one analyst contributing to the consensus forecasts.

Panel A of table 2 provides descriptive information on the IBES sample. Because of skewness in the distributions, we emphasize medians. Rows two through four provide information on the magnitudes of each of the three components of PVCF (see the appendix for calculation details). For the median firm, 16% of the present value is due to the after-interest cash flows forecast by analysts (usually for years one and two), 21% is due to the cash flows projected from the time of the last analyst forecast through to year five, and 62% is due to the perpetuity calculated from year six forward. Excess equity value (see the appendix) is 12%, consistent with the median firm having an abandonment option of positive value to equity investors. Note that the figure of 12% is very sensitive to assumptions about the rate of terminal growth and the year in which growth reaches its terminal rate. Therefore, this figure is not an accurate estimate of the abandonment option's relative value. Excess liquidation value (see the appendix) is −70%, consistent with the median firm's abandonment option being out of the money. **Excess book value** (see the appendix), which captures the percentage difference between the book value of the firm's net assets and the value of its after-interest cash flows, is −31%.[7]

The median sample firm has fixed assets equal to 34% of total assets. Less specialized assets, namely, cash, marketable securities, and receivables among current assets and land among fixed assets, represent 60% of current assets and 5% of fixed assets. We use the ratio of adjusted book equity over book equity, which has a median value of 1.15, to examine

[7]The excess equity value, excess liquidation value, and excess book value variables do not exhibit a time trend during the 1984-1990 period.

whether investors regard deferred taxes and other liabilities as material economic liabilities. Finally, the ratio of replacement value (see the appendix) to book value, with a median value of 1.28, is used as a control variable in the asset structure tests.

For the multiplier approach, we obtain 1989 data for all firms in the *Compustat Industry Segment* database meeting sample selection requirements. Segment-level data are used to allow the multiplier measures to more accurately industry-adjust for those multisegment firms whose segments operate in multiple industries.[8] We require firms to have sales of at least $20 million in an effort to avoid distorted valuation multiples for small firms. In addition, we remove financial services firms from consideration because many firms in this industry do not have available information on EBIT.

Panel B of table 2 provides descriptive information for the cash flow multiplier sample. **Excess firm value** (see the appendix) is designed to have a median value of zero, whereas median **lagged excess liquidation value** (see the appendix) is −58%, and median **lagged excess book value** (see the appendix) is −2%. The distributions of the asset structure and replacement-to-book variables (not reported in a table) are similar to those for the analyst forecast sample.

4. Empirical Results

4.1 Liquidation Value and Firm Value

Table 3 reports the results of regressions on the pooled 1984-1990 analyst forecast sample that test whether equity value is positively related to the liquidation value of net assets, after controlling for PVCF. In column one, excess equity value is regressed on excess liquidation value and several controls. The log of the book value of equity controls for firm size. Capital

[8]About 38% of our sample firms are multisegment and virtually all of these firms have their segments classified in differing SIC codes. FASB No. 14 and SEC Regulation S-K require firms to report information for segments that represent 10% or more of consolidated sales, assets or profits. The CIS tape reports segment information for all *Compustat* firms other than utility subsidiaries and those in the research database.

expenditures minus depreciation (scaled by assets), in addition to being a proxy for growth opportunities, controls for measurement error in PVCF introduced by the fact that analysts are trying to predict earnings rather than cash flows. The last two variables in column one also address the concern that measurement error in the proxy for PVCF could affect the inferences from the excess liquidation value variable. Specifically, if estimated liquidation value contains information about future cash flows not captured by PVCF, then a positive coefficient estimate on excess liquidation value may reflect the association between firm value and future cash flows rather than firm value and abandonment value. Sales/PVCF controls for this concern because sales, due to its more direct link to future cash flows, is likely to capture any information about future cash flows that liquidation value captures. R&D/sales is used as a control because R&D intensity potentially affects both future cash flows and estimated liquidation value (since FASB No. 2 dictates that R&D is not recorded as an asset for U.S. financial reports). Finally, all the table 3 regressions include fixed factors for each year, whose coefficient estimates are not reported.[9]

The 0.395 coefficient estimate on excess liquidation value in column one shows that it is significantly positively related to excess equity value.[10] This result shows that firms with a higher ratio of liquidation value to PVCF also have a higher ratio of market value to PVCF. In addition, the estimate falls between the theoretical lower and upper bounds of zero and one. The adjusted R-squared of 22% indicates that the explanatory variables explain a substantial portion of the variation in excess firm value. The significantly positive estimate on capital expenditures minus depreciation is consistent with analysts trying to predict earnings rather than cash flows.[11] In addition, capital expenditures minus depreciation and R&D/sales are

[9]Throughout the paper, all regressions that pool observations across years include unreported fixed factors for each year.

[10]In most of the reported regressions the White test rejects the null of homoskedasticity at the .01 level. Therefore, reported significance levels are calculated using White (1980) heteroskedasticity-consistent standard errors.

[11]Throughout the paper, the reported inferences are insensitive to using capital expenditures (scaled by assets) in place of the capital expenditures minus depreciation control variable.

both significant in controlling for growth opportunities not captured by PVCF. We also performed (unreported) regressions with a number of other control variables. Most did not produce coefficient estimates significant at the .10 level and none affected the reported inferences.

In column two, the controls for predictors of future cash are replaced by ex-post measures of changes in future cash flow. The yearly changes in cash flow for the first three years following the observation year are used. The inferences remain unchanged, with the coefficient estimate on excess liquidation value again positive and highly significant. A drawback of the ex-post controls for cash flow expectations is that their inclusion introduces a survivorship bias in the sample, which eliminates those sample firms in which the abandonment option is exercised within three years of the observation year.

Measurement error is introduced into the estimated liquidation values because we apply, for each of the three asset categories, the same estimate of liquidation value per dollar of book value to all sample observations. As a sensitivity test for this concern, we use untransformed book values in column three as our measure of abandonment value. Rather than using all of the control variables from columns one and two, we greatly increase the number of available observations by dropping the R&D/sales control and the yearly cash flow changes for the second and third years following the observation year. The column three results show that the inferences are not sensitive to whether total book value is used to measure abandonment value, as the coefficient estimate of 0.540 on excess book value is positive and highly significant.

In the preceding regressions, PVCF is the common denominator of both the dependent variable and excess liquidation value. The common denominator may affect the inferences. Therefore, in column four, we perform a "levels" version of the regression. Specifically, we regress the natural log of the market value of equity on the log of PVCF, excess liquidation

value, and the control variables used in column three. Natural logarithms are used to reduce the influence of outliers. The coefficient estimate of 1.005 on the PVCF variable shows that the market value of the firm's equity increases approximately one for one with increases in the present value of expected after-interest cash flows. The significantly positive estimate on the excess liquidation value variable continues to support the inference that the abandonment option makes a significant contribution to firm value beyond that made by PVCF.

To investigate the variation over time in the relation between excess liquidation value and excess equity value, and to address the concern that the pooled observations may not be independent because of the inclusion of the same firm for multiple years, table 4 reports the results from performing the table 3 regressions by year. The specification reported is the "ratios" version with the combined set of ex-ante and ex-post control variables. The results continue to show a strong, positive relation between the estimated liquidation value of the firm's net assets and the market value of its equity. They also show that the magnitude of the relation generally declines over the 1984-1990 period. With the exception of 1984, each of the yearly estimates on excess liquidation value is between zero and one, consistent with an extra dollar of liquidation value providing an increment to firm value of between zero and one dollar. Finally, the only consistently significant control is the change in cash flow for the year following the observation year.

Table 5 presents the results from assessing the effect of the abandonment option using the cash flow multiplier proxy for PVCF. Excess firm value is regressed on lagged excess liquidation value and controls for factors that may cause individual firms to have value-to-earnings multiples different from those of the median firm in their industry. In addition to controls used in the analyst approach, we add asset beta as a risk control (see the appendix for calculation details). The lagged value of excess liquidation value is used instead of the contemporaneous value to reduce the possibility of transitory cash flow shocks affecting the

results. If cash flow is temporarily high (or low) the multiplier assigns too high (low) a PVCF, resulting in excess firm value being too low (high). If estimated liquidation values are more stable than cash flow, excess liquidation value will also be too low (high) in the same year. Thus, transitory cash flow shocks will result in a positive relation between contemporaneous excess liquidation value and excess firm value. Using lagged excess liquidation value avoids this possibility, since current year cash flow does not affect this variable.

The coefficient estimate of 0.151 on lagged excess liquidation value in the column one regression shows a strong, positive relation between lagged excess liquidation value and excess firm value. The estimate falls within the theorized bounds of zero and one. As described in the appendix, firms with extreme values of excess firm value are removed from the sample, so the strong explanatory power of the regression is not driven by outliers.[12] The only control variable that is significant at better than the .10 level is firm size. In column two, we perform the estimation with lagged excess book value in place of lagged excess liquidation value. The inferences remain unchanged. In column three, we perform a levels version of the first regression. The lagged excess liquidation value variable continues to be significantly positively related to excess firm value.

4.2 Asset structure and firm value

Table 6 examines which types of assets contribute more to the abandonment option's value. The first two columns report the results of regressing excess equity value on excess book value, several asset structure variables, and the control variables. The significantly negative estimate, in column one, of -0.549 on the portion of assets that are fixed shows that, for a given level of excess book value, firms have less excess equity value when more of their assets are long-term. The significantly positive estimate of 0.327 on the portion of current assets that are noninventory shows that firms with more of their liquid assets in noninventory

[12]The results from our tests are not altered if the extreme excess firm value observations are included.

items have higher market values of equity. Both results are consistent with more specialized assets creating less abandonment option value per dollar of book value. Column two adds the portion of fixed assets in land as an additional explanatory variable. The significantly positive estimate of 0.486 on this variable indicates that firms with more of their fixed assets in land have higher equity values. This result is consistent with land, because of its less specialized nature, creating more abandonment value per dollar of book value.

Because we observe only book values (and not current values) of each asset category, the asset structure results could potentially be affected by systematic variation across asset categories in the extent to which book values reflect current values. Explaining the asset structure results on this basis is, however, very difficult for two of the three asset structure variables. Assuming noninventory current assets have book values that are similar to current values, then for accounting rules to explain the negative effect that increasing the ratio of inventory/current assets has on equity value, book value must overstate the current value of inventory. Generally accepted accounting principles require, however, the use of the lower-of-cost-or-market basis for most inventory reporting purposes.[13] This method results in book values never overstating current values for inventory. Similarly, for accounting rules to explain the negative estimate on the portion of assets that are fixed, book value must represent a greater portion of current value for fixed than for current assets. Noninventory items represent 60% of the book value of current assets (see table 2), so book value likely represents a large portion of current value for current assets, on average. This suggests that market-to-book ratios for current assets are slightly greater than one. Since the mean of the median market-to-book ratios for total assets for the years 1968-1985 is 1.2 (Penman, 1992), the relation of market-to-book is likely similar, on average, between fixed and current assets. Thus, the only asset structure variable whose results could plausibly be affected by

[13]During our sample period, approximately 90% of surveyed companies used lower-of-cost-or-market to price all or a portion of their inventories (AICPA, 1987, 1992).

accounting rules is Land/fixed assets. It is plausible, though not necessarily likely, that the ratio of book value to current value is higher for non-land fixed assets than for land.

Column three of table 6 examines two adjustments to book value. First, to address potential concerns about using book values are being used to proxy current values, we control for variation in the ratio of replacement-to-book value. Such variation can arise from differences in asset structure and vintage. For example, a firm with mainly old, fixed assets could have a higher book value, but a lower current asset value, than a firm with mainly liquid assets. The replacement-to-book variable controls for this concern because replacement value is calculated with an algorithm that adjusts assets for inflation based on asset age (see the appendix). After controlling for inflation's effect, the signs and significance levels of the coefficient estimates on the other variables remain unchanged. This result increases our confidence that the asset structure results reflect, at least in part, investors' expectation that more specialized assets will produce less abandonment value per dollar of current value.

The second adjustment in column three increases book equity by the amount of deferred taxes plus "other liabilities," as captured by the ratio of adjusted book equity to book equity. Because both deferred tax liabilities and other liabilities are of questionable economic stature, eliminating them may provide a better measure of the net-asset value realizable through liquidation. The insignificant estimate on the adjusted equity to book equity ratio provides no support for the argument that increasing book equity by the sum of deferred taxes and other liabilities strengthens the association between net assets and equity value.

Table 7 uses the cash flow multiplier approach to examine how excess firm value is affected by the structure of the assets providing the firm's book value. All the inferences are identical to those drawn under the analyst approach. Thus, the effect of asset structure on the abandonment option's value is the same when total asset values are compared to before-interest cash flows estimated from cash flow multipliers as when net asset values are

compared to after-interest cash flows estimated from analysts' consensus forecasts.

4.3 The abandonment option's sensitivity to financial distress likelihood and agency conflicts

One factor which we expect to increase the probability of abandonment is financial distress likelihood. We therefore examine whether, all else equal, excess equity value is more sensitive to variation in excess liquidation value for firms with higher probabilities of experiencing financial distress. Table 8 presents the results of regressing excess equity value on excess liquidation value, the controls, and an interactive indicator set equal to excess liquidation value for firms with an Altman (1968) Z-score in the bottom quartile of the sample, and to zero otherwise. The coefficient estimate of 0.161 on the interactive indicator is significantly positive, indicating that an extra dollar of liquidation value is more highly valued when the likelihood of experiencing financial distress is high. This result is consistent with abandonment put option theory's implication that market value is more sensitive to variation in liquidation value when the probability of exercise is higher.

To investigate the importance of agency problems to holders of the abandonment option, we test whether a given amount of excess liquidation value is associated with more excess equity value when there is a higher probability of managers liquidating at the time investors desire. We assume rational expectations, and therefore use the ex-post exercise of the abandonment option through a partial liquidation as an indicator of a higher ex-ante probability of timely exercise.

Table 9 presents three regressions of excess equity value on excess liquidation value, the controls, and an interactive indicator set equal to excess liquidation value for firms that subsequently had a liquidation and to zero otherwise. The subsample used for these regressions includes only those 1986 firms with a market value of equity of at least $1 billion.

We use 1986 as the base year in order to facilitate searching forward for partial liquidations. We impose the market value of equity requirement because our sample of large asset sales is drawn from the John and Ofek (1995) sample and includes only sales of at least $100 million. Therefore, we restrict the sample to firms large enough to realistically contemplate a partial liquidation of at least $100 million.

The three regressions in table 9 differ in their definition of partial liquidation. The first regression defines partial liquidation as having an asset sale of at least $100 million, the second as having a one-time dividend equal to at least 10% of equity value, and the third as either of these two events. The coefficient estimates on the interactive indicators are significantly positive (.01 level) in all three regressions, indicating that an extra dollar of liquidation value is more highly valued when partial liquidation is about to occur. The results are thus consistent with some managers delaying abandonment beyond the optimal time for investors.

4.4 Tests of Additional Abandonment Option Predictions

We examine two additional predictions arising from abandonment put option theory. First, theory shows that a put option's value increases at an increasing rate, within certain bounds, as it moves further into the money. We thus expect the relation of firm value to excess liquidation value to follow the same nonlinear form. Since firm value is positively related to excess liquidation value, we predict that the marginal effect of excess liquidation value on firm value increases with the level of excess liquidation value, within a bounded range. We test this prediction using a kernel estimation procedure and piecewise linear regression.[14] Kernel estimation is a non-parametric method for estimating the joint density of a set of random variables using a suitable kernel function and window width (or smoothing parameter).

[14]For a detailed discussion of kernel estimation see Ullah (1988). For applications of the kernel method in the empirical asset pricing literature, see, for example, Harvey (1991), Pagan and Hong (1991), and Boudoukh, Richardson, and Whitelaw (1994).

The kernel estimation results (not reported) show little evidence of the predicted nonlinear relation. The piecewise linear regressions are analagous to those reported in tables 3 to 5. We estimate specifications with both a single breakpoint of the excess liquidation value variable (at a value of zero), and with two breakpoints (at the bottom third and top third of the distribution of excess liquidation values). We find some evidence of the predicted nonlinear relation in both the cash flow multiplier sample and the analyst forecast sample. In the latter sample, however, evidence of nonlinearity is very sensitive to the assumed terminal growth rate. Overall, we thus find little support for the predicted nonlinear relation.

In a typical put option, when both the underlying stock value and the strike price are stochastic, the option's value is positively related to the standard deviation of the ratio of underlying stock value to strike price. For the abandonment option, the ratio is given by the inverse of the firm's excess liquidation value. We therefore predict that SDEV, the standard deviation of the inverse of excess liquidation value from equation 2, is positively related to excess equity (or firm) value. Because it is, however, very difficult to proxy for SDEV, our proxies appear more likely to capture the standard deviation of PVCF than the standard deviation of PVCF/liquidation value. In the analyst forecast sample, we use the standard deviation of daily stock returns in the calendar year preceding the analysts' consensus forecast. In the cash flow multiplier sample, we use the standard deviation of ($EBITD_t - EBITD_{t-1}$), divided by the mean of total assets, for the ten years ending in 1989. The results of the tests (not reported) provide mixed support for SDEV being positively related to equity (or firm) value. We generally find a significantly positive relation using the analyst approach, but do not find such a relation using the cash flow multiplier approach.

5. Conclusions

Investors in a firm have the option, as uncertainty about future cash flows is resolved, to abandon the firm for its liquidation value. Theory suggests that this option is priced as an

American put with both a stochastic strike price (liquidation value) and a stochastic value of the underlying security (the value of cash flows). With both liquidation value and cash flows stochastic, theory implies that a given current value produces more liquidation value when it derives from less specialized assets. We therefore investigate whether information about the liquidation value of a firm's assets available from the balance sheet is associated with the firm's market value and whether more generalizable assets produce more abandonment option value.

We estimate the relation between book value and liquidation value for major asset classes by using the discontinued operations footnotes of 157 firms with sufficiently detailed information. Applying these estimates to the balance sheet disclosures of each firm in the full sample provides us with estimated liquidation values. We use two approaches to proxy for PVCF. The first uses discounted analysts' forecasts of future earnings as proxies for the present value of cash flows; in the second, the proxies are industry-median cash flow multipliers. The results under both approaches provide strong evidence that, for a given value of future cash flows, the firm's market value varies directly with its liquidation value.

We find that a given amount of book value has a more positive effect on market value when more of the book value derives from certain categories of assets. These results are consistent with assets producing more abandonment value when they are more generalizable, as predicted by abandonment put option theory.

In addition to depending on the ratio of liquidation value to PVCF, the probability of the abandonment option's exercise is posited to depend on the firm's likelihood of experiencing financial distress and on the level of agency problems between the firm's investors and its managers. Abandonment put option theory predicts that market value will be more sensitive to variation in liquidation value when the probability of the option being exercised is higher. We find that an extra dollar of liquidation value is more highly valued when the likelihood

of experiencing financial distress is in the top quartile of the sample. In addition, tests using a subsample of firms that had partial liquidations support the hypothesis that investors attach more value the abandonment option when the probability of timely liquidation by the manager is higher.

Appendix

Data Definitions for Analyst Approach

Analyst Proxy for Value of Cash Flows: Equation 1 illustrates the analyst approach:

$$\mathrm{PVCF}_{analyst} = \sum_{t=1}^{n} \frac{\mathrm{ECF}_t}{(1+\mathrm{r})^t} + \sum_{t=n+1}^{5} \frac{\mathrm{ECF}_2*(1+\mathrm{gr})^{t-n}}{(1+\mathrm{r})^t} + \frac{\mathrm{ECF}_2*(1+\mathrm{gr})^4}{(\mathrm{r}-\mathrm{tg})} * \frac{1}{(1+\mathrm{r})^6} \quad (3)$$

where:

$\mathrm{PVCF}_{analyst}$	=	the present value of the cash flows expected by analysts
ECF_t	=	the expected year t after-interest cash flows
r	=	the expected CAPM return, described below
gr	=	the consensus forecast of five-year earnings growth
tg	=	the terminal growth rate of earnings
n	=	the number of years for which earnings are forecast
t	=	the year index

In calculating the second term, we assume cash flows from year two grow at the consensus growth rate through year five. If the year two forecast earnings are negative, year one's (or else year three's) are used if positive or, if positive earnings are not forecast, the observation is eliminated. The constant terminal growth rate is assumed to apply to all observations.

Expected CAPM return:

$$\mathrm{r} = \mathrm{r}_f + \beta_e * [\mathrm{r}_m - \mathrm{r}_f] \quad (4)$$

where r_f is the risk free rate, β_e is the firm's beta or systematic risk (from the CRSP beta file), and $r_m - r_f$ is the risk premium of the stock market over the risk-free rate. In implementing equation 2, we assume that the relevant investment horizon is short term and therefore use the one-month Treasury bill rate as a proxy for the risk-free rate and a risk premium of 8.67% (the arithmetic average spread from 1926 to 1991 between the return on the S&P 500 and the return on Treasury bills).

Excess equity value:

$$\text{excess equity value} = \left(\frac{\text{market value of equity}}{\text{PVCF}_{analyst}}\right) - 1$$

Extreme excess equity value measures are excluded from the analysis, with extreme defined as values above three or below -0.75.

Excess liquidation value:

$$\text{excess liquidation value} = \left(\frac{\text{estimated liquidation value of equity}}{\text{PVCF}_{analyst}}\right) - 1$$

Estimated liquidation value of equity is defined as: cash + 0.72*receivables + 0.55*inventory + 0.54*fixed assets − payables − total debt. Extreme excess liquidation value measures are excluded from the analysis, with extreme defined as values above three.

Excess book value:

$$\text{excess book value} = \left(\frac{\text{book value of equity}}{\text{PVCF}_{analyst}}\right) - 1$$

Extreme measures are excluded using the same procedures as for excess liquidation value.

Replacement value of assets: The replacement value is estimated using a modification of the Lindenberg and Ross (1981) algorithm. Plant and equipment are valued by setting up

an acquisition schedule and adjusting for price-level changes and depreciation as suggested by Lindenberg and Ross, while the technological change parameter of Lindenberg and Ross is, following Smirlock, Gilligan, and Marshall (1984), assumed to be zero. Specifically, we assume that the value of plant in 1970 (or the first year with available *Compustat* data) is equal to book value. Following Smirlock, Gilligan, and Marshall, we reduce the value of plant and equipment by 5% each year to compensate for depreciation and then adjust it for inflation using the GNP deflator. We then apply the Lindenberg and Ross formula. For inventories, we apply the Lindenberg and Ross algorithm directly.

Data Definitions for Multiplier Approach

Multiplier Proxy for Value of Cash Flows: Equations 3 and 4 illustrate the multiplier approach:

$$\text{PVCF}_{multiplier} = \sum_{i=1}^{n} \text{EBIT}_i * (\text{Ind}_i(\frac{\text{VALUE}}{\text{EBIT}})_{mf}) \quad (5)$$

$$\text{EVALUE} = (\frac{\text{VALUE}}{\text{PVCF}}) - 1 \quad (6)$$

where:

$\text{PVCF}_{multiplier}$	=	the present value of cash flows for the sum of a firm's segments
EBIT_i	=	segment i's earnings before interest and taxes (EBIT)
$\text{Ind}_i(\frac{\text{VALUE}}{\text{EBIT}})_{mf}$	=	the multiple of total capital to EBIT for the median firm in segment i's industry
EVALUE	=	excess firm value
VALUE	=	the firm's total capital (market value of equity + book value of debt)
n	=	the total number of segments in segment i's firm

Equation 3 shows that the firm's present value of cash flows is calculated from the sum of the present values of cash flows of the firm's lines of business. The present value for each segment is obtained using industry-median multipliers. Equation 4 details the calculation

of excess firm value, EVALUE. Extreme excess firm value measures are excluded from the analysis, with extreme defined as values above three or below -0.75.

In implementing the multiplier approach, the first step is to obtain the industry median multiple of capital to EBIT for the segment's industry. The segment's industry is the four-digit SIC code of the segment, as long as that SIC code has at least five firms. Otherwise, the three-digit code is used if it contains at least five firms and, if not, the matching two-digit code is used. To be included in the industry median calculations, a firm must have sales of at least \$20 million and available *Compustat* data.

For the multiplier approach to be valid, the sum of the *Compustat Industry Segment* tape's segment level EBITs for a firm must agree with the firm's total EBIT from *Compustat.* The segment figures do not, however, always agree with the firm total. Discrepancies arise because multisegment firms do not always allocate all of their expenses among their segments. We make adjustments as described below if the discrepancy is within 25%. If, however, the sum of the EBITs for the firm's segments is not within 25% of the firm's total EBIT, we eliminate the observation from our sample. As an additional assurance that the segment data we use are reliable, we also eliminate observations if the sum of the sales for the firm's segments is not within 1% of the total sales of the firm.

Because the sum of the segment level EBITs may differ from the firm EBIT by up to 25%, the firm's present value of before-interest cash flows is grossed up (or down) by this percentage deviation for those multisegment firms for which the segment EBITs do not sum exactly to the firm EBIT. An additional issue is how to treat segments with negative EBITs, since multiplier approaches do not typically assign negative values to firms with negative earnings. We address this issue by replacing the EBIT multiplier measure of PVCF for those segments with negative EBITs with either an EBITD multiplier value (replace EBIT with [EBIT + depreciation] in equation 3), if positive, or with the segment's sales multiplier value

(replace EBIT with sales in equation 3).

Excess firm value:

$$\text{excess firm value} = \left(\frac{\text{market value of equity + book value of debt}}{\text{PVCF}_{multiplier}}\right) - 1$$

Extreme excess firm value measures are excluded from the analysis, with extreme defined as values above three or below -0.75.

Lagged excess liquidation value:

$$\text{lagged excess liquidation value} = \left(\frac{\text{estimated liquidation value of total assets}}{\text{PVCF}_{multiplier}}\right) - 1$$

Estimated liquidation value of assets is defined as: cash + 0.72*receivables + 0.55*inventory + 0.54*fixed assets − payables. Extreme lagged excess liquidation value measures are excluded from the analysis, with extreme defined as values above three.

Lagged excess book value:

$$\text{lagged excess book value} = \left(\frac{\text{book value of total assets}}{\text{PVCF}_{multiplier}}\right) - 1$$

Extreme measures are excluded using the same procedures as for excess book value.

Asset beta: is calculated following Hamada (1972), who notes that if a firm's debt is riskless, its equity beta can be written as:

$$\beta_e = \beta_a(\text{V/E})$$

where V and E are the market values of assets (approximated by our measure of total capital) and equity and β_a is the asset beta. The β_e figures are obtained for the year preceding the observation year from the CRSP beta file. CRSP requires 50% of trade-only returns be available to make the β_e calculation.

REFERENCES

AICPA, 1987, Accounting trends & techniques, J. Shohet (ed) (AICPA, New York, NY).

——, 1992, Accounting trends & techniques, J. Shohet (ed) (AICPA, New York, NY).

Altman, E.I., 1968, Financial ratios, discriminant analysis and the prediction of corporate bankruptcy, Journal of Finance 23, 589-609.

Ball, R. and P. Brown, 1968, An empirical evaluation of accounting income numbers, Journal of Accounting Research 6, 159-178.

Berger, P. and E. Ofek, 1995, Diversification's effect on firm value, Journal of Financial Economics 37, 39-65.

Bonini, C., 1977, Capital investment under uncertainty with abandonment options, Journal of Financial and Quantitative Analysis 12, 39-54.

Boudoukh, J., M. Richardson, and R.F. Whitelaw, 1994, Nonlinearities in the relation between the equity risk premium and the term structure, working paper, New York University.

Burgstahler, D. and I. Dichev, 1994, Earnings, adaptation, and equity value, working paper, University of Washington.

Dyl, E. and H. Long, 1969, Abandonment value and capital budgeting: Comment, Journal of Finance 24, 88-95.

Foster, G., 1986, Financial statement analysis (Prentice-Hall, Englewood Cliffs, N.J.).

Freeman, R.N. and S.Y. Tse, 1992, Security price responses to unexpected earnings, Journal of Accounting Research 30, 185-209.

Hamada, R.S., 1972, The effect of the firm's capital structure on the systematic risk of common stocks, Journal of Finance 27, 13-31.

Harvey, C., 1991, The specification of conditional expectations, working paper, Duke University.

Hayn, C., 1994, The information content of losses, working paper, Northwestern University.

John, K. and E. Ofek, 1995, Asset sales and increase in focus, Journal of Financial Economics 37, 105-126.

Johnson, H., 1987, Options on the maximum or the minimum of several assets, Journal of Financial and Quantitative Analysis 22, 277-83.

Kaplan, S.N. and R.S. Ruback, 1995, The valuation of cash flow forecasts: an empirical analysis, Journal of Finance (forthcoming).

Kensinger, J.W., 1980, Project abandonment as a put option: dealing with the capital investment decision and operating risk using option pricing theory, working paper 80-121, Edwin L. Cox School of Business, Southern Methodist University.

————, 1988, The capital investment project as a set of exchange options, Managerial Finance 14, 16-27.

Lee, C.J., 1988, Capital budgeting under uncertainty: The case of optimal timing, Journal of Business Finance and Accounting 15, 155-168.

Lindenberg, E.B. and S.A. Ross, 1981, Tobin's q ratio and industrial organization, Journal of Business 54, 1-32.

McDonald, R. and D. Siegel, 1985, Investment and the valuation of firms when there is an option to shut down, International Economic Review 26, 331-49.

Majd, S. and R. Pindyck, 1987, Time to build, option value, and investment decisions, Journal of Financial Economics 18, 7-27.

Myers, S.C. and S. Majd, 1990, Abandonment value and project life, Advances in Futures and Options Research 4, 1-21.

Ofek, E., 1993, Capital structure and firm response to poor performance: An empirical analysis, Journal of Financial Economics 34, 3-30.

Ohlson, J.A., 1991, Earnings, book values and dividends in security valuation, working paper. Columbia University.

Paddock, J., D. Siegel, and J. Smith, 1988, Option valuation of claims on real assets: The case of offshore petroleum leases, Quarterly Journal of Economics 103, 479-508.

Pagan, A. and Y.S. Hong, 1991, Non-parametric estimation and the risk premium, in W. Barnett, J. Powell, and G. Tauchen (eds), Semiparametric and nonparametric methods in econometrics and statistics (Cambridge University Press, Cambridge, U.K.).

Penman, S. 1992, The articulation of price-earnings ratios and market-to-book ratios and the evaluation of growth, working paper, University of California at Berkeley.

Philbrick, D. and W. Ricks, 1991, Using value line and IBES analyst forecasts in accounting research, Journal of Accounting Research 29, 397-417.

Pindyck, R., 1988, Irreversible investment, capacity choice, and the value of the firm, American Economic Review 78, 969-85.

Quigg, L., 1993, Empirical testing of real option-pricing models, Journal of Finance 48, 621-40.

Robichek, A. and J. Van Horne, 1967, Abandonment value and capital budgeting, Journal of Finance 22, 577-590.

Ronen, J. and G.H. Sorter, 1973, Relevant accounting, The Journal of Business 46, 258-282.

Schipper, K., 1991, Analysts' forecasts, Accounting Horizons 5, 105-121.

Shleifer, A. and R.W. Vishny, 1992, Liquidation values and debt capacity: A market equilibrium approach, Journal of Finance 47, 1343-1366.

Smirlock, M., T. Gilligan and W. Marshall, 1984, Tobin's q and the structure-performance relationship, American Economic Review 74, 1051-1060.

Stickney, C.P. and R.L. Weil, 1994, Financial accounting: an introduction to concepts, methods, and uses (The Dryden Press, New York, NY).

Stulz, R., 1982, Options on the minimum or the maximum of two risky assets: Analysis and applications, Journal of Financial Economics 10, 161-85.

Triantis, A. and J. Hodder, 1990, Valuing flexibility as a complex option, Journal of Finance 45, 549-565.

Ullah, A., 1988, Non-parametric estimation of economic functionals, Canadian Journal of Economics 21, 625-658.

White, H., 1980, A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity, Econometrica 48, 817-838.

Williamson, O.E., 1988, Corporate finance and corporate governance, Journal of Finance 43, 567-592.

TABLE 1

Complementarities Between the Earnings Multiplier and Analyst Forecast Approaches to Approximating the Present Value of Cash Flows

Item	*Multiplier Approach*	*Analyst Approach*
	Type of Cash Flows	
Type of Cash Flows	Before-interest •requires total capital	After-interest •requires equity capital
	Effect on Estimated Value of Cash Flows	
Risk Adjustment	Industry median •controls for industry risk	Firm beta •controls for CAPM risk
Growth Estimate	Industry median •relies on representative firm	Forecasts + assumed terminal growth •relies on assumed growth
Number of years on which cash flow calculation depends	one year's EBIT •bias from transitory shock	$\geq$ 2 year forecasts •analysts optimistic, on average

TABLE 2

SAMPLE DESCRIPTION.

Variable	Median	Mean	SDEV	High	Low
a. analyst forecast data set[1]					
Market value of equity ($ millions)[2]	525	1,518	2,662	21,381	5
PVCF from forecast EPS[3]	0.1587	0.1755	0.0825	0.7211	-0.8358
PVCF from forecast 5-year growth[3]	0.2071	0.2000	0.0661	0.7700	0.0119
PVCF from 4% terminal growth[3]	0.6248	0.6245	0.0997	1.4099	0.1913
Excess equity value, terminal growth=4%[4]	0.1204	0.2855	0.6987	2.9965	-0.7496
Excess liquidation, terminal growth=4%[5]	-0.6959	-0.5976	0.4055	3.0000	-0.9992
Excess book value, terminal growth=4%[6]	-0.3139	-0.1696	0.5845	3.0000	-0.9950
Fixed assets/total assets[7]	0.3355	0.3825	0.2564	0.9712	0.0008
Noninventory current assets/current assets[8]	0.5981	0.5992	0.2010	1.0514	0.0010
Land/fixed assets[9]	0.0519	0.0750	0.0823	1.0000	0.0000
Adjusted book equity/book equity[10]	1.1488	1.2835	0.9277	50.5711	1.0000
Replacement value/total assets[11]	1.2810	1.3698	0.3697	6.1070	0.4990
b. multiplier approach data set[12]					
Excess firm value[13]	-0.0000	0.1466	0.6194	2.9885	-0.7470
Lagged excess liquidation value[14]	-0.5847	-0.3495	0.7470	3.0000	-0.9995
Lagged excess book value[15]	-0.0229	0.3043	0.9810	3.0000	-0.9402

[1] The sample includes all observations in the IBES summary tape with at least two years of earnings forecasts, a 5-year growth rate forecast, at least $20 million in sales, and available data on *Compustat* and CRSP, for a total of 7102 observations. Such IBES data are available for the period 1984-1990.

[2] Market value of the firm's equity at the time of the earnings forecast.

[3] The fraction of the net present value of equity cash flow (PVCF) generated from each of the following three components: (1) the present value (PV) of the consensus earnings forecast by analysts (for at least years one and two), (2) the PV of the earnings projected from the time of the last analyst forecast through to year five by multiplying the last specifically forecast positive earnings (say year 2) by the analyst forecast of 5-year earnings growth, and (3) the terminal value calculated at a 4% terminal growth rate.

[4] The ratio of market value of equity to PVCF, minus 1.

[5] The ratio of liquidation value of equity to PVCF, minus 1. Liquidation value is defined as: cash + 0.72*receivables + 0.55*inventory + 0.54*fixed assets − payables − total debt).

[6] The ratio of book value of equity to PVCF, minus 1.

[7] The ratio of property, plant, and equipment to total assets in the year before the forecast.

[8] The ratio of cash, marketable securities, and receivables to current assets in the year before the forecast.

[9] The ratio of book value of land to property, plant, and equipment in the year before the forecast.

[10] Adjusted book equity is the sum of book value of equity, other liabilities, and deferred taxes in the year before the forecast.

[11] The ratio of replacement value of assets to total assets in the year before the forecast.

[12] The sample includes 2254 nonfinancial firms with sales of $20 million or more and available data in 1989. All variables are measured with 1989 data, except that excess book value is measured with 1988 data.

[13] The ratio of total capital to PVCF, minus 1. PVCF is defined as the firm's earnings before interest and taxes (EBIT) multiplied by the industry median ratio of capital/EBIT. If a firm has more than one segment, PVCF is calculated for each segment separately and then summed across segments.

[14] The ratio of liquidation value of total assets to PVCF, minus 1. Liquidation value is defined as: cash + 0.72*receivables + 0.55*inventory + 0.54*fixed assets − payables).

[15] The ratio of total assets to PVCF, minus 1.

TABLE 3

RELATION BETWEEN A FIRM'S EQUITY VALUE AND ITS LIQUIDATION VALUE
ANALYST FORECAST APPROACH.[1]

Regression	1	2	3	4
Dependent variable	Excess equity value[2]			ln(equity)[3]
Observations	3044	2864	5156	4236
Adjusted R^2	0.223	0.186	0.247	0.907
Constant	0.019	0.378[a]	0.169[a]	0.251[a]
	(0.803)	(0.000)	(0.000)	(0.000)
ln(PVCF)[4]				1.005[a]
				(0.000)
Excess liquidation value[5]	0.395[a]	0.610[a]		0.358[a]
	(0.000)	(0.000)		(0.000)
Excess book value[6]			0.540[a]	
			(0.000)	
ln(book equity)	0.034[a]	0.033[a]	0.026[a]	
	(0.000)	(0.000)	(0.000)	
(Capital expenditures-depreciation)/total assets	1.759[a]	1.211[a]	1.042[a]	0.756[a]
	(0.000)	(0.000)	(0.000)	(0.000)
Sales/PVCF	0.087[a]		-0.000	0.045[a]
	(0.000)		(0.986)	(0.000)
R&D/sales	2.864[a]			
	(0.000)			
Change in cash flow year 0 to year 1[7]		0.124[a]	0.132[a]	0.094[a]
		(0.000)	(0.000)	(0.000)
Change in cash flow year 1 to year 2		0.083[a]		
		(0.000)		
Change in cash flow year 2 to year 3		0.031[c]		
		(0.064)		

[1] The sample includes all observations in the IBES summary tape with at least two years of earnings forecasts, a 5-year growth rate forecast, at least $20 million in sales, and available data on *Compustat* and CRSP. Such IBES data are available for the period 1984-1990. P-Values (in parentheses) are based on the White adjusted standard errors. All regressions include fixed factors for each year, whose coefficient estimates are not reported.

[2] The ratio of market value of equity to PVCF, minus 1. PVCF has the following three components: (1) the present value (PV) of the consensus earnings forecast by analysts (for at least years one and two), (2) the PV of the earnings projected from the time of the last analyst forecast through to year five by multiplying the last specifically forecast positive earnings (say year 2) by the analyst forecast of 5-year earnings growth, and (3) the terminal value calculated at a 4% terminal growth rate. The annual discount rate is calculated by using the CAPM. The risk free rate is the one month treasury bill rate in the month of the forecast, the beta is calculated over the calendar year prior to the forecast, and the market premium over the risk free rate is 8.67%.

[3] The natural log of the market value of equity at the time of the earnings forecast.

[4] See footnote 2 in this table.

[5] The ratio of liquidation value of equity to PVCF, minus 1. Liquidation value is defined as: cash + 0.72*receivables + 0.55*inventory + 0.54*fixed assets − payables − total debt).

[6] The ratio of book value of equity to PVCF, minus 1.

[7] Cash flow in year 1/cash flow in year 0, minus 1. Cash flow is defined as earnings before interest, taxes, and depreciation.

[a] Denotes significance at the 1% level for a two-tailed test.

[c] Denotes significance at the 10% level for a two-tailed test.

TABLE 4

BY YEAR RELATION BETWEEN A FIRM'S EQUITY VALUE AND ITS LIQUIDATION VALUE
ANALYST FORECAST APPROACH.[1]

Regression	1	2	3	4	5	6	7
Dependent variable	Excess equity value in year[2]						
	1984	1985	1986	1987	1988	1989	1990
Observations	123	779	714	685	730	753	446
Adjusted R^2	0.344	0.219	0.178	0.177	0.125	0.174	0.182
Constant	0.923[a]	0.618[a]	0.877[a]	0.390[a]	0.252[b]	0.096	0.068
	(0.004)	(0.000)	(0.000)	(0.008)	(0.017)	(0.474)	(0.577)
Excess liquidation value[3]	1.253[a]	0.680[a]	0.669[a]	0.453[a]	0.320[a]	0.418[a]	0.354[a]
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)
ln(book equity)	-0.010	0.027	-0.007	0.043[b]	0.024[c]	0.080[a]	0.066[a]
	(0.803)	(0.109)	(0.713)	(0.033)	(0.086)	(0.000)	(0.000)
(Capital expenditures-depreciation)/	2.974[a]	1.995[a]	1.597[a]	1.017[b]	0.279	0.608[b]	0.203
total assets	(0.000)	(0.000)	(0.002)	(0.036)	(0.458)	(0.048)	(0.713)
Sales/PVCF	0.018	0.044[a]	0.061[a]	0.086[a]	0.053[a]	0.055[a]	0.035[b]
	(0.671)	(0.000)	(0.001)	(0.000)	(0.002)	(0.001)	(0.016)
Change in cash flow year 0 to year 1[4]	0.212[a]	0.166[a]	0.115[a]	0.140[a]	0.087[a]	0.054	0.219[a]
	(0.004)	(0.000)	(0.001)	(0.000)	(0.001)	(0.105)	(0.000)

[1] The sample includes all observations in the IBES summary tape with at least two years of earnings forecasts, a 5-year growth rate forecast, at least $20 million in sales, and available data on *Compustat* and CRSP. Such IBES data are available for the period 1984-1990. P-Values (in parentheses) are based on the White adjusted standard errors.

[2] See footnote 2 in table 3.

[3] See footnote 5 in table 3.

[4] See footnote 8 in table 3.

[a] Denotes significance at the 1% level for a two-tailed test.

[b] Denotes significance at the 5% level for a two-tailed test.

[c] Denotes significance at the 10% level for a two-tailed test.

TABLE 5

RELATION BETWEEN A FIRM'S EQUITY VALUE AND ITS LIQUIDATION VALUE
EARNINGS MULTIPLIER APPROACH.[1]

Regression	1	2	3
Dependent Variable	Excess firm value[2]		*ln*(capital)[3]
Observations	1619	1638	1619
Adjusted R^2	0.033	0.052	0.943
Constant	0.282[a]	0.250[a]	0.358[a]
	(0.000)	(0.000)	(0.000)
ln(PVCF)[3]			0.944[a]
			(0.000)
Lagged excess liquidation value[4]	0.151[a]		0.092[a]
	(0.000)		(0.000)
Lagged excess book value[5]		0.185[a]	
		(0.000)	
ln(total assets)	-0.014[c]	-0.022[a]	
	(0.077)	(0.007)	
Asset Beta[6]	0.006	-0.038	0.051
	(0.906)	(0.476)	(0.172)
Capital expenditures/ Total assets	-0.027	0.124	0.209
	(0.887)	(0.527)	(0.172)
Lagged sales/PVCF	-0.001	-0.056[b]	-0.032[b]
	(0.973)	(0.018)	(0.019)

[a] The sample includes nonfinancial firms with sales of $20 million or more and available data in 1989. P-Values (in parentheses) are based on the White adjusted standard errors.

[2] The ratio of total capital to PVCF, minus 1. Capital is defined as the sum of the market value of equity plus the book value of long- and short-term debt. PVCF is defined as the firm's earnings before interest and taxes (EBIT) multiplied by the industry median ratio of capital/EBIT. If a firm has more than one segment, PVCF is calculated for each segment separately and then summed across segments.

[3] See footnote 2 in this table.

[4] The ratio of liquidation value of total assets to PVCF, minus 1. Liquidation value is defined as: cash + 0.72*receivables + 0.55*inventory + 0.54*fixed assets − payables).

[5] The ratio of total assets to PVCF, minus 1.

[6] Asset beta is calculated as the firm's equity beta multiplied by its ratio of market value of equity to total capital (debt is assumed to have a beta of 0). Equity beta is measured using daily stock returns in 1988.

[a] Denotes significance at the 1% level for a two-tailed test.

[b] Denotes significance at the 5% level for a two-tailed test.

[c] Denotes significance at the 10% level for a two-tailed test.

TABLE 6

FIRM'S EQUITY VALUE AND ITS ASSET STRUCTURE
ANALYST FORECAST APPROACH.[1]

Regression	1	2	3
Dependent Variable		Excess equity value	
Observations	4811	2879	4568
Adjusted R^2	0.273	0.276	0.274
Constant	0.066	-0.180[b]	0.065
	(0.264)	(0.030)	(0.325)
Excess book value	0.583[a]	0.523[a]	0.577[a]
	(0.000)	(0.000)	(0.000)
Fixed assets/total assets	-0.549[a]	-0.551[a]	-0.517[a]
	(0.000)	(0.000)	(0.000)
Noninventory current assets/current assets	0.327[a]	0.324[a]	0.357[a]
	(0.000)	(0.000)	(0.000)
Land/fixed assets		0.486[a]	
		(0.003)	
Replacement value/total assets			-0.032
			(0.244)
Adjusted book equity/book equity			-0.000
			(0.965)
ln(book equity)	0.050[a]	0.082[a]	0.053[a]
	(0.000)	(0.000)	(0.000)
(Capital expenditures-depreciation)/total assets	1.630[a]	1.804[a]	1.692[a]
	(0.000)	(0.000)	(0.000)
Sales/PVCF	0.000	0.007	0.005
	(0.957)	(0.445)	(0.485)
Change in cash flow year 0 to year 1	0.122[a]	0.116[a]	0.123[a]
	(0.000)	(0.000)	(0.000)

[1] The sample includes all observations in the IBES summary tape with available data in the period 1984-1990. P-Values (in parentheses) are based on the White adjusted standard errors. All regressions include fixed factors for each year, whose coefficient estimates are not reported. See footnotes 3-4, 6-11 in table 2 for variables definition.

[a] Denotes significance at the 1% level for a two-tailed test.
[b] Denotes significance at the 5% level for a two-tailed test.
[c] Denotes significance at the 10% level for a two-tailed test.

TABLE 7

FIRM'S VALUE AND ITS ASSET STRUCTURE
EARNINGS MULTIPLIER APPROACH.[1]

Regression	1	2	3
Dependent Variable[b]		Excess firm value	
Observations	1907	1091	1891
Adjusted R^2	0.050	0.043	0.053
Constant	0.078	0.166[b]	0.145[b]
	(0.224)	(0.018)	(0.049)
Lagged excess book value	0.143[a]	0.128[a]	0.148[1]
	(0.000)	(0.000)	(0.000)
Fixed assets/total assets	-0.179[b]	-0.260[b]	-0.154[b]
	(0.015)	(0.017)	(0.039)
Noninventory current assets/current assets	0.176[a]		0.188[1]
	(0.009)		(0.006)
Land/fixed assets		0.575[b]	
		(0.021)	
Replacement value/total assets			-0.062[c]
			(0.064)
ln(total assets)	-0.010	-0.014	-0.010
	(0.212)	(0.179)	(0.211)
Capital expenditures/ total assets	0.606[b]	0.691[b]	0.608[2]
	(0.011)	(0.011)	(0.010)

[1] The sample includes nonfinancial firms with sales of $20 million or more and available data in 1989. P-Values (in parentheses) are based on the White adjusted standard errors. See footnotes 7-13, 15 in table 2 for variables definition.

[a] Denotes significance at the 1% level for a two-tailed test.
[b] Denotes significance at the 5% level for a two-tailed test.
[c] Denotes significance at the 10% level for a two-tailed test.

TABLE 8

ABANDONMENT OPTION AND FINANCIAL DISTRESS[1]

Regression	1
Dependent variable	Excess equity value
Observations	4138
Adjusted R^2	0.207
Constant	0.209[a]
	(0.001)
Excess liquidation value	0.444[a]
	(0.000)
Excess liquidation value for firms in financial distress[2]	0.206[a]
	(0.000)
ln(book equity)	0.044[a]
	(0.000)
(Capital expenditures-depreciation)/total assets	1.186[a]
	(0.000)
Sales/PVCF	0.056[a]
	(0.000)
Change in cash flow year 0 to year 1	0.120[a]
	(0.000)

[1] The sample includes all observations in the IBES summary tape with available data in the period 1984-1990. P-Values (in parentheses) are based on the White adjusted standard errors. Include fixed factors for each year, whose coefficient estimates are not reported. See also footnotes 2, 5, 8 in table 3 for variables definition.

[2] Equal excess liquidation value if the firm has Z-score in the bottom quartile of all firms in the sample and 0 otherwise.

[a] Denotes significance at the 1% level for a two-tailed test.

TABLE 9

ABANDONMENT OPTION AND FUTURE PARTIAL LIQUIDATION THROUGH LARGE ASSET SALE OR A LIQUIDATING DIVIDEND[1]

Regression	1	2	3
Dependent Variable	Excess equity value		
Observations	233	714	233
Adjusted R^2	0.289	0.180	0.293
Constant	3.206[a]	0.858[a]	3.186[a]
	(0.000)	(0.000)	(0.000)
Excess liquidation value	0.679[a]	0.653[a]	0.652[a]
	(0.001)	(0.000)	(0.001)
Excess liquidation value if had a major asset sale and 0 otherwise[2]	0.462[a]		
	(0.003)		
Excess liquidation value if paid at least 10% of equity as dividend and 0 otherwise[3]		0.585[a]	
		(0.000)	
Excess liquidation value if either asset sale or dividend payment and 0 otherwise[4]			0.506[a]
			(0.001)
ln(book equity)	-0.285[a]	-0.005	-0.284[a]
	(0.000)	(0.795)	(0.000)
(Capital expenditures-depreciation)/total assets	0.231	1.558[a]	0.159
	(0.818)	(0.003)	(0.874)
Sales/PVCF	0.051	0.064[a]	0.058[c]
	(0.150)	(0.001)	(0.097)
Change in cash flow year 0 to year 1	0.204[a]	0.110[a]	0.189[a]
	(0.004)	(0.002)	(0.007)

[1] The sample includes only 1986 IBES forecasts for firms with at least $1 billion in equity value that had a large asset sale (of $100 million or more) or a large one-time dividend (of at least 10% of the market value of the equity) in 1986-1988. P-Values (in parentheses) are based on the White adjusted standard errors. See also footnotes 2, 5, 8 in table 3 for variables definition.

[2] A variable that equals excess book value if the firm sold assets of $100 million or more in the period 1986-1988, and 0 otherwise.

[3] A variable that equals excess book value if the firm paid a one-time dividend of at least 10% of its equity in the period 1986-1988, and 0 otherwise.
[4] A variable that equals excess book value if the firm either sold assets of $100 million or more or paid a one-time dividend of at least 10% of its equity in the period 1986-1988, and 0 otherwise.
[a] Denotes significance at the 1% level for a two-tailed test.
[b] Denotes significance at the 5% level for a two-tailed test.