Available online at www.sciencedirect.com
SCIENCE DIRECT®
ELSEVIER
Journal of Corporate Finance 11 (2005) 523–549
Journal of CORPORATE FINANCE
www.elsevier.com/locate/econbase

Replacement versus adaptation investments and equity value

Emeka T. Nwaeze*

School of Business, Rutgers University, Camden, NJ 08102, USA

Received 16 July 2002; accepted 28 January 2004
Available online 26 April 2004

Abstract

I examine the relative effects of replacement investments (RX) and adaptation investments (AX) on equity value. My analysis draws from the real-options theory that stresses the link between firm value and the option a firm holds to continue current practice or to adapt resources to new opportunities. The key prediction is that replacement and adaptation investments reflect the exercise of different investment options that have different implications for firm value; the effect of each investment type on firm value depends on the relative attractiveness of the underlying investment option. The results show that, in the presence of earnings, the effect of replacement investments on equity value is negative and increasing in earnings performance; by contrast, the effect of adaptation investments on equity value is positive and decreasing in earnings performance. Further analyses show that asset sales mediate the importance of adaptation investments in determining equity value.

JEL classification: G31
Keywords: Replacement investments; Adaptation investments; Investment option; Equity value

1. Introduction

The capital budgeting theory posits that a firm must periodically commit capital expenditures (CPX) to existing or new business to maintain value or achieve growth.

* Tel.: +1 856 225 6651; fax: +1 856 225 6231.
E-mail address: nwaeze@camden.rutgers.edu.

0929-1199/$ - see front matter
doi:10.1016/j.jcorpfin.2004.01.001

Several studies examine the effects of CPX on firm value on the premise that the level of or innovation in CPX conveys private information insiders have about investment opportunities available to a firm. Trueman (1986), Ambarish et al. (1987), and John and Mishra (1990), for example, argue that the level of capital spending signals the manager's expectation about the firm's investment opportunities. McConnell and Muscarella (1985) find that announcements of increases (decreases) in CPX lead to increases (decreases) in stock prices. Chan et al. (1995) show that stock prices react positively to business-relocation decisions motivated by business expansion or cost savings but negatively to decisions motivated by capacity reductions. Chung et al. (1998) show that price reactions to capital spending announcements are related to a firm's investment opportunities. They find that announcements of increases (decreases) in capital spending lead to positive (negative) price reactions for firms with valuable investment opportunities, but to negative (positive) price reactions for firms without such opportunities. Woolridge (1988), Lev and Thiagarajan (1993), and Kerstein and Kim (1995) also find that capital spending has value-relevant information.[1]

An issue often ignored in analyzing the market effects of CPX is that capital spending typically comprises two investment types—replacement investments (RX) and adaptation investments (AX)—that have different implications for expected future profits and firm value. RX represent funds devoted to the replacement of expired assets. In a steady state, such investments are made to maintain profits at current levels. Consequently, RX is not expected to have a marginal effect on firm value. By contrast, AX are devoted to alternative or new projects (e.g., growth). This investment type typically modifies the scope of business activity and the future profit path of a firm. If managers follow the value-maximization rule, this investment type, unlike RX, will have a positive effect on firm value. This latter point reinforces the notion that RX and AX have differential effects on firm value. As a result, lumping the two investment types as a single variable in valuation models masks their separate effects on firm value. Chambers et al. (1999) raise a similar concern, noting that combining RX and expansion expenditures into a single number can result in a substantial loss of information.

In this study, I examine the separate effects of RX and AX on equity value and test several predictions that the effects of RX and AX on equity value are a function of the relative attractiveness of replacement and adaptation options. The predictions (see Section

[1] Cross-sectional variation in the information content of investments is also explored in other contexts. For example, the pecking-order hypothesis considered by Myers (1984) and Myers and Majluf (1984) suggests that information asymmetry between insiders and investors raises the cost of external financing and compels managers to forego profitable investments when funds are not available internally. This view raises the possibility that investments financed by funds generated internally create higher value than those funded by debt (because internal funding allows managers to avoid the cost of external funds). Jensen (1986) discusses the impact of free cash flow on the quality of investments, arguing that firms with high free cash flow tend to spend them on negative net-present-value projects. Some researchers also argue that CPX decisions are explained largely by past results and liquidity rather than by profit opportunities, contrary to the value-maximization rule (Bar-Yosef et al., 1987; Fazzari et al., 1988; Hoshi et al., 1991). Jensen and Meckling (1976) also discuss related agency problems that affect the quality of investment decisions.

2) are extensions of the real-options theory, which relates firm value to the option the firm has to continue existing practice, applying its resources recursively, or to adapt its resources to new or alternative opportunities.[2]

Following Burgstahler and Dichev (1997), I define three option categories—replacement, adaptation, and mixed options—and benchmark the relative attractiveness of each option on the earnings-to-book-value ratio (where book value is a proxy for net assets in place). Specifically, a firm with high earnings-to-book ratio is classified as replacement suited (RX suited) and is predicted to benefit most by exercising its option to continue current business practice. By contrast, a firm with low earnings-to-book ratio is classified as adaptation suited (AX-suited) and is predicted to benefit most by exercising its option to adapt its business practice. The mid-range earnings-to-book-value ratio identifies a mixed-attribute (MX-suited) firm that is served by a mix of RX and AX. The use of earnings performance to rank the attractiveness of various investment options is supported by evidence. For example, John et al. (1992) examine a sample of firms that restructured voluntarily in the 1980s and report that poor earnings performance was the most frequent explanation managers gave for restructuring. John et al. (1992), Blackwell et al. (1990), and Lang et al. (1995) also show that declining earnings performance and financial distress are related to major adaptation activities, including asset sales, plant closings, and retrenchment.

The practical problem in testing the preceding predictions is that firms rarely disclose RX and AX separately. RX and AX are typically lumped together as CPX, with little reference to the amount devoted to replacement or to adaptation. To overcome this problem, I construct proxies for RX and AX based on two alternative methods. The first method estimates firm-year RX as the dollar amount required to replace the expired assets and estimates firm-year AX as the difference between total capital spending and estimated RX. A variation of this method is to designate current accounting depreciation as RX and to estimate AX as total capital spending minus depreciation, as in Lang et al. (1996). The second method uses ordinary least squares (OLS) to decompose firm-year CPX into RX and AX. Despite their conceptual appeal, both estimation methods (see Section 3) are ad hoc. However, if the methods yield completely random estimates of RX and AX, no significant relation can be expected between the equity value and the estimates.

I find that RX have a negative effect on equity value in the presence of earnings. The negative effect is most adverse for RX-suited firms, contrary to the argument that the replacement option is most desirable for RX-suited firms.[3] The effect of AX on equity value, on the other hand, is mostly positive and decreasing in the earnings-to-book-value ratio. That is, AX enhance value most for poorly performing firms. I also show that isolating the two expenditure types improves the explanatory power of the models. Further analyses show that the intensity of asset sales is related to variation in the value of AX across the stylized option categories.

[2] *Adaptation investments* in this context refer to the level of investments beyond the amount required to maintain existing operations. The term is used in lieu of *abnormal capital expenditures* to underscore the view that such investments reflect managers' discretionary but deliberate responses to new opportunities.

[3] The coefficient on the aggregate CPX also decreases in the earnings-to-book-value ratio, suggesting the results for RX are not driven by measurement error.

The remainder of the paper proceeds as follow. Section 2 motivates the study and discusses the hypotheses. Section 3 describes the empirical procedures for estimating RX and AX. Section 4 describes the sample-selection method and the data. Section 5 presents the empirical results. Section 6 summarizes the findings and concludes the study.

2. Motivation and hypotheses

2.1. Relative effects of RX and AX on equity value

Real-options theory describes the capital budgeting decision as the option a firm has at the start of each budget period either to continue current practice, applying and replacing resources recursively, or to adapt resources to new opportunities.[4] The firm exercises a replacement option when it replaces expired assets or technology; it exercises an adaptation option when it adapts resources to new opportunities. Typically, firms concurrently deploy some resources recursively and adapt others to new opportunities. At issue is whether and to what extent RX and AX are reflected in the market value of equity, and whether RX and AX are valued differently or identically.

A priori, there are reasons to expect RX and AX to have different implications for equity value. RX and AX reflect the exercise of two distinct investment options that emphasize different operating strategies and portend different profit paths. The exercise of a replacement option, for example, emphasizes continuation of current practice. The resources devoted to replacement provide support for existing operations. However, the investment simply maintains the current profit path and portends little change in expected future cash flows. RX, in such a role, has limited information for the market value of equity beyond what is in current earnings. Thus, the related hypothesis is:

H1. RX have no effect on equity value in the presence of earnings.

AX, by contrast, represents resources deployed to support growth and expansion (e.g., acquisition of new segments, addition of new product lines) or to restructure or modify existing business (e.g., disposition of segments, reorganizations). The organizational change that accompanies AX typically alters the scope of business and expected future cash flows. More important, expected cash flows from, and the market value of, AX are independent of the performance of prior investments and are instead a function of the expected success of the new investments. In such contexts, current profits are a weak

[4] Some early work on real options considers scenarios in which the value of liquidation rather than expected going-concern cash flows is the most important determinant of the market value of equity (e.g., Robichek and Van Horne, 1967; Dyl and Long, 1969; Shleifer and Vishny, 1992; Berger et al., 1996). Recent studies attempt to use balance sheet and income statement values to predict the relative weights of various options in the determination of firm value (Hayn, 1995; Burgstahler and Dichev, 1997; Barth et al., 1998; Subramanyam and Wild, 1996). Although imminent liquidation affects the market value of equity, this study assumes a going-concern status for the sample firms to concentrate on the impact of routine CPX decisions on equity value.

predictor of future cash flows and likewise have limited information for equity value.[5] All else being equal, the equity value reflects the future cash flows expected to be generated from the AX.[6] The related hypothesis is that:

H2. AX are positively related to equity value in the presence of earnings.

The possibility that RX and AX convey asymmetric information about changes in future cash flows raises the prospect that total CPX are a poor proxy for either RX or AX. To the extent that RX and AX have different information about expected future cash flows, failure to isolate RX and AX ignores the specific information provided by each component and reduces the power of statistical tests. As Chambers et al. (1999) point out, the aggregation of the two expenditure types into a single value may result in a significant loss of useful information. The proposition implied by this idea is that isolating RX and AX permits more efficient tests of the equity-value effects of various capital spending decisions.

2.2. Option status and the relative effects of RX and AX on equity value

Another potential determinant of the relative import of RX and AX for equity value is the attractiveness of the underlying option. In a general option framework, Burgstahler and Dichev (1997) model the value of a firm as a weighted average function of the recursion value (capitalized expected earnings when the firm recursively deploys its resources) and the adaptation value (the value of the firm's resources adapted to alternative uses), where the weights reflect the probability that the firm will exercise the adaptation option. The model predicts that the replacement option will be weighted more than the adaptation option when earnings from existing projects are high relative to book value. The logic is that when a firm's existing business is highly profitable, the firm is expected to continue its current practice, with the result that its equity value depends largely on the recursion value. If the firm exercises a replacement option, it aligns its investing activity with the market's expectation. However, the investment resources devoted to the option are not expected to alter the firm's existing profit path or its future cash flows and thus have little effect on equity value.

Views differ, however, about the incentives RX-suited firms have for exercising the adaptation option. One view is that managers of RX-suited firms wishing to build empires divert resources to questionable projects. Such motives are similar to the reputation problem modeled by Amihud and Lev (1981) that describes the incentive among managers to pursue business expansions that do not improve shareholder value in their desire to maintain their reputations and lengthen their tenure. Roll (1986) explains further that some managers overpay for projects because they are infected by hubris. High-profit firms are

[5] Smith and Watts (1992), Gaver and Gaver (1993), Skinner (1993), and Baber et al. (1996) also note that current earnings are a less reliable indicator of future prospects for growth or adaptive firms. They contend that accounting conservatism and other factors related to accounting measurement rules impair the ability of current earnings to reflect the impact of current investments and adaptations on future cash flow and earnings.

[6] AX may be priced negatively if the expected profits on adaptation are lower than the profits that can be earned on recursion. The potential for such a scenario is examined in prior studies. Jensen and Meckling (1976) and Myers and Majluf (1984), for example, raise the prospect that agency costs and information problems can motivate investments in negative net-present-value projects.

also likely to have high free cash flows and the overinvestment problem noted by Jensen (1986). If such incentives typify the spending decisions of RX-suited firms, AX by such firms will correlate negatively with equity value. On the other hand, adaptation by RX-suited firms may reflect the existence of new profit opportunities. Under the value-maximization rule (e.g., see Fama and Miller, 1972; Fama and Jensen, 1985), such investments are expected to enhance shareholder value. If adaptation by RX-suited firms is driven largely by the existence of new profit opportunities, adaptation by RX-suited firms will have positive effects on equity value. The primary hypothesis is:

H3. For an RX-suited firm, RX have no effect on equity value in the presence of earnings; AX may have a positive or a negative effect on equity value.

Burgstahler and Dichev (1997) predict that when current earnings are extremely low relative to book value, earnings have limited information for firm value. Extremely low earnings are an indication of an unprofitable business that calls for adaptation. Indeed, there is evidence that managers restructure investments in response to poor earnings performance (Blackwell et al., 1990; John et al., 1992; Lang et al., 1995). In such contexts, the market value of a firm derives not from the current or prior results but from the market's expectation that the firm will adapt its resources to lucrative uses (see also Yee, 2000).[7] Thus, if an AX-suited firm adapts resources to new and potentially lucrative projects, it aligns its investments with the market's expectation. The alignment causes AX to be correlated with equity value to the extent that the adaptation meets or exceeds the market's expectation. If, however, the firm's investment activities are inconsistent with investors' expectations—for example, if the firm continues to maintain unprofitable projects through additional RX outlays—investors may be disappointed and may revalue the firm (for misallocating resources that could have been deployed more profitably).[8] The related hypothesis is:

H4. For AX-suited firms, AX are positively related to equity value in the presence of earnings, whereas RX are negatively related to equity value.

3. Empirical methods for estimating RX and AX

3.1. RX and AX proxies—direct replacement-cost method

Under the direct replacement-cost method, RX for year t is estimated as the dollar allocation required to replace expired or depleted investments in plant and equipment in year t. The method involves three simple steps. First, the replacement value of investments in plant and equipment for year t is estimated. Second, the replacement value is divided by

[7] Berger et al. (1996) note that when profits are consistently low or negative and bankruptcy is imminent, exit values of assets are more important determinants of firm value (see also Hayn, 1995).

[8] Kanodia et al. (1989) discuss similar agency problems, contending that managers desirous of building their reputations often overcontinue existing projects. Tan (2000) associates the overcontinuation behavior with induced moral hazard (see also Demski and Sappington, 1987). The cost of such investment practices is the margin that could have been earned on more lucrative projects.

the remaining life of plant and equipment to obtain a replacement-cost proxy for RX in year t, denoted RX_{Ct} , where remaining life equals book value of investments in plant and equipment divided by depreciation. Third, the proxy for AX, denoted AX_{Ct} , is estimated as the difference between total CPX in year t and RX_{Ct} . Estimate of the replacement value of plant and equipment, based largely on the Lindenberg and Ross (1981) method, is given as (see also Chung et al., 1998):

$$\mathrm{RCF}_t = \mathrm{NPE}_{t-1}\left(\frac{\mathrm{GNP}_t}{\mathrm{GNP}_{t-\ell}}\right). \tag{1}$$

NPE_{t-1} is the beginning-period net plant and equipment; GNP_t and $\mathrm{GNP}_{t-\ell}$ are the gross national product deflators for nonresidential fixed investments for year t and for the asset-acquisition year, respectively; and ℓ is the mean age of fixed assets, estimated as the ratio of accumulated depreciation to current depreciation.[9]

3.2. RX and AX proxies—regression method

The second approach for estimating RX and AX assumes that aggregate CPX at period t comprises the amount required to maintain current operations and a residual spending devoted to adaptation (e.g., growth, expansion). The additive effect is represented as:[10]

$$\mathrm{CPX}_t = \mathrm{RX}_t + \mathrm{AX}_t. \tag{2.1}$$

In concept, RX comprises economic depreciation, ED_t , plus an adjustment, δ_t , for price-level changes. In other words, RX can be expressed as:

$$\mathrm{RX}_t = \mathrm{ED}_t + \delta_t. \tag{2.2}$$

Assume further that economic depreciation is related to the firm's depreciation policy; thus:

$$\mathrm{ED}_t = \rho D_t. \tag{2.3}$$

The term ρ reflects the effects of accounting measurement policy on the disparity between economic and accounting depreciation. Substituting the result in Eq. (2.3) into Eq. (2.2) and inserting the expression for RX_t into Eq. (2.1) yields a simple regression model:

$$\mathrm{CPX}_t = \delta_t + \rho D_t + \mathrm{AX}_t. \tag{3.1}$$

For a firm-year, the expression (δ_t+ρD_t) estimates the required CPX, whereas AX_t estimates the AX. The intercept δ_t as an indicator of price-level changes is expected to vary across time but to be identical across firms in similar businesses. The slope ρ relates a firm's

[9] This method of replacement-cost estimation is often criticized on the grounds that most firms have vintages of fixed assets with different economic lives as opposed to the averaged value used in most empirical studies. Moreover, adjusting fixed assets for price-level changes theoretically requires asset-specific price indexes rather than a general price-change index used in practice. As a result, derived indexes of replacement values may contain error. Several modifications are proposed to mitigate some of the noted problems (e.g., see Smirlock et al., 1984; Lewellen and Badrinath, 1997). However, the alternatives also suffer from the preceding criticisms.

[10] AX can be negative. Negative AX are akin to a business contraction, a downsizing, or a net decline in the level of operation that results, for example, from disposal of segments, sale of fixed assets, layoffs, and so on, without corresponding new or replacement investments.

depreciation policy to the firm's capital spending decisions. For simplicity, straight-line depreciation is assumed for all firms and ρ is assumed to be constant across firms in similar businesses (as in several prior studies).[11] The residual AX_t reflects the investments beyond those required to maintain current operations and is assumed to vary across firms and years.

The capital spending model suggests annual cross-sectional regressions of CPX on D to account for the effects of price-level changes and firm-year variations in AX. Furthermore, to reduce the effect of variable scale on the estimators, CPX and D are deflated by beginning-period net property, plant, and equipment (PPE_{t-1}). The empirical model is thus re-expressed as:

$$CPX_t' = \delta_t + \rho D_t' + AX_t' \tag{3.2}$$

where $CPX_t' = CPX_t/PPE_{t-1}$, $D_t' = D_t/PPE_{t-1}$, and $AX_t' = AX_t/PPE_{t-1}$. Annual estimates of of δ_t and ρ_t are then used to derive $(\delta_t+\rho D_t')$ and AX_t' for each firm-year. OLS proxies for RX and AX, denoted RX_R and AX_R, are obtained by multiplying $(\delta_t+\rho D_t')$ and AX_t', respectively, by PPE_{t-1}.

4. Sample selection and data

The sample includes manufacturing firms in Standard Industrial Classification (SIC) codes 2000–3999. Manufacturing firms are chosen because capital spending is a major part of their ongoing activities, they have large holdings of plant and equipment, and they operate under similar competitive forces. Data (item number) for the firms are obtaineD from Compustat from 1978 to 1997 and include total assets (no. 6) and revenues from asset sales (no. 107). Other data from the database are:

GPPE = gross investments (no. 7)
NPE = net investments in plant and equipment (nos. 8–158)
CPX = capital expenditures (no. 128)
D = depreciation, excluding amortization (nos. 14–65)
E = income before extraordinary items less preferred dividends (no. 18–19)
MV = market value of equity (no. 24 no. 25)
BV = book value of equity (no. 60).

Every firm in the sample has a December 31 fiscal year-end and nonmissing data for at least three consecutive years. These selection criteria result in 5478 firm-year observations.

Panel A of Table 1 reports the cross-sectional means (medians) of fixed-asset lives, CPX, depreciation, estimates of RX and AX generated from the replacement-cost approach, and mean (median) assets sales. The mean (median) lifespan of fixed assets ranges from 14 to 16 (11 to 15) years. The estimated mean RX are larger than the mean depreciation in the pooled sample and across the (unreported) annual samples. This result is encouraging because replacement-cost depreciation (which reflects the effects of price-

[11] Chambers et al. (1999) note that in 1987, more than 94% of 600 firms followed by Accounting Trends and Techniques, published by the American Institute of Certified Public Accountants, use straight-line depreciation for some or all their plant, property, and equipment.

Table 1
Summary estimates of the means and medians of fixed-asset lives, replacement value of fixed assets, and replacement and adaptation investments (RXC and AXC, respectively) based on the direct replacement-cost method

(A) Mean and median estimates for the variables

	Fixed-asset life	Total replacement value	CPX	D	RX_C	AX_C	Asset sales
Mean	14	1527.0	236.9	142.8	230.51	7.82	19.89
Median	12	177.15	29.42	19.09	28.47	− 0.29	0.26
Range	14 to 16	1017 to 2279	138.8 to 362.1	95.59 to 219.4	156.68 to 336.80	− 69.26 to 104.29	11.12 to 34.35

(B) Summary estimates of replacement and adaptation investments (RX_R and AX_R, respectively) based on the OLS model of capital expenditures

	RX_R	AX_R
Mean	229.1	0.00
Median	33.16	− 0.03
Range	145.2 to 359.6	− 11.54 to 48.18

Summary estimates of the parameters of the capital expenditures model: $CPX'_t = \delta_t + \rho D'_t + AX'_t$

	δ (t)	ρ (t)	F value (p value)	$\bar{R}^2$
Pooled estimate	0.061 (19.97)***	1.114 (48.25)***	2328 (0.000)	0.34
Mean estimate	0.044 (10.44)***	1.331 (14.63)***	–	0.38
Range of estimate	0.021 to 0.095	0.676 to 2.383	–	0.32 to 0.51

The sample has 5478 firm-year observations, and all values, except fixed-asset lives, are in million dollars. The range for each variable is based on its annual estimates from 1978 to 1997. CPX = capital expenditures; D = depreciation; RX_C = replacement-cost estimate of replacement investments; AX_C = replacement-cost estimate of adaptation investments; RX_R = ordinary least squares (OLS) estimate of replacement investments; AX_R = OLS estimate of adaptation investments. Note that all variables in the capital expenditure model are deflated by net property, plant, and equipment.

*** Statistically significant at the 0.0001 level.

level changes) is, on average, expected to be larger than acquisition-cost depreciation. The capital spending model also assigns a higher percentage of CPX to RX than to AX. Asset sales also constitute a significant portion of the divestment activities of the sample firms. The mean values range between US$11 million and US$34 million, respectively.

Panel B presents summary estimates of RX and AX obtained based on the OLS method. The means (medians) of RX and AX are similar to those obtained with the replacement-cost method. The mean RX are also larger than the mean depreciation. Thus, the regression model produces the intuitive result that accounting depreciation understates the level of consumption of fixed assets. Panel B also reports estimated coefficients and adjusted R^2s for the capital expenditure model. The pooled and mean estimates of δ are positive and significant ($p<0.05$). This result seems reasonable because δ is expected to capture the positive effects of price-level changes on RX. The coefficient ρ and its mean are significant ($p<0.0001$) and greater than unity. The amount by which the coefficient exceeds unity potentially reflects an upward adjustment for acquisition-cost depreciation.[12] These results taken together suggest a reasonable link between CPX decisions and depreciation.[13]

Table 2 reports correlations among the investment types and depreciation (all variables are deflated by PPE). The cross-sectional and mean correlations between CPX and D (column 1 of Panel A) exceed 94%. These results again suggest a close alignment between corporate depreciation policies and capital spending patterns. The relation between depreciation (i.e., accounting measure of RX) and the alternative indexes of RX is shown in columns 2 and 3. The results show that depreciation is highly correlated with both indexes of RX. By contrast, the correlations between depreciation and the alternative indexes of AX (not reported for brevity) are low and insignificant. Column 4 (column 5) shows a high correlation between RX_C (AX_C) and RX_R (AX_R), which suggests that the replacement-cost and OLS estimators yield similar estimates of RX (AX).

In columns 6 and 7, the correlation between RX and AX is negative but weaker between OLS proxies for RX and AX (column 7). Weak correlation between the OLS proxies for RX and AX is not surprising because the two proxies are orthogonal to each other (by design). The negative correlation between RX and AX is noteworthy. The result indicates, perhaps, that managers ration scarce resources between recursion and adaptation. That is, although most firms pursue recursion and adaptation simultaneously, budget constraints undoubtedly compel managers to ration resources among competing projects. With fixed resources, the larger (smaller) the amount of resources applied to replacement, the smaller (larger) is the amount of resources devoted to adaptation.

5. Empirical results

5.1. Benchmark regression results

The empirical analysis of the association between CPX types and equity value relies on the option-style model of equity proposed by Burgstahler and Dichev (1997). The model expresses the market value of equity as the value of the option to choose either recursion value or adaptation value, whichever is larger, at some future date. The model is given as:

$$\mathrm{MV}(E,\mathrm{AV}) = E[\max(cE,\mathrm{AV})] = \int_E \int_{\mathrm{AV}} \max(cE,\mathrm{AV}) f(E,\mathrm{AV})\, d\mathrm{AV}\, dE, \qquad (4)$$

where MV=market value of equity; E=expected future earnings using the firm's current business technology; c=capitalization factor; and AV=adaptation value.

[12] The model was re-estimated with CPX and depreciation averaged over 5 years to smooth out occasional discretionary adjustments in the level of CPX and D. The results are virtually the same as those based on annual regressions and are omitted for brevity.

[13] As an alternative method, I performed a fixed-effects regression with a dummy indicator variable for each year to account for the time-specific price-level changes. The estimates δt and ρt (not shown for brevity) are similar to those reported in Table 3.

Table 2

Pearson [Spearman] correlations among capital expenditures (CPX), depreciation (D), and capital expenditure components: (RX_C, RX_R) and (AX_C, AX_R)

(A) Product moment [rank] correlations among the investment types, including depreciation

	ρ(CPX′, D')	ρ(D', RX′ ∂)	ρ(D', RX'_R)	ρ(RX'_C RX'_R)	ρ(AX'_C, AX'_R)	ρ(RX'_C, AXC′)	ρ(RX'_R, AX'_R)
Pooled correlation	0.943 [0.963]	0.987 [0.990]	0.980 [0.994]	0.981 [0.945]	0.756 [0.695]	− 0.255 [− 0.399]	− 0.123 [− 0.268]
Mean correlation	0.970 [0.968]	0.990 [0.991]	0.998 [0.997]	0.985 [0.984]	0.779 [0.733]	− 0.296 [− 0.412]	− 0.122 [− 0.268]

(B) Range of the annual correlations among the investment types, including depreciation

	Product – moment correlation	Rank correlation
Range of ρ(CPX′, D′)	0.940 to 0.993	[0.947 to 0. 997]
Range of ρ(D′ ,RX′C)	0.977 to 0.997	[0.978 to 0.996]
Range of ρ(D′, RX'_R)	0.994 to 1.000	[0.988 to 1.000]
Range of ρ(RX'_C, RX'_R)	0.943 to 0.999	[0.962 to 0.992]
Range of ρ(AX'_C, AX'_R)	0.496 to 0.993	[0.503 to 0.929]
Range of ρ(RX'_C, AX'_C)	− 0.503 to − 0.127	[− 0.520 to − 0.274]
Range of ρ(RX'_R, AX_R)	− 0.490 to 0.170	[− 0.365 to 0.071]

ρ(•)=correlation operator; CPX′=capital expenditures deflated by net property, plant, and property; DV′ depreciation deflated by net property, plant, and equipment; RX'_C=replacement-cost estimate of replacement investments deflated by net property, plant, and equipment; AX'_C=replacement-cost estimate of adaptation investments deflated by net property, plant, and equipment; RX'_R=ordinary least squares (OLS) estimate of replacement investments deflated by net property, plant, and equipment; AX'_R=OLS estimate of adaptation investments deflated by net property, plant, and equipment.

E and AV are multivariate normal with a vector of means and variance –covariance structure that describe their joint normality (see Burgstahler and Dichev, 1997, for other assumptions and parameters of the model). The conditional density for book value (earnings) provides an expression for the market value of equity at fixed values of earnings (book value). Implicit in the model is the complementary effects of replacement and adaptation on firm value. Burgstahler and Dichev exploit this attribute to express the market value of equity as a linear combination of book value of equity and earnings thus:

$$P_t = \alpha B_t + \beta E_t + \text{error}. \tag{5}$$

The contributions of B and E to explaining P depend on the relative weights investors place on replacement and adaptation options. These weights are reflected in α and β. As replacement becomes more attractive, β approaches the earnings capitalization factor and α goes to 0; as adaptation becomes more attractive, α approaches unity and β

goes to 0.[14] To facilitate tests of the hypotheses, Model 3 in Burgstahler and Dichev (1997) is adopted. The model expresses the market value of equity as a function of earnings, holding book value constant. An empirical equivalent of the model is devised by dividing both sides of Eq. (5) by the beginning-period book value. The revised model is:[15]

$$P_t' = \alpha + \beta E_t' + e, \tag{6.1}$$

where $P_t'=P_t/B_{t-1}$; $E_t'=E_t/B_{t-1}$; e=error/B_{t-1}. To provide initial tests of the effect of various investment types on equity value, CPX and its components, all deflated by B_{t-1}, are specified within Eq. (6.1) as additional variables.[16] The two expanded models are given as:

$$P_t' = \alpha + \beta E_t' + \gamma \mathrm{CPX}_t' + e. \tag{6.2}$$

$$P_t' = \alpha + \beta E_t' + \kappa \mathrm{RX}_t' + \pi \mathrm{PX}_t' + e. \tag{6.3}$$

To reduce the effects of extreme values on results, I screened the observations for each variable and excluded those that were more than 3 standard deviations from the mean. This restriction reduced the sample from 5478 to 5391 observations. Table 3 presents the results and Vuong's (1989) Z tests comparing the performance of the models (Models (6.3a) and (6.3b) identify analyses in which proxies of RX and AX are obtained from the replacement-cost and OLS methods, respectively).

The coefficient on earnings is positive and significant for the base model ($p<0.0001$). The model's adjusted R^2 is 18%. The coefficient on aggregate CPX (column 3) is positive and significant ($p<0.0001$). Vuong's Z test, however, shows that the aggregate CPX have insignificant effect on the explanatory power of the model. With earnings in the model, the coefficient on $\mathrm{RX_C}$ or $\mathrm{RX_R}$ (column 4 or 5) is negative ($p<0.05$). That is, with earnings already in the model, the net effect of RX on equity value is negative. One possible explanation for this result is that the negative coefficient reflects a market discount for the component of expected consumption of fixed assets that is not reflected in accounting depreciation.[17]

The coefficient on $\mathrm{AX_C}$ or $\mathrm{AX_R}$ is positive and highly significant ($p<0.0001$), consistent with H2 that AX are positively related to equity value. Moreover, in Models (6.3a) and (6.3b), the size of the coefficient on AX is larger than the size of the coefficient on RX, suggesting that AX has a greater effect on equity value than does RX. Vuong's Z tests show that including $\mathrm{RX_C}$ and $\mathrm{AX_C}$ or $\mathrm{RX_R}$ and $\mathrm{AX_R}$ in the model achieves a significant increase in adjusted R^2 over the base model and over the model that includes total CPX ($p<0.05$), consistent with the proposition that a disaggregation of total CPX into RX and AX enhances the explanatory power for equity value. The model that includes $\mathrm{RX_C}$ and $\mathrm{AX_C}$ achieves

[14] Burgstahler and Dichev (1997) note that α can exceed 1 if, for example, measurement error in the proxy for book value biases the book value downward. Analogously, errors in the proxies of expected earnings can bias the empirical estimate of the earnings capitalization factor away from the expected value.

[15] Barth and Kallapur (1996) and Collins et al. (1999) justify using the book value of equity to scale variables in price-earnings models to mitigate the spurious effects of cross-sectional scale differences.

[16] In the spirit of Ohlson's (1995) framework, the additional variables represent information variables other than earnings and book value that modify the prediction of future (abnormal) earnings.

[17] Results based on agency models also suggest scenarios in which RX may be priced negatively, especially where managers overcontinue existing projects for their self-interest (Kanodia et al., 1989; Tan, 2000). Several prior studies also find a negative association between certain indexes of replacement costs and firm value (e.g., Ou, 1990; Chambers et al., 1999).

Table 3
Regression of market value of equity on earnings (Model (6.1)), on earnings with capital expenditures (Model (6.2)), and on earnings and alternative proxies of replacement and adaptation investments (Model (6.3))

Parameter	Model (6.1)	Model (6:2)	Model (6.3a): $\{RX_C, AX_C\}$	Model (6.3b): $\{RX_R, AX_R\}$
α (*t*)	1.457 (17.22)***	1.335 (18.03)***	1.505 (25.36)***	1.649 (22.73)***
β (*t*)	7.158 (35.41)***	7.239 (26.94)***	8.107 (29.73)***	7.951 (30.38)***
γ (*t*)		1.515 (5.11)***		
κ (*t*)			− 0.317 (− 2.34)*	− 0.782 (− 1.97)*
π (*t*)			3.559 (6.35)***	3.073 (5.95)***
F value	906.55	527.03	486.97	437.16
(*p* value)	(0.0001)	(0.001)	(0.0001)	(0.0001)
$\bar{R}^2$	0.18	0.19	0.22	0.213
$\%\bar{R}^2$		6%	22%	18%
Z: $\bar{R}^2 > \bar{R}_{6.1}^2$	–	1.42	4.53	3.88
(*p* value)		(0.0778)	(0.0001)	(0.0001)
Z: $\bar{R}^2 > \bar{R}_{6.1}^2$	–	–	3.74	3.14
(*p* value)			(0.0001)	(0.0008)

The sample comprises 5391 firm-year observations for manufacturing firms.

$$P_t' = \alpha + \beta E_t' + e \tag{6.1}$$

$$P_t' = \alpha + \beta E_t' + \gamma \mathrm{CPX}_t' + e \tag{6.2}$$

$$P_t' = \alpha + \beta E_t' + \kappa \mathrm{RX}_t' + \pi AX_t' + e \tag{6.3}$$

RX_C and AX_C are obtained by applying a two-step approach to the replacement cost of fixed assets. First, total replacement cost of fixed plant and equipment is divided by remaining life of fixed plant and equipment to obtain RX_C. Second, RX_C is subtracted from aggregate capital expenditures to obtain AX_C. RX_R and AX_R are obtained by regressing aggregate capital expenditures on depreciation as: $\mathrm{CPX}_t = \delta_t + \rho D_t + \mathrm{AX}_t$. The predicted level of capital expenditures $(\delta_t + \rho D_t)$ is a proxy for RX_R, and the regression residual is a proxy for AX_t. Z values are based on Vuong's Z test for model selection.

* Statistically significant at the 0.05 level.

*** Statistically significant at the 0.0001 level.

about a 5% increase in adjusted R^2 over the model that includes RX_R and AX_R. The difference, however, is not significantly different from zero (based on the Z value).

To mitigate the effect of cross-sectional correlation on t values caused by pooling data across time (e.g., see Bernard, 1987), each coefficient and its t value are re-estimated as the mean of the coefficients from annual regressions and the ratio of the mean coefficient to the standard error of the annual coefficients, respectively. The results are shown in Panel A of Appendix A. Overall, the mean coefficients lead to the same conclusions as those based on the pooled results.

5.2. Piecewise regression results

To examine the effect of firm-option status on the valuation of various investment types, I adopt a piecewise regression design that extends Model (6.1) by partitioning observations into three option groups ranked by the earnings-to-book ratio. The bottom group is the low-profit, or AX-suited, firms; the middle group is the median-profit, or MX-suited, firms; and the top group is the high-profit, or RX-suited, firms. Indicator variables are then used to specify separate intercepts and slopes for each group. The initial model that includes only earnings is estimated as a benchmark. To adjust and test for the effects of option status on the valuation of various investment types, aggregate and disaggregated CPX are included separately in the piecewise model. The models are:

$$P_t' = \alpha + \alpha_1 D_{\mathrm{M}} + \alpha_2 D_{\mathrm{H}} + \beta E_t' + \beta_1 D_{\mathrm{M}} E_t' + \beta_2 D_{\mathrm{H}} E_t' + e. \tag{7.1}$$

$$P_t' = \alpha + \alpha_1 D_{\mathrm{M}} + \alpha_2 D_{\mathrm{H}} + \beta E_t' + \beta_1 D_{\mathrm{M}} E_t' + \beta_2 D_{\mathrm{H}} E_t' + \gamma \mathrm{CPX}_t' + \gamma_1 D_{\mathrm{M}} \mathrm{CPX}_t' + \gamma_2 D_{\mathrm{H}} \mathrm{CPX}_t' + e. \tag{7.4}$$

$$P_t' = \alpha + \alpha_1 D_{\mathrm{M}} + \alpha_2 D_{\mathrm{H}} + \beta E_t' + \beta_1 D_{\mathrm{M}} E_t' + \beta_2 D_{\mathrm{H}} E_t' + \kappa \mathrm{RX}_t' + \kappa_1 D_{\mathrm{M}} \mathrm{RX}_t' + \kappa_2 D_{\mathrm{H}} \mathrm{RX}_t' + \pi \mathrm{AX}_t' + \pi_1 D_{\mathrm{M}} \mathrm{AX}_t' + \pi_2 D_{\mathrm{M}} \mathrm{AX}_t' + e. \tag{7.3}$$

D_{M} is an indicator variable equal to 1 if a firm-year is in the MX group, and 0 otherwise; D_{H} is an indicator variable equal to 1 if a firm-year is in the RX group, and 0 otherwise. D_{M} and D_{H} permit an assessment of the differences in coefficients across the three option groups. Table 4 presents the results and compares the performance of the models (Models (7.3a) and (7.3b) identify analyses in which proxies of RX and AX are based on the replacement-cost and OLS methods, respectively).

The results of the benchmark model (column 3) are similar to those reported by Burgstahler and Dichev (1997). For example, the book value coefficient is highest for the AX-suited firms and lowest for the RX-suited firms (i.e., $\alpha > \alpha + \alpha_2$). In fact, the coefficient on book value is not significant for RX-suited firms. The coefficient on earnings is highest for RX-suited firms and is increasing in the earnings-to-book-value ratio. The coefficient is not only small for AX-suited firms compared with RX-suited firms but also significantly

Notes to Table 4:
The sample comprises 5391 firm-year observations for manufacturing firms.

$$P_t' = \alpha + \beta E_t' + e \tag{6.1}$$

$$P_t' = \alpha + \alpha_1 D_{\mathrm{M}} + \alpha_2 D_{\mathrm{H}} + \beta E_t' + \beta_1 D_{\mathrm{M}} E_t' + \beta_2 D_{\mathrm{H}} E_t' + e \tag{7.1}$$

$$P_t' = \alpha + \alpha_1 D_{\mathrm{M}} + \alpha_2 D_{\mathrm{H}} + \beta E_t' + \beta_1 D_{\mathrm{M}} E_t' + \beta_2 D_{\mathrm{H}} E_t' + \gamma \mathrm{CPX}_t' + \gamma D_{\mathrm{M}} \mathrm{CPX}_t' + \gamma_2 D_{\mathrm{H}} \mathrm{CPX}_t' + e \tag{7.2}$$

$$P_t' = \alpha + \alpha_1 D_{\mathrm{M}} + \alpha_2 D_{\mathrm{H}} + \beta E_t' + \beta_1 D_{\mathrm{M}} E_t' + \beta_2 D_{\mathrm{H}} E_t' + \kappa \mathrm{RX}_t' + \kappa_1 D_{\mathrm{M}} \mathrm{RX}_t' + \kappa_2 D_{\mathrm{M}} \mathrm{RX}_t' + \pi \mathrm{AX}_t' + \pi_1 D_{\mathrm{M}} \mathrm{AX}_t' + \pi_2 D_{\mathrm{M}} \mathrm{AX}_t' + e \tag{7.3}$$

where P' = market value of equity scaled by beginning-period book equity; D_M (D_H) = indicator variable equal to 1 if a firm-year is in medium (high) earnings-to-book ratio panel, and 0 otherwise; E' = earnings scaled by beginning-period book equity; CPX′ = total capital expenditures scaled by beginning-period book equity; RX′ (AX′) = replacement investments (adaptation investments) scaled by beginning-period book equity.

Proxies of replacement and adaptation investments, denoted $\mathrm{RX_C}$ and $\mathrm{AX_C}$, respectively, are obtained by applying a two-step approach to the replacement cost of fixed assets. First, total replacement cost of fixed plant and equipment is divided by remaining life of fixed plant and equipment to obtain $\mathrm{RX_C}$. Second, $\mathrm{RX_C}$ is subtracted from aggregate capital expenditures to obtain $\mathrm{AX_C}$. Alternative proxies of replacement and adaptation investments, denoted $\mathrm{RX_R}$ and $\mathrm{AX_R}$, respectively, are obtained by regressing aggregate capital expenditures on depreciation as: $\mathrm{CPX}_t = \delta_t + \rho D_t + \mathrm{AX}_t$. The predicted level of investments ($\delta_t + \rho D_t$) is a proxy for $\mathrm{RX_R}$, and the regression residual is a proxy for AX_t. Z values are based on Vuong's Z test for model selection.

* Statistically significant at the 0.05 level.
** Statistically significant at the 0.01 level.
*** Statistically significant at the 0.0001 level.

Table 4
Regression of market value of equity on earnings (Model (6.1)); on earnings across firm-year indicators of low, medium, and high earning-to-book ratios (proxying for adaptation, mixed, and replacement options, respectively) (Model (7.1)); on earnings and capital expenditures across firm-year indicators of low, medium, and high earning-to-book ratios (Model (7.2)); and on earnings and alternative proxies of replacement and adaptation investments across firm-year indicators of low, medium, and high earning-to-book ratios (Model (7.3))

Parameter	Model (6.1)	Model (7:1)	Model (7.2)	Model (7.3a): $\{RX_C, AX_C\}$	Model (7.3b): $\{RX_R, AX_R\}$
α	1.457	1.635	1.285	1.427	1.440
(t)	(17.22)***	(14.87)***	(10.25)***	(11.19)***	(11.40)***
$\alpha+\alpha_1$		1.333	1.144	1.240	1.155
(t)		(5.50)***	(4.32)***	(4.51)***	(4.27)***
$\alpha+\alpha_2$		0.130	0.127	0.354	0.362
(t)		(0.56)	(0.40)	(1.08)	(1.12)
β	7.158	− 5.704	− 5.686	− 5.778	− 5.717
(t)	(25.41)***	(− 19.46)***	(− 19.50)***	(− 19.85)***	(− 19.91)***
$\beta+\beta_1$		6.335	5.864	5.775	5.882
(t)		(3.17)**	(2.93)***	(2.90)**	(3.01)**
$\beta+\beta_2$		16.719	16.713	17.415	17.856
(t)		(23.83)***	(23.50)***	(24.50)***	(24.49)***
γ			3.525		
(t)			(4.89)***		
$\gamma+\gamma_1$			1.859		
(t)			(1.71)		
$\gamma+\gamma_2$			0.25		
(t)			(0.20)		
κ				− 1.037	− 0.981
(t)				(− 1.34)	(− 1.82)
$\kappa+\kappa_1$				− 1.459	− 1.153
(t)				(− 3.16)**	(− 2.99)**
$\kappa+\kappa_2$				− 2.074	− 2.176
(t)				(− 2.06)*	(− 3.17)**
π				5.138	5.352
(t)				(7.57)***	(7.68)***
$\pi+\pi_1$				2.295	1.943
(t)				(2.54)**	(2.04)*
$\pi+\pi_2$				1.227	0.881
(t)				(1.38)	(1.42)
F value	906.55	459	350	317	276
(p value)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
$\bar{R}^2$	0.18	0.31	0.32	0.38	0.35
$\%\Delta\bar{R}^2$	–	72%	78%	111%	94%
Z: $\bar{R}^2>\bar{R}^2$	–	4.33	4.79	8.02	5.17
(p value)		(0.0001)	(0.0001)	(0.0001)	(0.0001)
Z: $\bar{R}^2>\bar{R}^2$	–	–	1.34	4.63	3.22
(p value)			(0.0901)	(0.0001)	(0.0006)
Z: $\bar{R}^2>\bar{R}^2$	–	–	–	3.88	2.01
(p value)				(0.0001)	(0.0222)

negative (i.e., $\beta < 0$).[18] The adjusted R^2 for this specification, however, is significantly higher than the adjusted R^2 for the base model ($p < 0.0001$). The results in column 4 indicate that the effect of aggregate CPX on market equity is decreasing in the earnings-to-book-value ratio. Its coefficient is highest for AX-suited firms and lowest (and insignificant) for RX-suited firms. This latter specification has only a marginal improvement in adjusted R^2 over the benchmark model ($p < 0.09$). That is, with earnings in the model, the addition of CPX to the piecewise model has only a marginal effect on the model's explanatory power.

Columns 5 and 6 show the coefficients on the proxies of RX and AX and compare their valuation effects across RX- and AX-suited firms. The coefficient on RX_C or RX_R is negative for AX-suited firms as well as for RX-suited firms; its absolute size is increasing in the earnings-to-book-value ratio and is most pronounced for RX-suited firms. The results for CPX (column 4) are similar; that is, at higher levels of accounting profits, RX have a larger negative effect on equity value.[19] AX_C or AX_R, on the other hand, have a positive and significant effect on the market value of equity for AX- and MX-suited firms. In line with H4, the coefficient on AX is highest for AX-suited firms and lowest or insignificant for RX-suited firms. The inclusion of RX and AX (from both estimation methods) in Model (7.3) achieves a marked improvement in adjusted R^2 over the base-earnings or piecewise model. Again, these results suggest that disaggregated CPX have information for equity value incremental to the information in book value and earnings, even after controlling for firm-option status. Note also that the models that include RX and AX (columns 5 and 6) have higher explanatory power than the model that uses aggregate CPX (column 4).

To reduce the effect of cross-sectional correlation on the coefficients and t values caused by pooling observations across time, I re-estimate the models annually. From the annual results, I obtain the mean of each coefficient and compute the t value as the ratio of the mean coefficient to the standard error of the annual coefficients. The results, shown in Panel B of Appendix A, lead to the same conclusions as those based on the pooled results.

5.3. Asset sales and the pricing of CPX components

Asset sales are a form of adaptation of a firm's business activity. The literature on asset sales suggests that firms sell assets largely in response to poor performance (e.g., see John et al., 1992; Lang et al., 1995). Anecdotal evidence indicates that such responses are designed to narrow business focus, shed unprofitable ventures, fund new projects, or resolve agency issues (see also Rosenfeld, 1984; Hite et al., 1987; John and Ofek, 1995; Lang et al., 1995). Asset

[18] A negative coefficient on earnings for distressed or low-profit firms is noted in prior studies, including Burgstahler and Dichev (1997) and Collins et al. (1999). Collins et al. suggest that such results reflect the omission of book values in the price-earnings regression. Burgstahler and Dichev, however, find that for loss firms, the coefficient remained significant and negative even after controlling for the information in book value. They conjecture that the negative coefficient reflects the cost of adaptation.

[19] Why RX has a more pronounced negative effect on the market value of equity of high-profit firms is puzzling. One possible explanation is that high-profit firms are more prone to capital bias and have a tendency to expand operations beyond the level justified by demand or to overcontinue existing operations. Incentives for overcontinuation are noted by Kanodia et al. (1989), who conjecture that managers, desirous of building reputation, often escalate existing projects (see also Demski and Sappington, 1987; Tan, 2000). It is also possible that RX predicts future consumption of fixed assets most reliably for RX-suited firms relative to either AX- or MX-suited firms and thus has the most pronounced effect on the market value of equity of RX-firms.

sales are believed to affect firm value. Alexander et al. (1984) note that although announcements of asset sales may have positive effects on share value, the underlying causes send negative signals. They contend that asset sales reflect managers' admission of prior misjudgments about the cash-flow prospects of assets and thus portend bad news for equity value. In an analysis of the effect of divestiture on shareholder wealth, Rosenfeld (1984) notes that asset sales may signal managers' struggle to raise cash to maintain solvency or they may represent a strategy to divest less profitable units and reinvest in those that are more profitable. In the case of asset sales to maintain solvency, concurrent AX may be viewed and valued less favorably; in the case of asset sales to divest less profitable units, a positive link can be expected between equity value and investments made concurrently with asset sales.

I examine whether AX that accompany asset sales are priced differently for AX- and RX-suited firms. Typically, AX-suited firms are earnings distressed and have incentives to switch resources to lucrative uses. Accordingly, their asset sales and concurrent investments may be motivated by a desire to divest unprofitable ventures and fund profitable ventures. To the extent that asset sales by poor performers are expected or viewed to fund positive net-present-value projects, their AX will be valued positively. However, there is an alternative view that project selection by earnings-distressed firms are motivated by short-term rather than long-term profit goals. Managers of distressed firms face potential job loss and higher recontracting costs and are thus under pressure to improve profits in the near term (Coughlan and Schmidt, 1985; Warner et al., 1988). Such pressures may tempt some AX-suited firms to adapt proceeds from asset sales to projects that generate quick but unsustainable profits (see also Narayanan, 1985). Jensen and Meckling (1976) and Gavish and Kalay (1983) further suggest that such firms often select riskier projects. The thrust of these views is that AX for earnings-distressed firms that are concurrently disposing assets may be perceived as investments with poor long-run profit prospects and may be valued accordingly.

A high-profit firm ordinarily has no incentive to divest profitable units or emphasize suboptimal sale of units. There is less pressure for such firms to sell profitable projects in midstream or to reinvest proceeds from asset sales in questionable projects. Rather, asset sales by profitable firms may signal an improved synergy or a strategy to obtain cheaper funds for more lucrative projects (Hite et al., 1987; John and Ofek, 1995). If investors link investments by profitable firms that are concurrently disposing of assets (i.e., switching resources) with improved focus and better profit prospects, investments by such firms can be expected to have a positive effect on equity value.

To examine whether asset sales affect the market value of AX, all observations are divided into three groups based on the relative proportion of asset sales to net property, plant, and equipment. This grouping is motivated by the prospect that the size of asset sales conveys additional information about the cash-flow prospects of AX. For example, Miles and Rosenfeld (1983) find that returns to spin-off announcements are increasing in the size of spin-offs. Following this, the bottom, middle, and top groups are identified as the low-, medium-, and high-switching groups, respectively. For each group, Model (7.3) that uses AX and RX-adjusted earnings in lieu of depreciation-adjusted earnings is estimated.[20] The RX-adjusted

[20] As an alternative specification, a three-way interaction among AX, an indicator of the intensity of asset sales, and an indicator of firm-option status was used in a pooled model to assess the effect of asset sales on the market value of AX across the option categories. The inferences based on this latter specification are the same as those based on the three panels described in the text and are omitted for brevity.

Table 5

(A) Regression analysis of the association between earnings and equity value and of the effects of asset sales on the association between equity value and replacement-cost estimates of adaptation investments. Each switching group has 1797 firm-year observations.

$$P_t' = \alpha + \beta E_t' + e \tag{6.1}$$

$$P_t' = \alpha + \alpha_1 D_{\mathrm{M}} + \alpha_2 D_{\mathrm{H}} + \beta E_t' + \beta_1 D_{\mathrm{M}} E_t' + \beta_2 D_{\mathrm{H}} E_t' + \pi \mathrm{AX}_{Ct}' + \pi_1 D_{\mathrm{M}} \mathrm{AX}_{Ct}' + \pi_2 D_{\mathrm{H}} \mathrm{AX}_{Ct}' + e \tag{7.3}$$

P' = market value of equity scaled by beginning-period book equity; D_{M} (D_{H}) = indicator variable equal to 1 if a firm-year is in medium (high) earnings-to-book ratio panel, and 0 otherwise; E' = RX−adjusted earnings scaled by beginning-period book equity; AX′ = adaptation investments scaled by beginning-period book equity

Parameter	Model (6.1)	Piecewise model		
		Low switching	Medium switching	High switching
α (t)	1.457 (17.22)***	1.309 (14.91)***	1.749 (11.93)***	1.881 (16.99)***
$\alpha+\alpha_1$ (t)		1.214 (5.08)***	1.007 (4.88)***	1.134 (4.35)***
$\alpha+\alpha_2$ (t)		0.334 (0.72)	0.490 (0.50)	0.551 (1.04)
β (t)	7.158 (25.41)***	− 2.363 (−5.04)***	− 1.352 (− 3.09)	− 1.012 (− 4.23)
$\beta+\beta_1$ (t)		5.114 (7.01)***	8.418 (5.23)***	9.649 (5.93)***
$\beta+\beta_2$ (t)		14.890 (10.51)***	15.241 (13.58)***	17.735 (19.30)***
π (t)		3.810 (5.58)***	2.289 (3.65)*	1.151 (2.79)**
$\pi+\pi_1$ (t)		0.779 (1.19)	1.351 (2.71)	3.447 (4.53)***
$\pi+\pi_2$ (t)		− 2.513 (− 3.45)**	− 1.119 (− 2.78)**	7.339 (5.77)***
F value	906.55	162	152	208
(p value)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
$\bar{R}^2$	0.18	0.44	0.47	0.50
$\%\bar{R}^2$	–	144%	161%	178%
Z: $\bar{R}^2 > \bar{R}_6^2$	–	3.87	4.50	4.85
(p value)		(0.0001)	(0.0001)	(0.0001)

$\mathrm{RX_C}$ and $\mathrm{AX_C}$ are estimates of replacement and adaptation investments, respectively, obtained from the replacement cost of fixed assets. First, replacement cost is divided by remaining life of fixed assets to obtain $\mathrm{RX_C}$. Second, $\mathrm{RX_C}$ is subtracted from aggregate capital expenditures to obtain $\mathrm{AX_C}$. Low, medium, and high switching panels are the bottom, middle, and top firm-year observations from three firm-year panels ranked by on the ratio of asset sales to net property, plant, and equipment. Z values are based on Vuong's Z test for model selection.

(B) Regression analysis of the association between earnings and equity value and of the effects of asset sales on the association between equity value and proxies of adaptation investments based on OLS. Each switching group has 1797 firm-year observations.

$$P_t' = \alpha + \beta E_t' + e \tag{6.1}$$

$$P_t' = \alpha + \alpha_1 D_{\mathrm{M}} + \alpha_2 D_{\mathrm{H}} + \beta E_t' + \beta_1 D_{\mathrm{M}} E_t' + \beta_2 D_{\mathrm{H}} E_t' + \pi \mathrm{AX}_{\mathrm{R}t}' + \pi_1 D_{\mathrm{M}} \mathrm{AX}_{Rt}' + \pi_2 D_{\mathrm{H}} \mathrm{AX}_{\mathrm{R}t}' + e \tag{7.3}$$

P′ = market value of equity scaled by the beginning-period book equity; D_{M} (D_{H}) = indicator variable equal to 1 if a firm-year is in medium (high) earnings-to-book ratio panel, and 0 otherwise; E' = RX-adjusted earnings scaled by the beginning-period book equity; AX′ = adaptation investments scaled by the beginning-period book equity.

Parameter	Base model (earnings only)	Piecewise model		
		Low switching	Medium switching	High switching
α (t)	1.457 (17.22)***	1.168 (10.27)***	1.271 (10.75)***	1.490 (11.78)***
$\alpha+\alpha_1$ (t)		0.973 (6.52)***	1.102 (4.84)***	1.194 (6.19)***
$\alpha+\alpha_2$ (t)		0.721 (2.07)*	0.775 (2.80)*	0.827 (1.91)*

Table 5 (*continued*)

Parameter	Base model (earnings only)	Piecewise model		
		Low switching	Medium switching	High switching
β (t)	7.158 (25.41)***	− 5.284 (− 5.61)***	− 4.33 (− 7.18)	− 3.192 (− 8.10)
$\beta+\beta_1$ (t)		5.290 (9.74)***	5.051 (4.67)***	8.138 (6.45)***
$\beta+\beta_2$ (t)		13.755 (12.27)***	13.789 (11.22)***	15.04 (14.08)***
π (t)		2.773 (3.88)***	2.716 (2.59)*	1.554 (2.99)***
$\pi+\pi_1$ (t)		0.447 (1.01)	1.035 (2.71)*	2.657 (5.37)***
$\pi+\pi_2$ (t)		− 1.288 (− 2.07)*	0.079 (0.58)	8.127 (10.39)***
F value	905.55	100	118	126
(p value)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
$\bar{R}^2$	0.18	0.43	0.45	0.51
$\%\Delta\bar{R}^2$	–	139%	150%	183%
Z: $\bar{R}^2>\bar{R}_{6.1}^2$	–	3.33	3.56	4.68
(p value)		(0.0004)	(0.0002)	(0.0001)

RX_R and AX_R are estimates of replacement and adaptation investments, respectively, from regressing aggregate capital expenditures on depreciation, where the predicted level of capital expenditures proxies for RX_R and the regression residual proxies for AX_t. Low, medium, and high switching panels are the bottom, middle, and top firm-year observations from three firm-year panels ranked by the ratio of asset sales to net property, plant, and equipment. Z values are based on Vuong's Z test for model selection.

* Statistically significant at the 0.05 level.

** Statistically significant at the 0.01 level.

*** Statistically significant at the 0.0001 level.

earnings are obtained by replacing the depreciation in earnings with the estimated RX. The adjustment is an attempt to include a forward-looking measure of depreciation in earnings.[21] The results based on the alternative proxies of AX are presented in Table 5.

In Table 5A, asset sales appear to affect the market value of investments differently for AX- and RX-suited firms. For AX-suited firms, asset sales have positive effects on the market value of AX, on average. Among these firms, however, the coefficient on AX is highest and most significant for the low-asset-sales group; the coefficient is lowest and least significant for the high-asset-sales group. One possible explanation for the muted effect of asset sales on the market value of AX among the low-asset-sales group is that when low-profit firms divest aggressively to finance new projects, their actions are seen as an effort to avoid external monitoring that accompanies external financing (see Lang et al., 1995; Alderson and Betker, 1995) and are valued accordingly. For medium- and high-profit firms, the coefficient on AX increases with the intensity of asset sales (although negative for high-profit firms in low- or mid-asset-sales group). A possible interpretation of these latter results is that, for medium- and high-profit firms, higher levels of asset sales provide more credible information about investment quality and, accordingly, affect the market value of concurrent AX more positively. Adaptation investments by medium- and high-profit firms can thus be expected to have a more positive effect on equity value when asset sales are substantial and aggressive.

The results in Table 5B are similar to those in Table 5A and indicate that the valuation weight of AX decreases with the intensity of asset sales for low-profit firms but increases

[21] Early attempts to justify forward-looking measures of depreciation as a more relevant index of capital consumption than original-cost depreciation include Anton (1956), Bierman (1961), Meyers (1973), and McIntyre (1977). Critics argue that the methods used to derive such measures are fraught with practical problems that make the present-value calculations inconsistent across time and firms (e.g., Drake, 1962).

with the intensity of asset sales for medium- and high-profit firms. A possible explanation for this result is that aggressive disposition of assets and concurrent investments in new projects by profitable firms may be perceived as a credible signal of increases in efficiency or an evidence of strategic adaptation of resources, or both (see also John and Ofek, 1995).

5.4. Robustness check: return specification

In cross-section, price-level models suffer from heteroskedasticity because of scale differences and cross-sectional variation in the slope. Price-earnings models also suffer from omitted-variables bias because the current price has information about expected future earnings that is not in current earnings. In the preceding sections, RX and AX are included as variables that have additional information about future earnings (and will mitigate the omitted-variables bias). The variables are also deflated by the book value of equity to reduce heteroskedasticity. Despite such measures, Kothari and Zimmerman (1995) recommend using a return specification to reduce heteroskedasticity and other specification problems. To this effect, the return equivalents of Models (7.2) and (7.3) are estimated in a framework similar to the return model used by Kothari and Zimmerman in their Eq. (2). For brevity, the models are re-estimated with proxies of RX and AX obtained from the replacement-cost procedure. The models are written as:

$$\begin{aligned} R_t = {} & \alpha + \alpha_1 D_{\mathrm{M}} + \alpha_2 D_{\mathrm{H}} + \beta E_t' + \beta_1 D_{\mathrm{M}} E_t' + \beta_2 D_{\mathrm{H}} E_t' + \gamma \mathrm{CPX}_t' \\ & + \gamma_1 D_{\mathrm{m}} \mathrm{CPX}_t' + \gamma_2 D_{\mathrm{H}} CPX_t' + e. \end{aligned} \tag{8}$$

$$\begin{aligned} R_t = {} & \alpha + \alpha_1 D_{\mathrm{M}} + \alpha_2 D_{\mathrm{H}} + \beta E_t' + \beta_1 D_{\mathrm{M}} E_t' + \beta_2 D_{\mathrm{H}} E_t' + \kappa \mathrm{RX}_t' + \kappa_1 D_{\mathrm{M}} \mathrm{RX}_t' \\ & + \kappa_2 D_{\mathrm{H}} \mathrm{RX}_t' + \pi \mathrm{AX}_t' + \pi_1 D_{\mathrm{M}} \mathrm{AX}_t' + \pi_2 D_{\mathrm{M}} \mathrm{AX}_t' + e. \end{aligned} \tag{9}$$

As in Kothari and Zimmerman (1995), $R_t = P_t / P_{t-1}$ and all other variables are defined as before, except that they are deflated by the beginning-period price, P_{t-1}. To reduce the bias in test results caused by pooling data across time, each coefficient is estimated as the mean of the coefficients from annual regressions, and the t value is the ratio of the mean coefficient to the standard error of the annual coefficients. The results are shown in Table 6.

Table 6A reports the results for Model (8) in column 2 and for Model (9) in column 3. In general, all conclusions about the market effects of book value, earnings, CPX, and components of CPX based on the deflated-price models are unaltered. For example, in both columns, the intercept is highest for AX-suited firms and declines with increases in earning-to-book ratio; by contrast, the coefficient on earnings is highest for RX-suited firms and negative for AX-suited firms. The coefficient on aggregate CPX (column 2) is most significant for AX-suited firms and decreases with increases in earnings-to-book ratio. The coefficients on RX and AX (column 3) also decrease with increases in earnings-to-book ratio. The RX coefficient is reliably negative for the high-profit groups. These results parallel those from the deflated-price models. Note, however, that the response coefficients in the return model are smaller in absolute size than those from the deflated-price models (which, perhaps, reflects the effects of prices leading earnings).

Table 6

(A) Analyses of the effects of earnings and capital expenditure types on return across firm-year indicators of low, medium, and high earning-to-book ratios for a sample of 5391 firm-year observations for manufacturing firms.

$$R_t = \alpha + \alpha_1 D_M + \alpha_2 D_H + \beta E_t' + \beta_1 D_M E_t' + \beta_2 D_H E_t' + \gamma \mathrm{CPX}_t' + \gamma_1 D_M \mathrm{CPX}_t' + \gamma_2 D_H \mathrm{CPX}_t' + e \quad (8)$$

$$R_t = \alpha + \alpha_1 D_M + \alpha_2 D_H + \beta E_t' + \beta_1 D_M E_t' + \beta_2 D_H E_t' + \kappa \mathrm{RX}_t' + \kappa_1 D_M \mathrm{RX}_t' + \kappa_2 D_H \mathrm{RX}_t' + \pi \mathrm{AX}_t' + \pi_1 D_M \mathrm{AX}_t' + \pi_2 D_M \mathrm{AX}_t' + e \quad (9)$$

$R_t = P_t/P_{t-1}$, where P_t is the year-end closing price; E' = earnings; CPX$'$ = total capital expenditures, RX$'$ = replacement investments (estimated as total replacement cost of fixed plant and equipment divided by the remaining life of fixed plant and equipment); AX$'$ = adaptation investments (estimated as CPX$'$ − RX$'$). All variables are deflated by the beginning-period price, P_{t-1}. Each coefficient is the mean of the coefficients from annual regressions; the t value is the ratio of the mean coefficient to the standard error of the annual coefficients.

Parameter	Model (8)	Model (9)
α (t)	0.0063 (1.82)*	0.0077 (2.18)**
$\alpha+\alpha_1$ (t)	0.0054 (1.41)	0.0049 (1.29)
$\alpha+\alpha_2$ (t)	0.0026 (0.87)	0.0038 (1.33)
β (t)	− 0.0081 (− 1.25)***	− 0.0889 (− 1.86)*
$\beta+\beta_1$ (t)	0.1449 (2.77)**	0.1465 (3.11)**
$\beta+\beta_2$ (t)	0.4430 (4.59)***	0.4605 (5.38)***
γ (t)	0.2349 (7.00)***	
$\gamma+\gamma_1$ (t)	0.1583 (3.29)**	
$\gamma+\gamma_2$ (t)	0.1007 (3.55)**	
κ (t)		0.0532 (2.73)**
$\kappa+\kappa_1$ (t)		0.0243 (1.83)**
$\kappa+\kappa_2$ (t)		− 0.0397 (−1.29)
π (t)		0.4856 (3.29)**
$\pi+\pi_1$ (t)		0.2154 (3.01)***
$\pi+\pi_2$ (t)		0.1955 (2.17)*
Mean adjusted R^2	0.0710	0.0923

(B) Analyses of the effects of asset sales on the association between returns and RX-adjusted earnings and adaptation investments, across firm-year indicators of low, medium, and high earning-to-book ratios. Each switching group has 1797 firm-year observations.

$$R_t = \alpha + \alpha_1 D_M + \alpha_2 D_H + \beta E_t' + \beta_1 D_M E_t' + \beta_2 D_H E_t' + \pi \mathrm{AX}_t' + \pi_1 D_M \mathrm{AX}_t' + \pi_2 D_H A \mathrm{X}_t' + e \quad (7.3)$$

$R_t = P_t/P_{t-1}$, where P_t is the year-end closing price; D_M (D_H) = indicator variable equal to 1 if a firm-year is in medium (high) earnings-to-book ratio panel, and 0 otherwise; E' = RX-adjusted earnings scaled by the beginning-period price; AX$'$ = adaptation investments scaled by the beginning-period price.

Parameter	Piecewise model		
	Low switching	Medium switching	High switching
α (t)	0.0291 (2.08)*	0.0183 (2.49)*	0.0371 (3.11)**
$\alpha+\alpha_1$ (t)	0.0475 (2.44)*	0.0124 (2.22)*	0.0592 (2.48)*
$\alpha+\alpha_2$ (t)	0.0756 (3.09)**	0.0180 (2.30)*	0.0834 (2.77)**
β (t)	− 0.3508 (− 3.51)**	− 0.07319 (− 1.43)	0.0672 (2.65)*
$\beta+\beta_1$ (t)	− 0.1450 (− 1.26)	0.1025 (2.18)*	0.2273 (3.05)***

(continued on next page)

Table 6 (*continued*)

Parameter	Piecewise model		
	Low switching	Medium switching	High switching
$\beta+\beta_2$ (t)	0.1973 (2.75)**	0.2315 (2.99)**	0.4537 (4.31)***
π (t)	0.4953 (4.57)***	0.1935 (2.14)*	0.1680 (2.35)*
$\pi+\pi_1$ (t)	0.0956 (2.36)*	0.1422 (2.09)*	0.2946 (3.12)**
$\pi+\pi_2$ (t)	0.0089 (1.03)	0.0571 (1.18)	0.7674 (4.83)***
Adjusted R^2	0.0557	0.1131	0.1208

RX_C and AX_C are estimates of replacement and adaptation investments, respectively, obtained from the replacement cost of fixed assets. First, replacement cost is divided by remaining life of fixed assets to obtain RX_C. Second, RX_C is subtracted from aggregate capital expenditures to obtain AX_C. Low, medium, and high switching panels are the bottom, middle, and top firm-year observations from three firm-year panels ranked by the ratio of asset sales to net property, plant, and equipment.

* Statistically significant at the 0.05 level.

** Statistically significant at the 0.01 level.

*** Statistically significant at the 0.0001 level.

Table 6B presents the results for three panels of firm-year observations ranked by the ratio of assets sales to the beginning-period PPE. These results are the counterpart of the deflated-price results based on the piecewise models in Table 5A, which evaluate the extent to which the intensity of asset sales mediates the association between AX and equity value. The pattern of the coefficients suggests that the returns on AX decrease with the intensity of asset sales for low-profit firms but increase with the intensity of asset sales for medium- and high-profit firms. Again, these results parallel those reported under the deflated-price models.[22]

5.5. Additional considerations

In practice, option decisions are made in imperfect and uncertain settings and are influenced by agency costs. The literature reports that debt, liquidity, information problems, and such affect the timing and quality of project selection. Jensen and Meckling (1976) argue that external financing has limited appeal for owner-managers in that it dilutes their stakes. Existing debt can also limit a firm's ability to obtain external financing. As a result, firms may shelve profitable projects when funds are unavailable internally. Myers and Majluf (1984) note that information asymmetry between managers and investors affect financing decisions. Information asymmetry raises the cost of external capital and thus constrains investments when funds are unavailable internally. Lamont (1997) also discusses agency costs of illiquidity that influence investment decisions. The consequence of such influences is that some AX-suited firms may continue to maintain

[22] As another robustness check, Models (7.2) and (7.3) are re-estimated using a maximum likelihood (ML) method with a multiplicative heteroskedastic error structure proposed by Harvey (1976). The model expresses the squared residual as a function of the explanatory variables, thus: $E(e_t^2)=\exp\{Z_t'\alpha^*\}$, where $Z_t'=\{z_{t1}, z_{t2},\ldots, z_{tm}\}$ is a $(1\times m)$ vector of the explanatory variables with $z_{t1}=1$, and $\alpha^*=\{\alpha_{t1}, \alpha'\}\equiv\{\alpha_1, \alpha_2, \ldots, \alpha_m\}'$ is an $(m\times 1)$ vector of unknown coefficients with $\alpha_1=\ln\sigma^2$. Harvey (1976) shows that, with such an error structure, the ML estimate for $(\beta', \sigma^2, \alpha')$ is asymptotically efficient. The results based on this specification (not shown for brevity) parallel those based on the OLS method. However, the ML statistic is significant for both models and suggests that the ML estimators are more efficient than the OLS estimators.

projects for which profits are below acceptable levels, and some RX-suited firms may switch prematurely to less profitable projects (see also Balakrishnan, 1991).[23]

To examine the sensitivity of results to some of these control factors, Model (7.3) was re-estimated with a proxy for leverage, liquidity, and information asymmetry. The leverage index is the ratio of debt to book value of equity; the liquidity index is the lagged value of operating cash flows deflated by book value of equity; and information asymmetry for a firm-year is represented by an indicator variable equal to 1 when the number of analysts following a firm exceeds the median number of analysts following the same firm for that year, and 0 otherwise. The three control variables are entered as additional explanatory variables. The results and inferences about the market value effects of RX and AX (not presented separately for brevity) are similar to the results and inferences described in the preceding sections.

6. Summary and conclusion

This study is an exploratory analysis of the market effects of RX and AX. Indexes of RX and AX are constructed from the balance sheet and from income statement data. The empirical predictions of the relative effects of the two investment types on equity value are derived from the real-options theory that stresses the link between firm value and the option a firm has either to deploy its resources recursively or to adapt its resources to alternative uses. The findings are that the effect of RX on equity value is reliably negative. The negative effect is increasing in the earnings-to-book-value ratio. This result is contrary to one of the key arguments in this study that RX are more desirable when existing projects are profitable. I speculate that, as has been noted in the literature on agency costs, high-profit firms tend to expand capital beyond the level justified by demand and to overcontinue unprofitable projects, causing the market to impose an extra penalty on their replacement investments. The effect of AX on equity value is, by contrast, mostly positive and decreasing in the earnings-to-book-value ratio. This finding is consistent with the prediction that AX are, on average, viewed by the market as enhancing shareholder value.

Across several designs, RX and AX are shown to possess valuable information incremental to the information in earnings and book value: the models in which the two investment types are specified separately achieve higher explanatory power over models that include their combined value. From a financial analysis standpoint, this finding raises the prospect that separate disclosures of RX and AX can yield relevant inputs for assessing firm value. Further analyses show that asset sales by AX-suited firms have a positive effect on market value of adaptation. However, for RX-suited or high-profit firms, tepid or modest asset sales appear to have a negative or little effect on the market value of adaptation, whereas aggressive asset sales have a large positive effect on the market value of adaptation. This latter result may reflect the market's belief that aggressive sale of assets by lucrative firms reliably signals improvement in efficiency and strategic adaptation of resources to more profitable uses.

[23] Asset sales and write-offs are, perhaps, ex post manifestations of investments on which the residual benefits are below acceptable levels. Increasing levels of asset sales and restructuring across industries and firms in recent years are an indication that businesses are continually switching and adapting resources to new uses (see Elliott and Hanna, 1996; Francis et al., 1996; Rees et al., 1996).

Appendix A

(A) Mean coefficients from the annual regressions of market value of equity on earnings (Model (6.1)), on earnings and capital expenditures (Model (6. 2)), and on earnings and alternative proxies of replacement and adaptation investments (Models (6.3a) and (6.3b))

Model	α (t)	β (t)	γ (t)	κ (t)	π (t)
(6.1)	1.39	7.08			
	(9.22)***	(13.52)***			
(6.2)	1.45	6.81	1.14		
	(7.28)***	(5.99)***	(3.88)***		
(6.3a)	1.51	7.00		−1.05	2.69
	(8.41)***	(6.35)***		(−2.09)*	(4.27)***
(6.3b)	1.62	6.98		0.79	1.77
	(12.33)***	(5.02)***		(−2.00)*	(2.94)**

(B) Mean coefficients from the annual regressions of market value of equity on earnings and proxies of various capital expenditure types, across firm- year indicators of low, medium, and high earnings- to- book ratios (proxying for adaptation, mixed, and replacement investment options, respectively)

Model	α (t)	$\alpha+\alpha_1$ (t)	$\alpha+\alpha_2$ (t)	β (t)	$\beta+\beta_1$ (t)	$\beta+\beta_2$ (t)	γ (t)	$\gamma+\gamma_1$ (t)	$\gamma+\gamma_2$ (t)	κ (t)	$\kappa+\kappa_1$ (t)	$\kappa+\kappa_2$ (t)	π (t)	$\pi+\pi_1$ (t)	$\pi+\pi_2$ (t)
(7.1)	1.54	1.26	0.40	−4.89	6.52	15.17									
	(11.24)***	(16.93)***	(1.31)	(−6.98)***	(8.72)***	(8.96)***									
(7.2)	1.16	1.04	0.32	−4.67	5.99	14.90	3.71	2.11	0.84						
	(8.95)***	(11.96)***	(1.05)	(−6.52)***	(7.28)***	(8.96)***	(4.93)***	(5.75)***	(1.28)						
(7.3a)	1.35	1.24	0.52	−4.77	5.75	15.77				3.11	1.21	−1.15	5.16	2.80	0.76
	(8.70)***	(12.75)***	(1.59)	(−6.80)***	(6.88)***	(8.74)***				(4.35)***	(2.97)***	(−1.92)*	(6.30)***	(4.66)***	(1.17)
(7.3b)	1.40	1.31	0.48	−5.76	3.88	11.98				2.57	1.77	−1.83	5.76	2.61	0.66
	(5.95)***	(12.64)***	(0.98)	(−7.32)***	(4.81)***	(14.03)***				(1.99)*	(3.80)***	(−2.05)*	(4.12)***	(4.60)***	(1.25)

Each coefficient is the mean of the coefficients from annual regressions. The t value is the ratio of the mean coefficient to the standard error of the coefficients.

* Statistically significant at the 0.05 level.

** Statistically significant at the 0.01 level.

*** Statistically significant at the 0.0001 level.

References

Alderson, M.J., Betker, B.L., 1995. Liquidation costs and capital structure. Journal of Financial Economics 39, 45–69.

Alexander, G.J., Benson, P.G., Kampmeyer, J.M., 1984. Investigating the valuation effects of announcements of voluntary corporate selloffs. Journal of Finance 39, 503–517.

Ambarish, R., John, K., Williams, J., 1987. Efficient signaling with dividends and investments. Journal of Finance 42, 321–344.

Amihud, Y., Lev, B., 1981. Risk reduction as a managerial motive for conglomerate mergers. The Bell Journal of Economics 12, 605–617.

Anton, H.R., 1956. Depreciation, cost allocation, and investment decisions. Accounting Research 117, 134.

Baber, W.R., Janakiraman, S.U., Kang, S.-H., 1996. Investment opportunities and the structure of executive compensation. Journal of Accounting and Economics 21, 297–318.

Balakrishnan, R., 1991. Information acquisition and resource allocation decisions. The Accounting Review 66, 120–139.

Barth, M., Kallapur, S., 1996. The effects of cross-sectional scale differences on regression results in empirical accounting research. Contemporary Accounting Research 13, 527–567.

Barth, M., Beaver, W.H., Landsman, W., 1998. Relative valuation roles of equity book value and net income as a function of financial health. Journal of Accounting and Economics 25, 1–34.

Bar-Yosef, S., Callen, J.L., Livnat, J., 1987. Autoregressive modeling of earnings–investment causality. Journal of Finance 42, 11–28.

Berger, P.E., Ofek, E., Swary, I., 1996. Investor valuation of abandonment option. Journal of Financial Economics 42, 257–287.

Bernard, V.L., 1987. Cross-sectional dependence and problems of inference in market-based accounting research. Journal of Accounting Research 25, 1–48.

Bierman, H., 1961. Depreciable assets—timing of expense recognition. The Accounting Review 36, 613–618.

Blackwell, D., Marr, M.W., Spivey, M., 1990. Plant closing decisions and the market value of the firm. Journal of Financial Economics 26, 277–288.

Burgstahler, D.C., Dichev, I.D., 1997. Earnings, adaptation, and equity value. The Accounting Review 72, 187–215.

Chambers, D., Jennings, R., Thompson, R.B., 1999. Evidence on the usefulness of capital expenditures as an alternative measure of depreciation. Review of Accounting Studies 4, 169–195.

Chan, S.H., Gau, G.W., Wang, K., 1995. Stock market reaction to capital investment decisions: evidence from business relocations. Journal of Financial and Quantitative Analysis 30, 81–100.

Chung, K.H., Wright, P., Charoenwong, C., 1998. Investment opportunities and market reaction to capital expenditures. Journal of Banking and Finance 22, 41–60.

Collins, D.W., Pincus, M., Xie, H., 1999. Equity valuation and negative earnings: the role of book value of equity. The Accounting Review 74, 29–61.

Coughlan, A.T., Schmidt, R.M., 1985. Executive compensation, management turnover, and firm performance: an empirical investigation. Journal of Accounting and Economics 7, 43–66.

Demski, J.S., Sappington, D.E.M., 1987. Delegated expertise. Journal of Accounting Research 25, 68–89.

Drake, D., 1962. The service potential concept and interperiod tax allocation. The Accounting Review 37, 677–684.

Dyl, E.A., Long, H.W., 1969. Abandonment value and capital budgeting: comment. Journal of Finance 24, 88–95.

Elliott, J.A., Hanna, J.D., 1996. Repeated accounting write-offs and the information content of earnings. Journal of Accounting Research 34, 135–155 (Suppl.)

Fama, E., Jensen, M.C., 1985. Organizational forms and investment decisions. Journal of Financial Economics 14, 101–119.

Fama, E., Miller, M.H., 1972. The Theory of Finance. Dryden Press, Hinsdale, IL.

Fazzari, S., Hubbard, G., Petersen, B., 1988. Financial constraints and corporate investments. Brookings Papers on Economic Activity 1, 141–195.

Francis, J., Hanna, J.D., Vincent, L., 1996. Causes and effects of discretionary asset write-offs. Journal of Accounting Research 34, 117–134 (Suppl.)
Gaver, J., Gaver, K., 1993. Additional evidence on the association between the investment opportunity set and corporate financing, dividend, and compensation policies. Journal of Accounting and Economics 16, 125–160.
Gavish, B., Kalay, A., 1983. On the asset substitution problem. Journal of Financial and Quantitative Analysis 18, 21–30.
Harvey, A.C., 1976. Estimating regression models with multiplicative heteroscedasticity. Econometrica 44, 461–465.
Hayn, C., 1995. The information content of losses. Journal of Accounting and Economics 20, 125–153.
Hite, G., Owers, J., Rogers, R., 1987. The market for interfirm asset sales: partial sell-offs and total liquidations. Journal of Financial Economics 18, 229–252.
Hoshi, T., Kashyap, A., Scharfstein, D., 1991. Corporate structure, liquidity, and investment: evidence from Japanese industrial groups. Quarterly Journal of Economics 106, 33–60.
Jensen, M.C., 1986. Agency costs of free cash flows, corporate finance and takeovers. American Economic Review 76, 323–329.
Jensen, M.C., Meckling, W.H., 1976. Theory of the firm: managerial behaviors, agency costs, and capital structure. Journal of Financial Economics 3, 305–360.
John, K., Mishra, B., 1990. Information content of insider trading around corporate announcements: the case of capital expenditures. Journal of Finance 45, 835–855.
John, K., Ofek, E., 1995. Asset sales and increase in focus. Journal of Financial Economics 37, 105–126.
John, K., Lang, L.H.P., Netter, J., 1992. The voluntary restructuring of large firms in response to performance decline. Journal of Finance 47, 891–917.
Kanodia, C., Bushman, R., Dickhaut, J., 1989. Escalation errors and the sunk cost effect: an explanation based on reputation and information asymmetries. Journal of Accounting Research 27, 59–77.
Kerstein, J., Kim, S., 1995. The incremental information content of capital expenditures. The Accounting Review 70, 513–526.
Kothari, S.P., Zimmerman, J.L., 1995. Price and return models. Journal of Accounting and Economics 20, 155–192.
Lamont, O., 1997. Cash flow and investment: evidence from internal capital markets. Journal of Finance 52, 83–109.
Lang, L., Poulsen, A., Stulz, R., 1995. Asset sales, firm performance, and the agency cost of managerial discretion. Journal of Financial Economics, 3–37.
Lang, L., Ofek, E., Stulz, R.M., 1996. Leverage, investment, and firm growth. Journal of Financial Economics 40, 3–29.
Lev, B., Thiagarajan, S.R., 1993. Fundamental information analysis. Journal of Accounting Research 31, 190–215.
Lewellen, W.G., Badrinath, G.G., 1997. On the measurement of Tobin's q. Journal of Financial Economics 44, 77–122.
Lindenberg, E.B., Ross, S.A., 1981. Tobin's q ratio and industrial organization. Journal of Business 54, 1–32.
McConnell, J.J., Muscarella, C.J., 1985. Corporate capital expenditure decisions and the market value of the firm. Journal of Financial Economics 14, 399–422.
McIntyre, E.V., 1977. Present value depreciation and the disaggregation problem. The Accounting Review 52, 162–171.
Meyers, S.L., 1973. An examination of the relationship between interperiod tax allocation and present value depreciation. The Accounting Review 47, 44–49.
Miles, J.A., Rosenfeld, J.D., 1983. The effect of voluntary spin-off announcements on shareholder wealth. Journal of Finance 38, 1597–1606.
Myers, S.C., 1984. The capital structure puzzle. Journal of Finance 39, 575–592.
Myers, S.C., Majluf, N.S., 1984. Corporate financing and investment decisions when firms have information that investors do not have. Journal of Financial Economics 13, 187–221.
Narayanan, M.P., 1985. Managerial incentives for short-term results. Journal of Finance 40, 1469–1484.

Ohlson, J.A., 1995. Earnings, book value, and dividends in security valuation. Contemporary Accounting Research 11, 661–687.
Ou, J.A., 1990. The information content of nonearnings accounting numbers as earnings predictors. Journal of Accounting Research 82, 144–163.
Rees, L., Gill, S., Gore, R., 1996. An investigation of asset write-downs and concurrent abnormal returns. Journal of Accounting Research 34, 157–169 (Suppl.)
Robichek, A.A., Van Horne, J.C., 1967. Abandonment value and capital rationing. Journal of Finance 22, 577–589.
Roll, R., 1986. The hubris hypothesis of corporate takeovers. Journal of Business 59, 197–216.
Rosenfeld, J.D., 1984. Additional evidence on the relation between divestiture announcements and shareholder wealth. Journal of Finance 39, 1437–1448.
Shleifer, A., Vishny, R.W., 1992. Liquidation values and debt capacity: a market equilibrium approach. Journal of Finance 47, 1343–1366.
Skinner, D., 1993. The investment opportunity set and accounting procedure choice. Journal of Accounting and Economics 16, 407–446.
Smirlock, M.T., Gilligan, T., Marshall, W., 1984. Tobin's q and the structure–performance relationship. American Economic Review 74, 1051–1060.
Smith, C., Watts, R., 1992. The investment opportunity set and corporate financing, dividend, and compensation policies. Journal of Financial Economics 33, 263–392.
Subramanyam, K., Wild, J., 1996. The going concern status, earnings persistence, and informativeness of earnings. Contemporary Accounting Research 13, 251–273.
Tan, P.M.S., 2000. Project termination decisions, underinvestment, and overinvestment. Contemporary Accounting Research 17, 135–170.
Trueman, B., 1986. The relationship between the level of capital expenditures and firm value. Journal of Financial and Quantitative Analysis 21, 115–129.
Vuong, Q.H., 1989. Likelihood ratio tests for model selection and non-nested hypotheses. Econometrica 57, 307–333.
Warner, J.B., Watts, R.L., Wruck, K.H., 1988. Stock prices and top management changes. Journal of Accounting and Economics 20, 461–492.
Woolridge, J.R., 1988. Competitive decline and competitive restructuring: is a myopic stock market to blame? Journal of Applied Corporate Finance, 26–36.
Yee, K.K., 2000. Opportunities knocking: residual income valuation of an adaptive firm. Journal of Accounting, Auditing & Finance 15, 225–270.