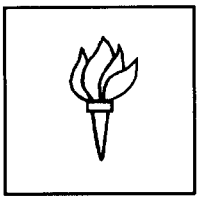

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Investor Valuation of the Abandonment Option.

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ABSTRACT

We investigate whether investors price the 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. Using discounted earnings forecasts to proxy for expected cash flows, and relying on prior literature to categorize asset generalizability, we find strong support for abandonment option theory's predictions.

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 exceptions 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. 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 going-concern 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 going-concern 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** controlling for the relation between market value and the present value of expected cash flows (PVCF).

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 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.

We find a positive and highly significant relation between market value and estimated liquidation value after controlling for PVCF. This relation 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 proxy. Further assurance that correlated omitted variables do not drive the results is provided by the fact that the positive relation between liquidation and market values holds in changes as well as levels.

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. We find support for 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 likelihood of managers (who control the option's exercise) delaying abandonment past the time that is optimal for the firm's investors. Variation around a given level of liquidation value has greater effect on market value when the probability of the option being exercised is higher. Consistent with this prediction, we find that firms with higher probabilities of either financial distress (as measured by the inverse of Altman's (1968) Z-score) or timely abandonment have market values that are more sensitive to variation in estimated liquidation values.

Section 2 describes abandonment put option theory and develops our predictions. Section

3 describes the estimation of liquidation values, details the construction of PVCF from discounted analysts' forecasts, 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 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. 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:

[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.

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 1 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 1 by PVCF and rearrange terms in equation 2, the result is an expression of **abandonment option value** (the percentage by which firm value exceeds PVCF) as a function of the option's parameters. We present the relation in this form because it facilitates hypothesis development. 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 2, 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 2 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. 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, whereas when the value of expected cash flow increases, the option moves further out of the money. Thus, excess liquidation value is positively related to abandonment option 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

[2]The additive form of equation 1 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.

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.

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,

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

Although investors hold the abandonment option, 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 firm value is more sensitive to variation around a given 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 abandonment option 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

The salvage value of a firm's assets is not observable, whereas the book value is. 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 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 $R^2 = 0.85$

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.

3.2 Proxies for the Present Value of Cash Flows

We use analysts' earnings forecasts to calculate the PVCF proxy. The fact that analysts are forecasting earnings, rather than distributable cash flows, offers both an advantage and a disadvantage. The advantage is that, because accountants measure going-concern earnings, a PVCF proxy based on forecasts of these earnings does not incorporate the abandonment option's value. If analysts' were instead forecasting distributable cash flows, their forecasts presumably would incorporate cash flows expected from non-going concern events (i.e., liquidations). The shortcoming is that earnings differ from cash flows, so that the present value of going-concern earnings needs to be adjusted to obtain the present value of going-concern cash-flows. Adjustments must be made because capital expenditures may not equal depreciation, and growth in working capital is not subtracted from earnings. An adjustment for capital structure changes is not required because we assume that such changes are not foreseeable.

Equation 3 illustrates the construction of the PVCF proxy from analysts' discounted earnings forecasts:

$$\begin{aligned} \text{PVCF} = & \sum_{t=1}^{n} \frac{\text{EARN}_t}{(1+\text{r})^t} + \sum_{t=n+1}^{10} \frac{\text{EARN}_2*(1+\text{gr})^{t-2}}{(1+\text{r})^t} + \\ & \frac{\text{EARN}_2*(1+\text{gr})^9}{(\text{r}-\text{tg})} * \frac{1}{(1+\text{r})^{10}} - \text{CAPEX ADJUST} - \text{WC ADJUST} \end{aligned} \quad (3)$$

where:

PVCF	= the present value of analysts' predicted going-concern cash flows
$EARN_t$	= the analyst forecast of year t after-interest earnings
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
CAPEX ADJUST	= a reduction to the present value of analysts' earnings forecasts to adjust for the difference between capital expenditures and depreciation
WC ADJUST	= a reduction to the present value of analysts' earnings forecasts to adjust for growth in working capital

The expected CAPM return is defined as:

$$r = r_f + \beta_e * [r_m - r_f] \tag{4}$$

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 4, 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).

As equation 3 shows, the analyst forecast approach uses five components to proxy for the present value of after-interest cash flows. First, expected earnings from analysts' forecasts are discounted and summed. These forecasts are available for at least two years for all sample firms. The second term projects earnings for the period from the last forecast earnings through year ten using analysts' consensus long-term (five-year) earnings growth forecast, then discounts and sums these expected inflows.[4] The third term calculates the present value of the perpetuity for the earnings from year 11 forward by assuming a constant 4% nominal

[4]In calculating the second term, we assume earnings from year two grow at the consensus growth rate through year ten. 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.

terminal growth rate applies for all observations.[5] The fourth term subtracts the present value of the excess of future capital expenditures minus future depreciation. This adjustment for future 'excess' capital expenditures is needed because analysts' are forecasting earnings, not distributable cash flows, and earnings growth typically requires capital investment in excess of depreciation charges. The details of the excess capital expenditures adjustment are provided below. The fifth term makes a similar subtraction for the present value of working capital growth, and its calculation is also detailed below.

Because we start from forecast earnings to calculate discounted cash flows, we adjust for future excess capital expenditures, which are a major source of the difference between future earnings and future cash flows. Forecasts of excess capital expenditures are, however, unavailable. We could attempt to develop our own forecasts from historical figures, but, for extreme values, historical variation in excess capital expenditures tends to overstate future variation. The rank order of historical excess capital expenditures is, however, a good predictor of the rank order for future excess capital expenditures.[6] Therefore, we adjust each future years' earnings by a fixed percentage that depends on the decile ranking of the historical level of excess capital expenditures. The decile rankings are based on the ratio of the sum of capital expenditures to the sum of depreciation expense, with the sums calculated using those observations within the most recent three years that have available information.

[5]Three factors lead us to project firm-specific growth for ten years. First, although the earnings growth forecasts we have are for five-year growth, it seems unrealistic to assume that earnings growth moves immediately from its firm-specific rate to a terminal rate in year six. Second, ten is the most common number of years for the management cash flow forecasts of the 52 firms studied by Kaplan and Ruback (1995). Third, we compared the PVCF figures that result from projecting firm-specific growth for five, ten, 15, and 20 years and found that ten years performed best in terms of minimizing the variance of the log of the ratio of equity value to PVCF. Minimizing this variance is a desirable feature for the PVCF proxy, because true PVCF is presumably quite close to equity value for most firms. With respect to the 4% terminal growth rate, Kaplan and Ruback (1995) present results using nominal growth rates of 4%, 2%, and 0%, but state that they feel "the 4% rate is economically the most appropriate."

[6]Using 20 years of Compustat data we find that firms with relatively high (low) excess capital expenditures in a given year have an increased likelihood of having relatively high (low) excess capital expenditures the following year, and an increased likelihood of having a more negative (positive) percentage change in excess capital expenditures in the following year.

After grouping observations into deciles, we calculate the median amount to subtract from discounted earnings as the median ratio of the present value of future excess capital expenditures to equity value. Equation 5 shows how this ratio is calculated:

$$\text{CAPEX ADJUST} = \frac{(\text{CAPEX}_0 - \text{DEPN}_0/(r-g))}{\text{EQUITY}_0} \tag{5}$$

where year zero is the year for which PVCF is calculated and the variables not previously defined are:

CAPEX_0 = the year zero capital expenditures
DEPN_0 = the year zero depreciation expense
EQUITY_0 = the year zero market value of equity
g = the growth rate of excess capital expenditures, set to -4%

We set the growth rate of excess capital expenditures to a negative value because we expect the gap between capital expenditures and depreciation to shrink as earnings growth declines to its terminal rate. The median value of CAPEX ADJUST is 12%. We use increments of 2% of discounted earnings to increase the amount deducted from firms in each historical excess capital expenditures decile. Therefore, 3% of discounted earnings is subtracted from all observations in the smallest decile, and 21% is subtracted for observations in the largest decile, resulting in a median deduction of 12%.

Expenditures made to increase working capital are also not captured by earnings. The amount spent on future working capital growth depends on both the historical level of working capital and the future growth of the firm. Therefore, we adjust each future years' earnings by a fixed percentage that depends on the decile ranking of the product of expected earnings growth times the ratio of average net working capital[7] to average assets, with the averages calculated over all of the most recent three years with available information.

We calculate the median amount to subtract from discounted earnings as the median ratio of the present value of future working capital growth to equity value. Equation 6 shows

[7]We define net working capital as current assets minus current liabilities plus short-term debt.

how this ratio is calculated:

$$\text{WC ADJUST} = \frac{([.5(gr)+.5(tg)] * .5[\text{NETWC}_0])/r}{\text{EQUITY}_0} \quad (6)$$

where the variable not previously defined is:

NETWC_0 = the average net working capital for the three years ending in year 0

The median value of WC ADJUST is 5.5%.[8] We use increments of 1% of discounted earnings to increase the amount deducted from firms in each working capital growth decile. Therefore, 1% of discounted earnings is subtracted from all observations in the smallest decile, and 10% is subtracted for observations in the largest decile, resulting in a median deduction of 5.5%.

Several factors potentially introduce measurement error into the PVCF proxy. Discounting future earnings using the expected return implied by the CAPM reflects each firm's systematic risk, but does not incorporate risk factors that may be omitted from the CAPM. The optimism in analysts' forecasts is another potential source of measurement error in the PVCF proxy.[9] Measurement error is also introduced by the lack of forecast information with respect to excess capital expenditures and working capital growth. Finally, the PVCF proxy is sensitive to the assumed terminal growth rate and to the year in which terminal growth is assumed to begin.

We address the potential for measurement error in the PVCF proxy in three ways. First, we include variables in the regressions which could be correlated with the portion of true PVCF omitted from our proxy. Second, we assess the sensitivity of our results to the assumed

[8]The numerator of WC ADJUST is a weighted earnings growth rate times half of average net working capital, all discounted at the expected CAPM return. The weighted earnings growth rate is the equal-weighted average of the five-year analysts' growth rate and the 4% terminal growth rate. This rate is multiplied by only half of net working capital to recognize that working capital growth may be less than earnings growth and that some of the growth in working capital is in the form of interest-bearing assets.

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

terminal growth rate, and to the year in which growth is assumed to reach its terminal rate. None of our inferences are sensitive to changing these assumptions within reasonable ranges. Third, we perform all of the reported tests using an alternative PVCF proxy, which is constructed by multiplying an industry-median capital-to-cash flow multiplier by the firm's cash flow. The resulting proxy is analogous to the Berger and Ofek (1995) earnings-based measure for imputing the values of segments of diversified firms. None of the main results is sensitive to the use of the alternative PVCF proxy.

3.3 Sample Selection and Description

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 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 to ensure that we correctly align the year in which liquidation value is estimated from the balance sheet with the year for which PVCF is calculated. 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 because the PVCF proxy is likely to be less accurate for extremely small firms.

Table 1 provides descriptive information on the IBES sample. Because of skewness in the distributions, we emphasize medians. Rows two through four provide information on the first three components of PVCF, whose sum we refer to as unadjusted PVCF. For the median firm, 13% of unadjusted PVCF is due to the earnings forecast by analysts (usually for years one and two), 42% is due to the earnings projected from the time of the last analyst forecast through year ten, and 44% is due to the perpetuity calculated from year 11 forward. The median ratio of PVCF to unadjusted PVCF is 80%, showing that the adjustments for excess capital expenditures and working capital growth reduce unadjusted PVCF by 20%.

Abandonment option value (see the appendix for calculation details) 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 (see table 8). Therefore, this figure is not an accurate estimate of the abandonment option's relative value. Excess liquidation value (see the appendix) is −76%, showing that the median firm's liquidation value is 24% of its PVCF. **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%, showing that book value represents 69% of PVCF.[10]

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. 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.

4. Empirical Results

4.1 Liquidation Value and Firm Value

Table 2 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, we report the regression of equity value on PVCF and liquidation value. The variables in this specification are undeflated in order to provide assurance that the common deflators used in later specifications do not affect the inferences. We therefore take logs of all variables to reduce the influence of outliers. In addition, all the table 2 regressions include fixed factors for each year, whose coefficient estimates are

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

not reported.[11] The column one results are that the coefficient estimates on both the log of PVCF and the log of liquidation value are positive and significant at the .001 level.[12]

Theory shows that the ratio of liquidation value to PVCF, rather than liquidation value itself, is the stochastic strike price of the abandonment option. Therefore, in column two, we report the results when the log of liquidation value is replaced by excess liquidation value. The coefficient of 1.024 on the PVCF variable shows that, after controlling for the option's strike price, the market value of the firm's equity increases approximately one for one with increases in the present value of 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.

In columns three and four we normalize equity value, PVCF, and liquidation value by sales in order to adjust for size differences across observations. We continue to use no controls in column three, whereas controls are added in column four. The controls address the concern that, rather than capturing the intended economic constructs, PVCF and estimated liquidation value could merely be labels for measures that capture a single economic construct. Specifically, if estimated liquidation value contains information about going-concern cash flows not captured by estimated PVCF, then a positive coefficient estimate on excess liquidation value may reflect the association between equity value and future cash flows rather than equity value and abandonment value. Although the control variables, the tests of the additional implications of abandonment option theory, the analysis performed in changes, and the sensitivity tests are all consistent with our measures capturing the intended economic constructs, it is impossible to completely dismiss the possibility that the liquidation

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

[12] 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.

value and PVCF measures capture the same underlying construct.

The first control variable, capital expenditures minus depreciation (scaled by assets), potentially affects both future cash flows and estimated liquidation value (because it is a growth proxy, a source of difference between earnings and cash flows, and is related to the vintage of the firm's tangible assets). Similarly, R&D/sales potentially affects both future cash flows and estimated liquidation value (since R&D is a growth proxy and is not recorded as an asset for U.S. financial reports).[13] The change in cash flow for the first year following the observation year is used as an ex-post control for future cash flows potentially omitted from PVCF.

The coefficient estimates on the PVCF and liquidation value variables are similar without (column three) and with (column four) the inclusion of the controls. The estimates on both variables are positive and significant at the .001 level. To gauge the relative economic effects of variation in PVCF and liquidation value, we multiply the estimates reported in column four for each variable by the variable's standard deviation. The results are that a one standard deviation change in PVCF/sales leads to a 0.641 change in equity value/sales, whereas for liquidation value/sales the associated change is 0.265. These results show that liquidation value has an economically significant effect on equity value. The significantly positive estimates on all of the controls show that these variables are significant in controlling for growth opportunities not captured by PVCF.

In columns five and six we present regressions whose functional form corresponds to that used in the hypothesis development. This functional form directly relates the value of the abandonment option to the option's strike price. The 0.491 coefficient estimate on excess liquidation value in column five shows that the option's strike price is significantly positively related to abandonment option value. The estimate falls between the theoretical lower and

[13]Firms with R&D less than 1% of sales are not required to disclose their R&D expenditures. We therefore treat unreported R&D as being equal to zero.

upper bounds of zero and one. The adjusted R-squared of 24% indicates that the explanatory variables explain a substantial portion of the variation in abandonment option value. We add to the control variables the ratio of sales/PVCF 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. As in column four, all of the controls have significantly positive coefficient estimates.

We also performed an unreported regression like that in column five, but with lagged excess liquidation value used in place of the contemporaneous value. Using the lagged value serves as a check against the possibility that analysts are unable to distinguish transitory from permanent earnings shocks, which could affect the results.[14] The inferences using the lagged variable are consistent with those for the reported results. The coefficient estimate of 0.164 on lagged excess liquidation value is significant at better than the 0.001 level, and the adjusted R-squared of the regression is 0.170.

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 six as our measure of abandonment value. The column six results show that the inferences are not sensitive to whether total book value is used to measure abandonment value, with the coefficient estimate of 0.577 on excess book value positive and highly significant.

To investigate the variation over time in the relation between excess liquidation value and abandonment option value, and to address the concern that the pooled observations

[14]If analyst forecasts of future earnings are too high (low) when earnings are temporarily high, our proxy assigns too high (low) a PVCF, resulting in abandonment option value being too low (high). If estimated liquidation values are more stable than earnings, excess liquidation value will also be too low (high) in the same year. Thus, transitory earnings shocks could result in a positive relation between contemporaneous excess liquidation value and abandonment option value. Using lagged excess liquidation value avoids this possibility, since current year earnings do not affect this variable.

may not be independent because of the inclusion of the same firm for multiple years, table 3 reports the results from performing the table 2, column five regression by year. 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. The magnitude of the relation does not exhibit an obvious pattern over the 1984-1990 period. 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 coefficient estimates on all of the controls are consistently positive, and are generally significant at the .10 level.

To further mitigate the concern that the inferences may be affected by the liquidation value measure capturing a portion of true PVCF that is omitted from our proxy, we perform an analysis in changes. The dependent variable is the percentage change in equity value, and the independent variables are percentage changes in PVCF, liquidation value, and EBITD, as well as the level of EBITD/sales. The two EBITD variables are included as controls for changes in true PVCF omitted from the proxy measure.

The sample consists of all first differences of the observations from the levels analysis that meet sample selection restrictions. We require that the first earnings forecast occur no later than the fourth month after the date liquidation value is measured, which ensures that the changes in liquidation value and PVCF are aligned correctly in time for each firm. The percentage change in equity value is meant to capture the effect of operational decisions, not the effects of issuances and redemptions. Therefore, we eliminate observations with issuances or retirements (see the appendix for additional details about the construction of the percentage change variables).

The results for the changes specification are presented in table 4. As expected, the coefficient estimate of 0.114 on the percentage change in PVCF is larger than the estimate

of 0.042 on the percentage change in liquidation value. The fact that the latter estimate is significantly positive provides strong evidence, however, that the relation we documented earlier between liquidation value and equity value was not driven by liquidation value and the PVCF proxy both measuring different portions of true PVCF. The constant component of any relation between liquidation value and the omitted portion of true PVCF is eliminated by examining changes rather than levels. Therefore, continuing to find the strong, positive relation between liquidation value and equity value in changes reinforces our confidence in the inferences from the levels analysis.

4.2 Asset structure and firm value

We previously documented, using asset sell-offs from 157 firms with available information, that asset structure affects firm liquidation value. In the preceding section, we showed that estimated liquidation value affects market value. Finally, theory suggests that redeployable assets produce more abandonment option value because their liquidation values are closer to their going-concern values. Thus, both the previous empirical results and theory imply that asset structure should affect market value. We therefore examine the effect of asset structure on the abandonment option's value, both to test the theoretical prediction and to provide an internal consistency check on our earlier results. Table 5 reports the results of regressing abandonment option value on excess book value, several asset structure variables, the control variables, and a replacement-to-book variable. The significantly negative estimate, in column one, of -0.134 on the portion of assets that are fixed shows that, for a given level of excess book value, firms have less abandonment option value when more of their assets are long-term. The significantly positive estimate of 0.175 on the portion of current assets that are noninventory shows that firms with more of their liquid assets in noninventory 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 0.284 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) for each asset category, the extent to which book values reflect current values could affect the asset structure results. Explaining these results on the basis of accounting rules is, however, very difficult. The first result is that increasing the ratio of inventory/current assets decreases equity value. Noninventory current assets generally have book values that approximate current values. Thus, for accounting rules to explain the result, book value must overstate the current value of inventory (so that having a larger portion of book value in inventory would provide less current value). Generally accepted accounting principles require, however, the use of the lower-of-cost-or-market basis for most inventory reporting purposes.[15] 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 overstate the current value of fixed assets more than current assets. Book value's reflection of current value is likely similar, however, between fixed and current assets.[16] Thus, the only asset structure variable whose results could plausibly be affected by 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.

To address potential concerns about book values being used to proxy current values,

[15]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).

[16]Noninventory items represent 60% of the book value of current assets (see table 1), 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.

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). Controlling for inflation's effect with the replacement-to-book variable in column two does not affect the inferences from the asset structure variables. 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.

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

Abandonment option theory shows that market value is more sensitive to variation in liquidation value when the probability of the option being exercised is higher. For given levels of PVCF and liquidation value, one factor that could increase the probability of abandonment is financial distress likelihood. We therefore examine whether, all else equal, abandonment option value is more sensitive to variation in excess liquidation value for firms with higher probabilities of experiencing financial distress. Table 6 presents the results of regressing abandonment option value on excess liquidation value, the controls, and a variable that interacts excess liquidation value with the probability of financial distress. In column one, the interactive variable is multiplicative, and the probability of financial distress is measured as the inverse of the Altman (1968) Z-score.[17] In column two, the interactive variable is an indicator set equal to excess liquidation value for firms with a Z-score in the bottom quartile

[17]We add 1.4 to all Z-scores in order to make the minimum Z-score greater than one. This ensures that the probability of financial distress measure has values between zero and one.

of the sample, and to zero otherwise. The sample for both regressions includes all observations of industrial firms (SIC codes between 2000-3999) during 1984-1990 on the IBES summary tape with available data. Non-industrials are excluded because the parameters used to calculate Z-scores were estimated by Altman for industrial firms only.

The results show that a given excess liquidation value is valued more highly when the likelihood of experiencing financial distress is high. The coefficient estimates on the interactive indicators are significantly positive in column one (.01 level) and column two (.05 level). A concern we have with the table 6 tests is that firms with higher financial distress probabilities are likely to have higher financial distress costs, and these costs will tend to be omitted from the PVCF estimate because analysts are forecasting going concern earnings. Therefore, the reported results could be sensitive to the assumptions used to calculate PVCF, and we have performed sensitivity tests that partially assess this concern. We find that, as the assumptions used to calculate the terminal value component of PVCF are varied within reasonable ranges (see table 8, the coefficient estimates on the interactive indicators remains positive and significant. The reported results are thus insensitive to the calculation of terminal value, but financial distress costs may be omitted from the PVCF proxy under all of our terminal value calculations. The table 6 results should therefore be interpreted with caution.

The probability of abandonment may also increase when agency conflicts between owners and managers are reduced. To investigate the importance of agency problems to holders of the abandonment option, we test whether a given excess liquidation value is associated with more option value when there is a higher probability that managers will liquidate 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. Some ex-post liquidations would be unexpected by share-

holders, because events such as forced CEO resignations and defensive restructurings can arise between the date we measure abandonment option value and the liquidation date. We therefore search the Wall Street Journal Index for such events, and exclude all observations in which one of these interventions occurs.

Table 7 presents three regressions of abandonment option value on excess liquidation value, the controls, and an interactive indicator set equal to excess liquidation value for firms that subsequently had at least one liquidation and to zero otherwise. The three regressions in table 7 differ in their definition of partial liquidation. The first regression defines partial liquidation as having an asset sale during 1986-1988 of at least $100 million, the second as having a one-time dividend during 1986-1988 equal to at least 10% of equity value, and the third as either of these two events. The sample used for these regressions includes 1986 observations only. We use 1986 as the base year in order to facilitate searching forward for partial liquidations. The subsample used for the first and third regressions includes only those 1986 observations with a market value of equity of at least $1 billion. 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 coefficient estimates on the interactive indicators are significantly positive 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 Sensitivity tests

We assess the sensitivity of the reported results to the calculation of PVCF by performing regressions in which PVCF is calculated under alternative assumptions. We vary PVCF

along three dimensions. The first dimension is whether or not PVCF is adjusted for excess capital expenditures and working capital growth. The second dimension is the terminal growth rate, and the third is the year in which growth is assumed to reach its terminal rate.

Table 8 provides descriptive information on how excess equity value, the dependent variable in the sensitivity regressions, is affected by varying the PVCF calculation along each of the three dimensions. The table's first row reports information for the version of PVCF used in the reported results (i.e., with adjustment for excess capital expenditures and working capital growth, using a 4% terminal growth rate, and assuming the terminal growth rate begins in year 11). The median abandonment option value is 0.115. The remaining rows describe what happens to abandonment option value when one dimension of the PVCF calculation is changed from that used in the reported results. When no adjustment is made to PVCF for excess capital expenditures and working capital growth, PVCF is increased and the median abandonment option value is lowered to -0.104. The same effect occurs if the assumed rate of terminal growth is increased, or if the year in which terminal growth starts is postponed. Thus, the median abandonment option value falls from 0.223 with 0% terminal growth to -0.011 with 6% terminal growth; and from 0.333 when terminal growth starts in year six to -0.142 when it starts in year 21.

Table 9 presents the sensitivity regressions. It is readily apparent that varying the assumptions used in calculating PVCF has little effect on the inference from the excess liquidation value variable. The column with terminal growth starting in year 11 is the original result, which was presented in column five of table 2. The estimate on excess liquidation value is between 0.4 and 0.5, and is significant at the .001 level. The same is also true in each of the seven sensitivity regressions. Moreover, as either the rate of terminal growth or its starting year are increased, no trend is evident in the magnitude of the coefficient estimate on excess liquidation value. The estimate decreases from 0.494 to 0.479 as the terminal

growth rate is increased from 0% to 2%, but it then increases when terminal growth is raised to 4% (the original results) and decreases again when the growth rate is changed to 6%. Similarly, the estimate on excess liquidation value is greater when terminal growth begins in year 11 instead of year six, but thereafter it becomes smaller as the starting year for terminal growth is increased. With respect to the control variables, the striking pattern is that the estimates on the controls generally become smaller as the year of starting terminal growth is increased. Thus, extending firm-specific growth out farther in time appears to reduce the extent to which growth opportunities are omitted from the PVCF proxy. Overall, the sensitivity regressions provide strong evidence that our inferences are not affected by changing, within reasonable ranges, the assumptions used to calculate PVCF.

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, whose value is increasing in liquidation value. We estimate liquidation value based on the relation between book value and liquidation value for major asset classes, as disclosed by firms with sufficiently detailed discontinued operations footnotes. We measure abandonment option value as the percentage by which equity value exceeds going concern after-interest cash flows. The present value of these cash flows is calculated using analysts' earnings forecasts. Specific earnings forecasts are discounted and summed, earnings for the period from the last forecast through year ten are projected based on analysts' consensus earnings growth forecast, and a perpetuity for the earnings from year 11 forward is added by assuming a constant 4% nominal terminal growth rate applies for all observations. The present value of future earnings is then adjusted to arrive at the present value of future cash flows distributable to equity holders. Adjustments are made for the present value of future capital expenditures minus future depreciation and for the present value of working

capital growth. We find a positive and highly significant relation between market value and estimated liquidation value after controlling for the value of future cash flows. This relation holds in levels, in changes, and for various methods of estimating the value of future cash flows.

Option pricing theory suggests that if future cash flows become disappointing, the value of the firm's generalizable assets will not decline as much as the value of its specialized assets. We therefore investigate whether more generalizable assets produce more abandonment option 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.

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 support for the prediction that an extra dollar of liquidation value is more highly valued when the likelihood of experiencing financial distress is higher, although this result is sensitive to the assumptions made in controlling for future cash flows. In addition, tests using a subsample of firms that had partial liquidations support the hypothesis that investors attach more value to the abandonment option when the probability of timely liquidation by the manager is higher.

Appendix

Data Definitions for Analyst Approach

Abandonment option value:

$$\text{abandonment option value} = \left(\frac{\text{market value of equity}}{\text{PVCF}}\right) - 1$$

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

Excess liquidation value:

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

Estimated liquidation value of equity is defined as: cash + 0.72*receivables + 0.55*inventory + 0.54*fixed assets − payables − total debt. Abandonment strike price is truncated at minus one and at three.

Excess book value:

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

Excess book value is truncated using at minus one and at three.

Percentage change in equity value:

$$\text{percentage change in equity value} = \left(\frac{\text{market value of equity}_t}{\text{market value of equity}_{t-1}}\right) - 1$$

Observations are excluded with issuances or retirements that create a change in value, or in the number of shares outstanding, exceeding 2%. One additional observation is eliminated because it is an extreme outlier.

Percentage change in PVCF:

$$\text{percentage change in PVCF} = \left(\frac{\text{PVCF}_t}{\text{PVCF}_{t-1}}\right) - 1$$

Percentage change in PVCF is truncated at its 99th percentile (4.3).

Percentage change in liquidation value:

$$\text{percentage change in liquidation value} = \left(\frac{\text{liquidation value}_t}{\text{liquidation value}_{t-1}}\right) - 1$$

Percentage change in liquidation value is adjusted in cases where either or both the year t−1 and the year t liquidation values are negative. If both are negative, the percentage change is set to zero. If the year t−1 value is negative (positive) and the year t value is positive (negative), the percentage change is set to one (minus one). Finally, the percentage change in liquidation value is truncated at its 99th percentile (3.24).

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.

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TABLE 1
SAMPLE DESCRIPTION.[1]

Variable	Median	Mean	STD	High	Low
Market value of equity ($ millions)[2]	525	1,518	2,662	21,381	5
Unadjusted PVCF from forecast EPS[3]	0.128	0.144	0.080	0.622	-0.645
Unadjusted PVCF from 10 years of forecast growth[3]	0.420	0.413	0.086	1.161	0.037
Unadjusted PVCF from 4% terminal growth[3]	0.437	0.443	0.120	1.521	0.084
PVCF/unadjusted PVCF[4]	0.801	0.810	0.073	0.960	0.711
Abandonment option value[5]	0.115	0.275	0.704	2.989	-0.750
Excess liquidation value[6]	-0.761	-0.666	0.414	3.000	-1.000
Excess book value[7]	-0.308	-0.156	0.627	3.000	-1.000
Fixed assets/total assets[8]	0.336	0.383	0.256	0.971	0.001
Noninventory current assets/current assets[9]	0.598	0.599	0.201	1.051	0.001
Land/Fixed assets[10]	0.052	0.075	0.082	1.000	0.000
Replacement value/total assets[11]	1.281	1.370	0.370	6.107	0.499

[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 future earnings 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 ten 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 the present value of future cash flows to the present value of future earnings.

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

[6] 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).

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

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

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

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

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

TABLE 2

RELATION BETWEEN A FIRM'S EQUITY VALUE AND ITS LIQUIDATION VALUE[1]

Regression	1	2	3	4	5	6
Dependent variable	ln(equity)[2]		Market equity/sales		Abandonment option value[3]	
Observations	4718	5745	5753	5076	5076	5115
Adjusted R^2	0.910	0.900	0.681	0.696	0.236	0.309
Constant	0.297[a]	0.283[a]	0.200[a]	0.159[a]	0.420[a]	0.275[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ln(PVCF)[4]	0.786[a]	1.024[a]				
	(0.000)	(0.000)				
ln(liquidation value)[5]	0.241[a]					
	(0.000)					
PVCF/sales			0.679[a]	0.659[a]		
			(0.000)	(0.000)		
Liquidation value/sales			0.939[a]	0.920[a]		
			(0.000)	(0.000)		
Excess liquidation value[6]		0.489[a]			0.491[a]	
		(0.000)			(0.000)	
Excess book value[7]						0.577[a]
						(0.000)
(Capital expenditures-depreciation)/total assets				1.530[a]	1.053[a]	1.164[a]
				(0.000)	(0.000)	(0.000)
Sales/PVCF					0.084[a]	0.009
					(0.000)	(0.133)
R&D/sales				1.439[a]	1.683[a]	1.904[a]
				(0.000)	(0.000)	(0.000)
Change in cash flow year 0 to year 1[8]				0.099[a]	0.125[a]	0.134[a]
				(0.000)	(0.000)	(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. All regressions include fixed factors for each year, whose coefficient estimates are not reported.
[2] The natural log of the market value of equity at the time of the earnings forecast.
[3] The ratio of market value of equity to PVCF, minus 1. PVCF has the following five 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, (3) the terminal value calculated at a 4% terminal growth rate, (4) a reduction to the present value of analysts' earnings forecasts to adjust for the difference between capital expenditures and depreciation, and (5) a reduction to the present value of analysts' earnings forecasts to adjust for growth in working capital. 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%.
[4] See footnote 3 in this table.
[5] Liquidation value is defined as: cash + 0.72*receivables + 0.55*inventory + 0.54*fixed assets − payables − total debt).
[6] The ratio of liquidation value of equity to PVCF, minus 1.
[7] The ratio of book value of equity to PVCF, minus 1.
[8] 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.

TABLE 3

RELATION BETWEEN A FIRM'S EQUITY VALUE AND ITS LIQUIDATION VALUE, BY YEAR[1]

Regression	1	2	3	4	5	6	7
Dependent variable	Abandonment option value in year[2]						
	1984	1985	1986	1987	1988	1989	1990
Observations	133	878	826	815	882	951	585
Adjusted R^2	0.417	0.254	0.230	0.187	0.184	0.200	0.167
Constant	0.430[a]	0.592[a]	0.547[a]	0.574[a]	0.277[a]	0.532[a]	0.485[a]
	(0.008)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Excess liquidation value[3]	0.772[a]	0.560[a]	0.482[a]	0.496[a]	0.327[a]	0.530[a]	0.449[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
(Capital expenditures-depreciation)/	1.145[c]	1.480[a]	1.564[a]	1.112[a]	0.310	0.878[a]	1.045[b]
total assets	(0.089)	(0.000)	(0.000)	(0.001)	(0.389)	(0.003)	(0.032)
Sales/PVCF	0.116[a]	0.076[a]	0.108[a]	0.093[a]	0.088[a]	0.084[a]	0.044[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R&D/sales	1.781	2.656[a]	4.302[a]	1.891[a]	0.901[b]	0.997[a]	-0.985[c]
	(0.174)	(0.000)	(0.000)	(0.001)	(0.032)	(0.007)	(0.065)
Change in cash flow year 0 to year 1[4]	0.224[a]	0.193[a]	0.154[a]	0.120[a]	0.086[a]	0.048[c]	0.154[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.075)	(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 3 in table 2.

[3] See footnote 6 in table 2.

[4] See footnote 8 in table 2.

[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 4

RELATION BETWEEN CHANGES IN EQUITY VALUE AND CHANGES IN LIQUIDATION VALUE[1]

Regression	1
Dependent variable	Percentage change in equity value[2]
Observations	1577
Adjusted R^2	0.226
Constant	0.003
	(0.885)
Percentage change in PVCF[3]	0.114[a]
	(0.000)
Percentage change in liquidation value[4]	0.042[a]
	(0.002)
Percentage change in EBITD	0.054[a]
	(0.000)
EBITD/Sales	0.547[a]
	(0.000)

[1] The sample includes first differences of 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, available data on *Compustat* and CRSP, a first earnings forecast that occurs no later than the fourth month after the date liquidation value is measured, and no issuances or retirements exceeding 2% of either equity value or of the number of shares outstanding. Such IBES data are available for the period 1984-1990. P-Values (in parentheses) are based on the White adjusted standard errors.

[2] The ratio of market value of equity to lagged market value of equity, minus 1.

[3] The ratio of the present value of cash flows to the lagged value of same, minus 1.

[4] The ratio of liquidation value to lagged liquidation value, minus 1.

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

TABLE 5

FIRM'S EQUITY VALUE AND ITS ASSET STRUCTURE[1]

Regression	1	2
Dependent Variable	Abandonment option value	
Observations	4787	2852
Adjusted R^2	0.311	0.298
Constant	0.257[a]	0.326[a]
	(0.000)	(0.000)
Excess book value	0.600[a]	0.574[a]
	(0.000)	(0.000)
Fixed assets/total assets	-0.134[a]	-0.201[b]
	(0.006)	(0.019)
Noninventory current assets/current assets	0.175[a]	0.182[a]
	(0.000)	(0.009)
Land/fixed assets		0.284[c]
		(0.070)
Replacement value/total assets		-0.057[b]
		(0.040)
(Capital expenditures-depreciation)/total assets	1.199[a]	1.100[a]
	(0.000)	(0.000)
Sales/PVCF	0.008	0.015
	(0.241)	(0.130)
R&D/sales	1.473[a]	1.379[a]
	(0.000)	(0.000)
Change in cash flow year 0 to year 1	0.128[a]	0.134[a]
	(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 3-6, and 8 in table 2 for variable definitions.

[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

ABANDONMENT OPTION VALUE AND FINANCIAL DISTRESS[1]

Regression	1	2
Dependent variable	Abandonment option value	
Observations	3013	3013
Adjusted R^2	0.260	0.260
Constant	0.168[a]	0.183[a]
	(0.003)	(0.000)
Excess liquidation value	0.160[a]	0.251[a]
	(0.002)	(0.000)
Excess liquidation value x Probability of financial distress[2]	0.598[a]	
	(0.003)	
Excess liquidation value for firms with high financial distress probability[3]		0.107[b]
		(0.036)
(Capital expenditures-depreciation)/total assets	0.881[a]	0.911[a]
	(0.002)	(0.001)
Sales/PVCF	0.133[a]	0.129[a]
	(0.000)	(0.000)
R&D/sales	2.208[a]	2.234[a]
	(0.000)	(0.000)
Change in cash flow year 0 to year 1	0.129[a]	0.131[a]
	(0.000)	(0.000)

[1] The sample includes all observations of industrial firms (SIC between 2000-3999) 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. Both regressions include fixed factors for each year, whose coefficient estimates are not reported. See also footnotes 3-6, and 8 in table 2 for variable definitions.

[2] The product of excess liquidation value and $\frac{1}{Z-score}$.

[3] 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.

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

TABLE 7

ABANDONMENT OPTION VALUE AND FUTURE PARTIAL LIQUIDATION THROUGH LARGE ASSET SALES OR LIQUIDATING DIVIDENDS[1]

Regression	1	2	3
Dependent Variable	Abandonment option value		
Observations	266	820	266
Adjusted R^2	0.200	0.229	0.204
Constant	0.740[a]	0.551[a]	0.736[a]
	(0.000)	(0.000)	(0.000)
Excess liquidation value	0.246	0.480[a]	0.232
	(0.134)	(0.000)	(0.155)
Excess liquidation value if had a major asset sale, and 0 otherwise[2]	0.468[a]		
	(0.008)		
Excess liquidation value if paid at least 10% of equity as dividend, and 0 otherwise[3]		0.384[b]	
		(0.018)	
Excess liquidation value if either asset sale or dividend payment, and 0 otherwise[4]			0.490[a]
			(0.003)
(Capital expenditures-depreciation)/total assets	1.159	1.571[a]	1.198
	(0.377)	(0.000)	(0.414)
Sales/PVCF	0.098[a]	0.108[a]	0.101[a]
	(0.000)	(0.000)	(0.001)
R&D/sales	4.991[a]	4.280[a]	4.950[a]
	(0.000)	(0.000)	(0.001)
Change in cash flow year 0 to year 1	0.334[a]	0.147[a]	0.320[a]
	(0.000)	(0.000)	(0.000)

[1] The sample includes only 1986 IBES forecasts, and in columns one and three is restricted to firms with at least $1 billion in equity value. P-Values (in parentheses) are based on the White adjusted standard errors. See also footnotes 3-6, and 8 in table 2 for variable definitions.

[2] A variable that equals excess liquidation 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 liquidation 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 liquidation 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.

TABLE 8

ABANDONMENT OPTION VALUE WITH VARIOUS PVCF CALCULATIONS.

Excess equity value with vaiouse PVCF[2]	Median	Mean	STD	Q3	Q1
Terminal growth=4%, 10 years with specific growth	0.115	0.275	0.704	0.594	-0.226
Unajusted for capex-depreciation and WC changes	-0.104	0.023	0.548	0.266	-0.369
Terminal growth=0%	0.223	0.380	0.705	0.702	-0.118
Terminal growth=2%	0.157	0.315	0.694	0.628	-0.177
Terminal growth=6%	-0.011	0.140	0.645	0.433	-0.324
Terminal growth starts at year 6	0.333	0.494	0.754	0.881	-0.068
Terminal growth starts at year 16	-0.061	0.067	0.586	0.337	-0.357
Terminal growth starts at year 21	-0.142	-0.023	0.542	0.223	-0.418

TABLE 9

RELATION BETWEEN ABANDONMENT OPTION VALUE AND LIQUIDATION VALUE FOR VARIOUS PVCF CALCULATIONS[1]

Regression	1	2	3	4	5	6	7	8
Dependent variable	Abandonment option value							
	Not adjusted	Terminal value growth rate= 0%	2%	6%	Terminal value start at year 6	year 11	year 16	year 21
Observations	5013	5049	5061	4998	4906	5076	4817	4749
Adjusted R^2	0.208	0.226	0.225	0.231	0.212	0.232	0.244	0.249
Constant	0.213[a]	0.508[a]	0.443[a]	0.304[a]	0.612[a]	0.420[a]	0.272[a]	0.203[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Excess liquidation value[3]	0.403[a]	0.494[a]	0.479[a]	0.451[a]	0.476[a]	0.491[a]	0.452[a]	0.427[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
(Capital expenditures-dereciation)/total assets	0.330[a]	1.018[a]	0.988[a]	0.860[a]	1.543[a]	1.053[a]	0.524[a]	0.416[a]
	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Sales/PVCF	0.074[a]	0.069[a]	0.074[a]	0.085[a]	0.063[a]	0.084[a]	0.083[a]	0.088[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R&D/sales	1.217[a]	1.602[a]	1.689[a]	1.869[a]	2.546[a]	1.683[a]	0.845[a]	0.614[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Change in cash flow year 0 to year 1[4]	0.095[a]	0.130[a]	0.124[a]	0.112[a]	0.133[a]	0.125[a]	0.089[a]	0.075[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(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. See also footnotes 3-6, and 8 in table 2 for variable definitions.

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