A Comparison of the Clean Surplus and Prospect Theory Valuation Models

Zane L. Swanson
University of Central Oklahoma

Richard Alltizer

This study investigates the explanatory power of the clean surplus versus prospect theory valuation models. Literature argues the approaches are consistent from a theoretical perspective (Levy, De Giorgi and Hens 2012). To the authors' knowledge, this the first empirical study to compare comprehensively these approaches, in particular, before and after the 2008 financial crisis. The clean surplus model appears to be a better predictor of firm value than prospect theory. The study is comprehensive with base case analyses, and model performance in regards to growth options, size/risk factors, and the pre/post 2008 crash periods.

INTRODUCTION

Theoretical literature (Levy, De Giorgi and Hens 2012) claims prospect theory and traditional linear risk/return capital market theory (as may be evidenced by the clean-surplus approach) are consistent. Prospect theory (as is discussed in detail later in this paper) takes a behavioral approach to investment decision-making where the value of gains (e.g., earnings) diminishes as one makes more money above a reference point (e.g., book value). On the other hand, the clean-surplus model presumes a "rational" expectation of a positive linear relation of earnings and firm investment value. Ultimately, investors and researchers should be interested in the characteristics of theoretical drivers of firm value in the stock market so as to facilitate the best allocation of resources in the context of firm valuation. Therefore, we have a motivation for this study's major purpose which is to empirically compare whether the clean surplus model (Ohlson, 1995) or the prospect theory model (Kahneman and Tversky,1979) better explains firm value in a variety of circumstances.

Richardson, et al. (2010) cite the clean surplus model as the best place to begin fundamental analyses of firm value. However, past literature has raised concerns about the clean surplus theory. For example, Lyle et al. (2013) question the clean surplus theory in terms of risk and return. And so, the aforementioned work helps motivate the current work's empirical research focus.

The current study empirically tests the rigor of the Ohlson model against the alternative behavioral economics proposition based on Kahneman and Tversky's prospect theory. This study's methodology will cover the following conditions: 1) pre/post 2008 crash subsamples 2), model formulations without and with growth options, 3) high/low risk subsamples and 4) high/low size subsamples. These features are appropriate empirical characteristics for robustness conclusions of any comparison. In particular, the 2008 crash deserves attention because the economy shifted dramatically from an expansion mode to a depression/recovery situation. Thus, it is appropriate to analyze the accounting information impact. The true accounting information dynamic for valuation purposes is an empirical question and is addressed in this study.

For valuation research frontier purposes, the study utilizes an analytical framework based upon Lang and Litzenberger's (1989) adaptation of Modigliani and Miller's (1966) limited growth model. This research framework facilitates an examination including intangible asset growth options of the subjective value of R&D, and the tangible asset impact of capital expenditures. Richardson et al. (2010) identify both R&D and capital expenditures as inherently risky. As part of the aforementioned decision process, investors and researchers have reason to consider the implications of firm growth options (R&D and capital expenditure) in the context of various economic factors. For example, do the growth options exhibit increasing or decreasing returns on investment? Will firm characteristics affect the growth option impact? Incorporating intangible R&D and tangible capital asset options gives a full firm perspective. This study investigates these research questions because context is important for wealth maximization. With regards to the last two motivators, investors should be interested in the risk/return impact of these variables in the context of valuation models. The reason for examining risk and size is that they are key attributes for the financial statement user in considering the context of valuations. Thus, both risk and size sensitivities are tested.

From an overall perspective, empirical results indicate that both clean surplus and prospect theory models are potentially useful for researchers and investors. Utilizing Vuong tests, the findings also suggest that the clean surplus model has greater explanatory power over the prospect theory approach. The empirical results also provide significant support for a growth option model version vis-à-vis the base case clean surplus and prospect theory models. The remainder of the paper is organized into four sections covering literature review, empirical framework, results, and finally, summary in the final section.

LITERATURE REVIEW

Overview

Congruent with the study's purpose, this section reviews the alternative valuation approaches of the clean surplus model, and the prospect theory formulation. And, a subsection gives background for the assets-in-place / growth option framework which is also used in the empirical analyses. It is an adaptation of the Lang and Litzenberger (1989) limited growth model.

Clean Surplus Model

The Ohlson (1995) clean surplus model postulates an equation where firm market price relates to a company's book value and earnings. In Ohlson's conceptual framework, Feltham and Ohlson (1995) begin with a basic algebraic accounting relation as follows:

$$BV_t = BV_{t-1} + X_t - D_t \tag{1}$$

where, D_t = dividends per share at time t,
X_t = earnings per share at time t, and
BV_t = book value per share at time t.

Utilizing market value as discounted cash flow of dividends and equation (1), they derive equity value (firm price) as a linear function of the relative values of book value and earnings. Equation (2) in the empirical section expresses this concept. As such, the clean surplus model provides a theoretical firm valuation framework for investors, regulators and accountants (Kothari 2001). As constituted, the clean surplus theory provides a means for financial statement analysis (Belmonte 2005).

Subsequent to Ohlson's (1995) work, there has been a development of alternative model formulations which are in contrast to the clean surplus model's linear premises. Burgstahler and Dichev (1997) develop an option-style model hypothesizing that firms invest where they can generate value. Burgstahler and

Dichev postulate an adaption model in which firms extract option's worth from book value. Their findings indicate a nonlinear earnings relation with firm price. Their research is a reason for the current study's incorporation of growth options in an analytical framework. From a general perspective, Beaver (2002) supports Ohlson's framework as a platform for future research. There have been limited further clean surplus theory investigations, with one exception applicable to the current study. Mahmood et. al. (2018) examine the implications of negative earnings in the context of clean surplus theory and find that they adversely affect earnings quality. Of course, the rigor of any theory is how well it performs against alternative theoretical explanations, which is the purpose of the current study.

Prospect Theory Model

This study compares the aforementioned clean surplus formulation to an alternative behavioral model which is based upon Kahneman and Tversky's (1979) prospect theory concepts. This literature section discusses the theory from the fundamental psychological principles up through relevant investment literature. Kahneman and Tversky (1979) created prospect theory as a probabilistic approach to individual decision making under uncertainty. Additional financial market research utilizing prospect theory include Li and Yang (2013) and Wasiuzzaman et al. (2015).

A literature review by Barberis (2013) identifies four major elements of prospect theory: "1) reference dependence, 2) loss aversion, 3) diminishing sensitivity, and 4) probability weighting". These elements are key factors in the current work's creation of empirical variables. The following discussion identifies characteristics relevant to the formulation of any prospect theory model.

Reference Dependence

With regards to the first element, in a financial setting, people relate to their losses and gains from a reference point. In the context of the literature, it is apparent that prospect theory is not a heavily researched market model and that its reference point is a key feature which is addressed in this study. In the current analysis, we theorize a reference point of book value. This hypothetical feature is different from prior works which select stock value and investor liability in a financial setting. This approach differs from expected utility theory, which holds that a rational agent is indifferent to the reference point. From a review of the literature, it is apparent that prospect theory is not a heavily researched empirical market model.

Loss Aversion

The second element suggests that losses hurt more than gains feel good, which indicates an asymmetrical condition.

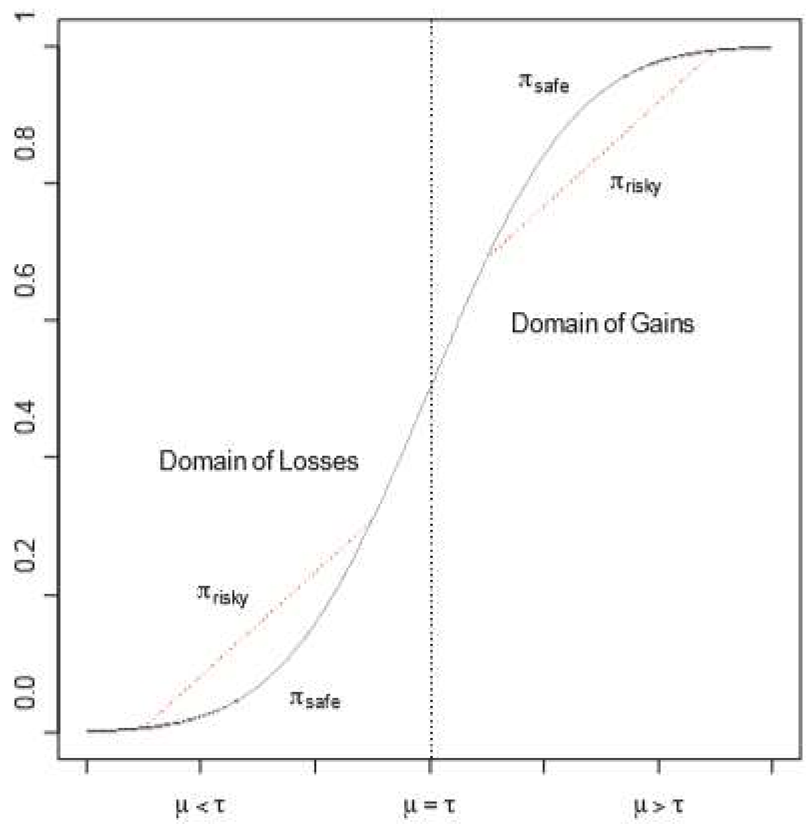
Diminishing Sensitivity

The third element, diminishing sensitivity, defines a value function which is concave for gains and convex for losses. This concept is best understood graphically with McDermott et al (2008) (see Figure 1).

Probability Weighting

The fourth element hypothesizes that people use a probability weighting approach in utility functions, which is demonstrated in Figure 1, where the vertical axis is probability weighting. The probability function that passes through the reference point is s-shaped and asymmetrical. With respect to the reference point in the gains (losses) region, the curvilinear line (prospect theory) is above the straight line (expected utility theory). Figure 1 suggests that individuals overweight (underweight) probabilities in gain (loss) situations. In terms of investor behavior, Tversky and Kahneman (1981) theorize decision making behavior that avoids risk when a positive frame is presented and takes risks in a negative frame setting. Barberis and Huang (2008) report empirical stock market evidence of skewness to support this proposition. From this foundation, researchers (e.g., Barberis and Huang 2008 and Barberis 2013) have extended the principles of prospect theory for use in the analysis of investor stock decision-making.

FIGURE 1
TOTAL PAYOFF



After their original prospect theory paper, Kahneman and Tversky (1992) develop a cumulative prospect theory which provides an umbrella for market studies and financial market theory. Lewandowski (2006) argues that expected utility theory can be regarded as a sub-theory within cumulative prospect theory. In other words, the two theories can measure the same market circumstances in different manners. The cumulative prospect theory concept is consistent with first order stochastic dominance (He and Zhou, 2011) and has been developed into a multiperiod model by Shi et al (2014). There have been other theoretical analyses supportive of this contention in financial markets research. Subramanyam (1996) develops an S-shaped returns-surprise relation based upon an uncertainty principle.

In a further development on this research stream, Levy et al. (2012) present a theoretical financial market analysis, utilizing a firm security market line, establishing that prospect theory is consistent with the established CAPM and von Neumann-Morgenstern's (1954) expected utility framework. Nwogugu (2005) concludes: "Prospect theory, cumulative prospect theory, expected utility theory, and market-risk models are conceptually the same." In other words, across the entire market, both expected utility and prospect theory could express similar aggregate investor decision-making for any specific firm. The empirical research question of prospect theory, in an accounting-price framework, remains open and is a subject of the current study.

Summarizing prospect theory (i.e., the four features), the characteristics hypothesize an individual value function that passes through a reference point and is S-shaped. In expected utility theory, the individual only cares about absolute wealth (e.g. clean surplus theory), and not relative wealth in each situation (e.g. prospect theory). Thus, prospect theory suggests that individuals' assessment of firm value may behave in a nonlinear as opposed to a traditional linear earnings-price manner. It must be noted from the literature that the specific identification of variable(s) for a logical theoretical framework is a challenge.

Challenges to the clean surplus model have been made and alternative theories exist. Thus, the current study empirically tests the rigor of the Ohlson model against a Kahneman and Tversky's prospect theory-based formulation. The Ohlson clean surplus model has been previously identified here as a correct approach. However, challenges to the clean surplus model have been made and alternative theories exist. Thus, the current study empirically tests the rigor of the Ohlson model against Kahneman and Tversky's prospect theory.

Recently, prospect theory validity has been questioned with regards to the proposition that losses being more important than gains (Gal 2018). As previously discussed, our work does not include observations with negative firm value or earnings because they are indicative of firm distress. It does address investor behavior that the present time earnings can fall (or rise) from the previous period. Thus, our measure of firm earnings performance (arctangent) does investigate prospect theory principles as opposed to linear thinking.

R&D and Capital Expenditures as Firm Growth Options

Numerous past studies analyze the effect of R&D and capital asset expenditures with regard to firm valuation. And, that is a reason for including capital expenditures and R&D as part of this study's comparative analysis of the alternative clean surplus and prospect theory model formulations. This section's literature summarizes the growth option background and next section places it in an empirical framework. R&D is identified as a driver of economic growth (Jones, 1995; Ball et al, 2010). Lyle et al. (2013) also present theoretical and empirical analyses indicating that firm fundamental variables (e.g. R&D and capital expenditures) contribute to firm value. Thus, this issue has economic implications (Coccia, 2009) in investor stock selection. Economic literature stresses the value of R&D expenditures, but questions remain open concerning the marginal effectiveness of a dollar spent on R&D with respect to increases in firm value. The literature generally reports a positive market response to firm R&D expenditures (Woolridge, 1988). In support of this proposition, prior research (e.g., Lev and Sougiannis, 1996 and Szewczyk et al., 1996) also finds value relevance when capitalizing R&D. While not as extensive as the R&D research, the literature (e.g. Anthony and Ramesh (1992) and Vafeas and Shenoy (2005)) also supports the proposition that firm value responds positively to capital asset expenditures.

In summary, the literature indicates that expenditures for R&D and capital assets enhance firm value. Based on prior literature, the present study includes variables for both R&D and capital asset expenditures to investigate the impact of growth options on stock prices. And for the purposes of completeness noted in the literature by Amir et al. (2007), this study includes an interaction variable between capital expenditures and R&D.

EMPIRICAL FRAMEWORK

Overview

The empirical design compares two alternative valuation approaches, clean surplus and prospect theory. For purposes of robustness, we extend the analysis examining the effect of growth options as per Lang and Litzenberger (1989).

Base Case Valuation Models

To address this study's research question, we investigate equations (1) and (2) which incorporate information obtained from financial statements and the market. An Ohlson (1995) clean surplus model is presented in equation (2).

$$P_t = \beta_0 + \beta_1 BV_{t-1} + \beta_2 X_t + \varepsilon_t \quad (2)$$

where, P_t = stock price per share plus dividends per share at time t,
X_t = earnings per share at time t,
BV_{t-1} = book value per share at time t-1, and
ε_t = error term at time t.

Prospect theory provides an alternative explanation of firm price as a function of earnings. The empirical formulation for prospect theory utilizes an arctan[1] function of earnings. As previously mentioned in the literature review, this analysis will assume that the initial book value is the reference point. Thus, equation (3) is the empirical model for prospect theory.

$$P_t = \beta_0 + \beta_1 BV_{t-1} + \beta_2 \mathrm{Arctan}X_t + \varepsilon_t \quad (3)$$

The following hypothesis compares the research question of clean surplus versus prospect theory.

H1: *The explanatory power of prospect theory (equation 3) is greater than clean surplus (equation 2).*

Growth Options

Lang and Litzenberger's (1989) limited growth model motivates and provides a theoretical framework sensitivity analysis to the base-case empirical research designs. The cost of capital, the average return on investment and the finite growth horizon are assumed constants. In regards to the prospect theory empirical analysis, the arctangent function is applied to the growth option variables.

Equation (4) is the combination of assets-in-place (base-case equation 2) and growth options (R&D and capital asset expenditures) for the clean surplus investment model. The model assumes that investments for capital expenditures and R&D are made evenly over the year. However, suppose the cash is spent at the beginning of the year, then the BV_{t-1} should be replaced with a variable called BVadj which is BV_{t-1} - $CAPX_t$ - RD_t. This concept was utilized in a sensitivity analysis and dropped because the result was not significantly different than equation (3). The source of the dependent variable, stock price, is market data. An interaction variable between R&D and capital asset expenditures is introduced in equation (4) for model completeness and economic logic. Previous literature (Hall and Hayashi 2010) indicates that firm R&D may influence capital expenditures. Amir et al. (2007) find that R&D and capital expenditures jointly have an impact of subsequent period earnings variability.

All independent variable information comes from the financial statements. This model, based on internal firm characteristics, contrasts with the Fama and French (1993) three-factor market model. In order to place the contrast in perspective, size and risk sensitivity analyses are included in a later section as further robustness checks.

$$P_t = \beta_0 + \beta_1 BV_{t-1} + \beta_2 X_t + \beta_5 CAP_t + \beta_6 RD_t + \beta_7 CAPRD_t + \varepsilon_t \quad (4)$$

where: $CAPX_t$ = capital expenditures per share during time t,
RD_t = R&D expense per share during time t, and
$CAPRD_t$ = $CAPX_t$ times RD_t at time t.

Equation (5) is a *prospect theory* version with the growth options formulation.

$$P_t = \beta_0 + \beta_1 BV_{t-1} + \beta_2 AX_t + \beta_5 ACAPX_t + \beta_6 ARD_t + \beta_7 ACAPRD_t + \varepsilon_t \quad (5)$$

where, “A” specifies the arctangent function is applied to the variable from equation (4).

In this situation, empirical literature is not currently available for the arctangent transformed variables of capital expenditures and R&D, and their interaction. Thus, this information is subject to empirical analysis and gives robustness to the findings. Empirically it is appropriate to assess whether growth options are valid and thus can be used in comparative analyses. Therefore, hypothesis two (which follows) will be analyzed.

H2: *Growth options generate explanatory power.*

With respect to growth options, hypothesis 3 addresses the valuation comparison of clean surplus versus prospect theory.

H3: *The explanatory power of prospect theory (equation 5) is greater than clean surplus (equation 4) with growth options.*

RESULTS

Sample

The study requires that firms have both R&D and capital asset expenditures. Therefore, observations are restricted to firms from SIC two-digit codes 10 to 79 while excluding financial firms with SIC codes 60 to 69. Utilities with SIC 48 and 49 are excluded as well because of their regulatory nature. The data comes from the years 2000 through 2016, which includes the financial crisis of 2008. Thus, the current study offers an opportunity to investigate the models under more volatile circumstances than the relatively stable period previously studied by Swanson from 1989 through 1998 (Swanson 2001).[2] All data items for equations (3) and (4) must be present for each firm-year observation. For each specific year, extreme data points of earnings and book values greater than three standard deviations are eliminated to ensure the results are unaffected by outliers. Negative earnings variable (X_t) observations are eliminated because firm distress and/or a big bath could confound the investment association with firm price (Hayn 1995), and this study's empirical analysis[3]. Similarly, negative shareholder equity, negative capital expenditure, negative R&D or shareholdings of less than 10,000 are eliminated.

Descriptive statistics are reported in Table 1. The presence of outliers does not appear to be an issue.

TABLE 1
DESCRIPTIVE STATISTICS OF 10372 OBSERVATIONS

Variable	Mean	Std. Dev.	Minimum	Maximum
P_t	35.501	57.550	0.470	1898.000
BV_{t-1}	13.031	38.481	0.163	2575.000
X_t	0.914	2.011	0.005	43.997
Arctan X_t	0.421	0.433	0.005	1.548
CAP_t	0.555	1.529	0.000	34.573
RD_t	0.671	2.210	0.002	160.524
$CapRD_t$	1.242	12.527	0.000	521.371

Note: P_t is the stock price per share plus dividends per share at time t. BV_{t-1} is the book value per share at time t-1. X_t is the earnings per share at time t. ArctanX_t is arctangent of the earnings per share at time t. CAP_t is the capital expenditures per share at time t. RD_t is the research & development expense per share at time t. $CapRD_t$ is the product of CAP_t and RD_t. All are expressed in dollars.

Table 2 panel A presents simple correlation statistics. The CAPXL and RDL growth option variables are correlated at a statistically significant level with the dependent variable P_t. Generally, the magnitudes of the correlations between the independent variables are less than 50 percent. The lack of correlation between independent variables is a good indication that multicollinearity is minimal (Kennedy, 2003).

TABLE 2
SIMPLE PEARSON CORRELATIONS OF 10372 OBSERVATIONS

Panel A Clean Surplus

Variable	P_t	BV_{t-1}	X_{t-1}	CAP_{t-1}	RD_{t-1}
BV_{t-1}	0.62*				
X_t	0.45*	0.14*			
CAP_t	0.25*	0.14*	0.57*		
RD_t	0.15*	0.03#	0.35*	0.27*	
$CapRD_t$	0.24*	0.08*	0.40*	0.51*	0.58*

Panel B Prospect Theory

Variable	P_t	BV_{t-1}	AX_{t-1}	$ACAP_{t-1}$	ARD_{t-1}
BV_{t-1}	0.62*				
AX_t	0.30*	0.07*			
$ACAP_t$	0.26*	0.09*	0.76*		
ARD_t	0.13*	-0.02#	0.58*	0.52*	
$ACapRD_t$	0.27*	0.08*	0.73*	0.85*	0.80*

Note: * signifies a t-statistic (α=.01) and # signifies a t-statistic (α=.05). P_t is the stock price per share plus dividends per share at time t. BV_{t-1} is the book value per share at time t-1. X_t is the earnings per share at time t. AX_t is arctangent of the earnings per share at time t. $ACAP_t$ is the arctangent of capital expenditures per share at time t. ARD_t is the arctangent of research and development expense per share at time t are expressed in dollars. $ACapRD_t$ is arctangent of the product of CAP_t times RD_t .

Regression Analysis

Table 3 reports the regression[4] findings for clean surplus equations (2) and (4) and prospect theory equations (3) and (5). According to usual econometric practice, both year and industry dummy variables are included in the regressions to account for the effects of exogenous variables. Industry dummy variables are included for these specific SICs 20-29, 30-39 and 70-79. The regressions performed well with respectable adjusted R-squares for a market study. The base case model coefficients for the book value, earnings and arctan earnings are significant at .01 across all the tested formulations. These findings are consistent with prior research (Collins et al., 1999 and Swanson, 2001). Also, the adjusted R-square does not appear to change appreciably across either model for the growth option assumption. The interaction variable growth option capx and R&D is positive and significant suggesting synergy. The individual capx and R&D variables are negative and significant which indicates investors regard them as having diminishing returns by themselves.

TABLE 3
RESULTS BY CLEAN SURPLUS VERSUS PROSPECT THEORY
(FULL SAMPLE=10372)

Clean Surplus			**Prospect Theory**		
Variable	Base Case Eq. (2)	Growth Options Eq. (4)	Variable	Base Case Eq. (3)	Growth Options Eq. (5)
β_0	24.52*	25.40*	β_0	15.63*	23.90*
BV_{t-1}	0.84*	0.84*	BV_{t-1}	0.89*	0.86*
X_t	11.12*	11.01*	AXt	45.73*	43.31*
CAP_t		-3.65*	$ACAP_t$		-27.17*
RD_t		-0.98*	ARD_t		-30.38*
$CapRD_t$		11.51*	$ACapRD_t$		50.08*
Industry dummy	Yes	Yes		Yes	Yes
Year dummy	Yes	Yes		Yes	Yes
Adj. R^2	.51	.52		.46	.47

Note: * signifies a t-statistic (α=.01); # signifies a t-statistic (α=.05); and & signifies a t-statistic (α=.10). "β_0" is the intercept. BV_{t-1} is book value per share at time t-1. X_t is the earnings per share at time t. $ArctanX_t$ is arctangent of the earnings per share at time t. $LCAPX_t$ is the log of firm capital expenditures per share during time t. LRD_t is the log of firm R&D expense per share during time t. $LCapxRD_t$ is the product of LRD_t times $LCAPX_t$. Year XX Dummy is 1 in the year of and 0 otherwise. Industry Dummies are included for SIC 20s, 30s and 70s. All are expressed in dollars.

Next, a set of three analyses (risk, size and pre- and post- 2008 crash,) address sensitivity issues and check the implications of these subsets.

Sensitivity Analysis by Risk

Risk[5] is one of two major factors (risk and return) that investors apply in their decision making (Fama and MacBeth, 1973). Therefore, the study tests robustness by examining the extent to which risk may impact the generalizability of the results. To do so, we divide the sample into two subsamples according to the price-earnings ratio which proxies for risk in valuation analyses (Richardson, et al. 2010). The current research examined high and low subsamples of risk (and size) according to the median so as not to bias results. Portfolios could be further detailed by other fractional measures (e.g., quintiles) in order to look for additional nonlinearity effects. The results are presented in Table 4 for clean surplus and prospect theory.

TABLE 4
SENSITIVITY ANALYSIS TO FIRM RISK
(LOW AND HIGH SUBSAMPLES=5186)

	(Clean Surplus)					(Prospect Theory)			
	Base Case Eq. (2)		Growth Options Eq. (4)			Base Case Eq. (3)		Growth Options Eq. (5)	
Variable	Low	High	Low	High	Variable	Low	High	Low	High
β_0	1.21	17.34*	2.57	16.96*	β_0	-13.94*	10.23*	-14.74*	19.00*
BV_{t-1}	0.94*	0.81*	0.94*	0.81*	BV_{t-1}	1.82*	0.82*	1.83*	0.80*
X_t	11.07*	105.46*	10.49*	111.86*	AXt	38.28*	146.77*	35.09*	141.94*
CAP_t			-4.31*	-1.72	$ACAP_t$			-11.65*	-12.77&
RD_t			-0.60*	-4.29&	ARD_t			8.63*	-48.27*
$CAPRD_t$			0.40*	-0.01	$ACAPRD_t$			8.19*	57.37*
Industry dummy	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes
Adj. R^2	.71	.51	.73	.51		.59	.50	.60	.51

Note: * signifies a t-statistic (α=.01), # signifies a t-statistic (α=.05), and & signifies a t-statistic (α=.10). "β_0" is the intercept. BV_{t-1} is book value per share at time t-1. X_t is the earnings per share at time t. ArctanX_t is arctangent of the earnings per share at time t. $ACAP_t$ is the arctangent of firm capital expenditures per share during time t. ARD_t is the arctangent of firm R&D expense per share during time t. $ACAPRD_t$ is the arctangent of the product capital expenditures per share and firm R&D expense per share during time t. Year XX Dummy is 1 in the year of and 0 otherwise. All are expressed in dollars. Industry Dummies are included for SIC 20s, 30s and 70s. The sample is split low and high, based on a proxy for risk (P/E ratio).

The results are presented for the low- and high-risk subsamples for base case models and growth option formulations. The base case model coefficients for the book value, earnings and arctan earnings are again all significant at .01. Results in Table 4 exhibit higher (lower) explanatory power R squares for the lower (higher) risk subsamples. And, a comparison of the adjusted R-squares in Table 4, suggests that the clean surplus model has higher explanatory power over the prospect theory approach. In three of the four subsamples, the interaction term of capx and R&D is positive and significant consistent with the synergy proposition noted in Table 3. The individual capx and R&D terms vary in sign and significance precluding judgments about the underlying economics in the subsamples. Overall, these subsample findings do suggest that one should consider including growth options in valuation analyses.

Sensitivity Analysis by Size

Size is an important factor in many accounting/finance empirical studies (Fama and French 1992) because it captures several firm fundamental factors. Utilizing the same subsample methodology as in the risk analysis, the sample is divided into two subsamples according to market value in Table 5. The models have greater (lower) explanatory adjusted R square for smaller (larger) firms.

Consistent with a synergy proposition, the capx and R&D interaction terms are positive and significant in three of the four subsample regressions. Regarding the individual growth option regression coefficients, the signs are not consistent for small firms as contrasted with large firms. There are several possible reasons for these results including agency effects where large and more risky firms make relatively excessive expenditures. These differences may also be due to the impact of firm life cycles, where smaller firms are developing opportunities and larger firms have reached a plateau (see Black, 1998, Jenkins et al., 2004).

TABLE 5
SENSITIVITY ANALYSIS TO FIRM SIZE
(SMALL AND LARGE SUBSAMPLES=5186)

(Clean Surplus)					**(Prospect Theory)**				
	Base Case Eq.(2)		Growth Options Eq.(4)			Base Case Eq.(3)		Growth Options Eq.(5)	
Variable	Small	Large	Small	Large	Variable	Small	Large	Small	Large
β_0	3.43#	34.50*	3.30#	34.45*	β_0	-0.75	18.47*	-2.92&	25.13*
BV_{t-1}	1.74*	0.79*	1.77*	0.78*	BV_{t-1}	1.98*	0.83*	2.04*	0.82*
X_t	6.35*	11.80*	6.87*	9.43*	AXt	17.35*	71.91*	15.36*	63.37*
$CAPX_t$			-1.86*	-5.22*	$ACAPX_t$			-2.61	-21.09*
RD_t			-0.19	6.77*	ARD_t			7.58*	-18.92*
$CAPRD_t$			0.05&	0.83*	$ACAPRD_t$			-0.56	49.23*
Industry dummy	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes
Adj. R^2	.64	.50	.64	.53		.59	.46	.60	.46

Note: * signifies a t-statistic (α=.01), # signifies a t-statistic (α=.05), and & signifies a t-statistic (α=.10). "β_0" is the intercept. BV_{t-1} is book value per share at time t-1. X_t is the earnings per share at time t. $ArctanX_t$ is arctangent of the earnings per share at time t. $ACAP_t$ is the arctangent of firm capital expenditures per share during time t. ARD_t is the arctangent of firm R&D expense per share during time t. $ACAPRD_t$ is the arctangent of the product capital expenditures per share and firm R&D expense per share during time t. Year XX Dummy is 1 in the year of and 0 otherwise. All are expressed in dollars. Industry Dummies are included for SIC 20s, 30s and 70s. The sample is split low and high, based on a proxy for size (market value of equity).

Pre- and Post-2008 Crash Sensitivity Analysis

The 2008 crash has been heavily discussed (e.g., McKeon and Netter, 2009); however, a comparison of firm valuation models for pre-and post-periods, which is done in the current study, has not been previously covered in the literature. We follow the dating of the crisis established by Folkinshtey and Meric (2014); therefore, the sample is divided into a pre-period of 2000 through 2006 and a post-period from 2010 through 2016. The results are presented for both the clean surplus model and the prospect theory formulation in Table 6.

The base case clean surplus and prospect theory models have generally greater (lower) explanatory adjusted R squares for post-period versus pre-crash observations. The growth option models provide equivocal information value over the base case models. These findings support hypothesis 3 alternative for clean surplus and for prospect theory. The growth model coefficients flip in sign both pre-and post-crash. Implications are that capital expenditures have increasing (decreasing) returns to scale before (after) the crash. On the other hand, R&D exhibits decreasing (increasing) returns to scale before (after) the crash. These findings indicate changes of investor reactions to financial data and changes in firm behavior. The results also indicate that long-term findings (e.g., Table 3) may be subject to changing business conditions (e.g., crash and economic recovery) that year indicator controls do not appear to capture.

TABLE 6
PRE-VS POST 2008 CRASH SENSITIVITY ANALYSIS
(PRE-SUBSAMPLE=3205 AND POST SUBSAMPLE= 5486)

(Clean Surplus)					(Prospect Theory)				
	Base Case Eq.(2)		Growth Options Eq.(4)			Base Case Eq.(3)		Growth Options Eq.(5)	
Variable	Pre	Post	Pre	Post	Variable	Pre	Post	Pre	Post
β_0	27.89*	0.85	27.86*	1.00	β_0	24.26*	-14.31*	27.19*	-12.49*
BV_{t-1}	0.78*	1.40*	0.78*	1.52*	BV_{t-1}	0.78*	1.88*	0.76*	1.85*
X_t	3.37	9.63*	10.87*	9.07*	AXt	18.56*	44.95*	43.81*	34.37*
CAP_t			3.61	-5.07*	$ACAP_t$			7.81	-12.63*
RD_t			-8.84*	3.34*	ARD_t			-46.19*	10.26*
$CAPRD_t$			0.16	0.37*	$ACAPRD_t$			7.48	11.56*
Industry dummy	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes
Adj. R^2	.49	.60	.49	.63		.49	.49	.51	.53

Note: * signifies a t-statistic (α=.01), # signifies a t-statistic (α=.05), and & signifies a t-statistic (α=.10). "β_0" is the intercept. BV_{t-1} is book value per share at time t-1. X_t is the earnings per share at time t. ArctanX_t is arctangent of the earnings per share at time t. $ACAP_t$ is the arctangent of firm capital expenditures per share during time t. ARD_t is the arctangent of firm R&D expense per share during time t. $ACAPRD_t$ is the arctangent of the product capital expenditures per share and firm R&D expense per share during time t. Year XX Dummy is 1 in the year of and 0 otherwise. All are expressed in dollars. Industry Dummies are included for SIC 20s, 30s and 70s. The sample is divided into 2000-2007 and 2010-2016 years.

Overall Explanatory Power Analysis

Table 7 contains explanatory power comparisons of clean surplus versus prospect theory. As one may surmise from the Table 3 R squares, Vuong tests indicate that clean surplus has higher explanatory power than prospect theory (at the .01 level for the base case Hypothesis 1 and .05 level for the growth options Hypothesis 2). Thus, the clean surplus model is the more powerful tool in estimating firm value. Low risk (as opposed to high risk) provide explanatory growth option value. Large firms (as opposed to small) generate explanatory growth option value. Post 2008 (as opposed to pre) has significant explanatory growth option information.

TABLE 7
GROWTH OPTION EXPLANATORY POWER ANALYSIS

	Clean Surplus		Prospect Theory	
Table 3 All Obs.				
F(3,10372)	52.00		82.28 #	
Table 4 Risk	Low	High	Low	High
F(3,5163)	133.67 #	2.66	47.94 #	24.11
Table 5 Size	Small	Large	Small	Large
F(3,5163)	13.85	111.77 #	24.50	26.07 #
Table 6 Pre/Post	Pre F(3,3192)	Post F(3,5473)	Pre F(3,3192)	Post F(3,5473)
2008 Sensitivity	13.22	179.14 #	42.23	148.50 #

CONCLUSION

Both the clean surplus and prospect theory have respectable explanatory power. This finding indicates each may have purpose in various situations for investors, researchers and analysts. In other words, investors will not go wrong whichever theoretical model they choose in relativistic terms. Ultimately, the clean surplus model does appear to have greater explanatory power than the prospect theory empirical model supporting Hypotheses One and Three.

Generally, the models appear to be relatively robust over most conditions. The base models, with growth options added, provide incremental statistical value supporting Hypothesis Two. In general, the effect on firm value for the interaction between capital expenditures and R&D is positive and significant. However, the capital expenditure and R&D specific variable effects appear to vary according to size, risk and the pre/post 2008 crash subsamples.

With respect to future research, it remains an open question regarding firm circumstances where there are increasing or decreasing returns to scale of capital expenditures and R&D. Future research could investigate how loss firms which are indicative of financial distress affect investors' perspectives. Future research could also explore the life-cycle aspects of growth option effects on firm value.

ENDNOTES

1. The literature supporting a nonlinear earnings model is demonstrated with exploratory market empirical work using changes of Freeman and Tse (1992), and behavioral theoretical work done by Kahneman and Tversky (1979), Subramanyam (1996) (who also uses a changes formulation) and Levy, et al (2012).
2. Swanson (2001) did a year by year analysis by adding incremental investment information to the Collins et. al. (1999) format. Average diminishing returns for capital expenditures and R&D are reported over the period.
3. An analysis did perform a replication of the full sample with only negative earnings observations. While the book value and growth options of capital expenditures and R&D are significant, the earnings variable (for both clean surplus and prospect theory) is not which is in keeping with the reasoning to eliminate those observations.
4. To check for multicollinearity, variance inflation statistics (VIF) were run on all the regressions. VIFs are less than 10 (with one exception at 10) which suggests multicollinearity is not a problem in the present data (Kennedy, 2003).
5. See Richardson et al. (2010) for a discussion of risk models relating to accounting information.

ACKNOWLEDGEMENTS

The authors acknowledge the opportunity to present this work at the 2018 Academy of Behavioral Finance & Economic conference and appreciate the feedback.

REFERENCES

Amir, E., Guan, Y., & Livne, G. (2007). The Association of R&D and Capital Expenditures with Subsequent Earnings Variability. *Journal of Business Finance & Accounting*, 222-246.

Anthony, J., & Ramesh, K. (1992). Association between Accounting Performance Measures and Stock Prices. *Journal Accounting and Economics*, 203-227.

Arthur, B.(1996). Increasing Returns and the New World of Business. *Harvard Business Review*, 1-10.

Ball, R., Kothari, S., & Nikolaev, V. (2010). Econometrics of Basu Asymmetric Timeliness Coefficient and Accounting Conservatism. *SSRN.* Retrieved 2012, from http://ssrn.com/abstract=999710

Barberis, N. (2013). Thirty Years of Prospect Theory in Economics: A Review and Assessment. *Journal of Economic Perspectives*, 173-196.

Barberis, N., & Huang, M. (2008). Stocks as Lotteries: The Implications of Probability Weighting for Security Prices. *American Economic Review*, 2066-2100.

Beaver, W. (2002). Perspectives on Recent Capital Market Research. *The Accounting Review*, 453-474.

Belmonte, J. (2005). Clean surplus accounting: Value relevance of book value and earnings. *PhD Dissertation.* ProQuest Dissertation Publication.

Black, E. (1998). Life-cycle Impacts on the Incremental Value-Relevance of Earnings and Cash Flow Measures. *Journal of Financial Statement Analysis*, 40-56.

Burgstahler, D., & Dichev, I. (1997). Earnings, Adaption and Equity Value. *The Accounting Review*, 187-215.

Coccia, M. (2009). What is the Optimal Rate of R&D Investment to Maximize Productivity Growth? *Technological Forecasting and Social Change*, 2009, 433-446.

Collins, D., Pincus, M., & Xie, H. (1999). Equity Valuation and Negative Earnings: The Role of Book Value of Equity. *The Accounting Review*, 29-61.

Fama, E.(1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *Journal of Finance*, 607-636.

Fama, E., & MacBeth, J. (1973). Risk, Return, and Equilibrium: Empirical Tests. *Journal of Political Economy*, 607-636.

Fama, E., & French, K. (1992). The Cross-Section of Expected Stock Returns. *Journal of Finance*, 427-465.

Feltham, G., & Ohlson, J. (1995). Valuation and Clean Surplus Accounting for Operating and Financial Activities. *Contemporary Accounting Research*, 689-731.

Folkinshteyn, R., & Meric, G. (2014). The Financial Characteristics of Large and Small Firms Before and After the 2008 Stock Market Crash. *The International Journal of Business and Finance Research*, 1-16.

Freeman, R., & Tse, S. (1992). A nonlinear model of security price responses to unexpected earnings. *Journal of Accounting Research*, 185-209.

Gal, D. (2018, July 31). Why the Most Important Idea in Behavioral Decision-Making Is a Fallacy. Retrieved September 12, 2018, from https://blogs.scientificamerican.com/observations/why-the-most-important-idea-in-behavioral-decision-making-is-a-fallacy/

Hall, B., & Hayashi, F. (2010). Research and Development as an Investment. *NBER Working Paper No. 2973.* NBER Working Paper Series.

Hayn, C. (1995). The Information Content of Losses. *Journal of Accounting and Economics*, 125-153.

He, X., & Zhou, X. (2011). Portfolio choice under cumulative prospect theory: An analytical treatment. *Management Science*, 2011, 315-331.

Hirshleifer, J. (1958). On the Theory of Optimal Investment Decision. *Journal of Political Economy*, 329-352.
Jenkins, D., Kane, G., & Velury, U. (2004). The Impact of Corporate Life-Cycle on the Value-Relevance of Disaggreated Earnings. *Review of Accounting and Finance*, 5-20.
Jensen, M. (1986). Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers. *AEA Papers and Proceedings*, 1986, 323-329.
Jones, C. (1995). R&D-Based Models of Economic Growth. *Journal of Political Economy*, 759-784.
Kahneman, D., & Tversky, A. (1992). Advances in prospect theory: cumulative representation of uncertainty. *Journal of Risk and Uncertainty*, 297-323.
Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, 263-291.
Kennedy, P. (2003). *A Guide to Econometrics.* Cambridge: The MIT Press.
Kothari, S.P. (2001). Capital Research in Accouting. *Journal of Accounting and Economics*, 105-231.
Lang, L., & Litzenberger, R. (1989). Dividend Announcements Cash Flow Signalling vs. Free Cash Flow Hypothesis? *Journal of Financial Economics*, 181-191.
Lev, B., & Sougiannis, T. (1996). The Capitalization, Amortization, and Value-Relevance of R&D. *Journal of Accounting & Economics*, 107-139.
Levy, H., De Giorgi, E., & Hens, T. (2012). Two Paradigms and Nobel Prizes in Economics: A Contradiction or Coexistence? *European Financial Management*, 163-182.
Lewandowski, M. (2006) *Is Cumulative Prospect Theory a Serious Alternative for the Expected Utility Paradigm?* Retrieved June 27, 2017, from http://web.sgh.waw.pl/~mlewan1/Site/Research_files/CPT%201006.pdf
Li, Y., & Yang, L. (2013). Prospect theory, the disposition effect, and asset prices. *Journal of Financial Economics*, 715-39.
Lyle, M., Callen, J., & Elliot, R. (2013). Dynamic Risk, Accounting-Based Valuation and Firm Fundamentals. *Review of Accounting Studies*, 899-929.
Mahmood, J., Willett, R., Shantapriayan, P., Jidin, MD., & Radzi, M. (2018). *Earnings Quality and the Clean Surplus Principle.* Retrieved November 3, 2018, from https://ssrn.com/abstract=3128706
McDermott, R., Fowler, J., & Smirnov, O. (2008). On the Evolutionary Origin of Prospect Theory Preferences. *Journal of Politics*, 335-350.
McKeon, R., & Netter, J. (2009). What caused the 1987 stock market crash and lessons for 2008 crash. *Review of Accounting and Finance*, 123-137.
Miller, M., & Modigliani, F. (1966). Some Estimates of the Cost of Capital to the Electric Utility Industry, 1954-57. *American Economic Review*, 333-391.
Nwogugu, M. (2005). Towards multi-factor models of decision making and risk. *The Journal of Risk Finance*, 267-274.
Ohlson, J. (1995). Earnings, Book-values and Dividends in Equity Valuation. *Contemporary Accounting Research*, 661-687.
Pindyck, R., & Rubinfeld, D. (1992). *Microeconomics.* Upper Saddle River: Prentice-Hall.
Richardson, S., Tuna, I., & Wysocki, P. (2010). Accounting Anomalies and Fundamental Analysis: A Review of Recent Research Advances. *Journal of Accounting and Economics*, 410-454.
Shi, Y., Cui, X., & Li, D. (2014). "Discrete-Time Behavioral Portfolio Selection Under Prospect Theory." *SSRN.* Retrieved June 26, 2017, from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2457762
Subramanyam, K. (1996). Uncertain Precision and Price Reactions to Information. *Accounting Review*, 207-220.
Swanson, Z. (2001). Diminishing Returns to Investment: Stock Market Investor Reactions. *Business Research Yearbook.* Orlando: International Academy of Business Disciplines.
Szewczyk, S., Gesetsekos, G., & Zantout, Z. (1996). The Valuation of Corporate R&D Expenditures: Evidence from Investment Opportunities and Free Cash Flow. *Financial Management*, 105-110.

Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science*, 453-8.
Vafeas, N., & Shenoy, C. (2005). An Empirical Investigation of Capital Expenditure Announcements. *Applied Economics Letters*, 907-911.
Wasiuzzaman, I., Nioufar, S., & Negad, R. (2015). Prospect Theory, Industry Characteristics and Earnings Management. *Review of Accounting and Finance*, 324-347.
Woolridge, J. (1988). Competitive Decline and Corporate Restructuring: Is a Myopic Stock Market to Blame? *Journal of Applied Corporate Finance*, 26-36.
Yan, Z. (2006). A New Methodology of Measuring Corporate Life-Cycle Stages. Retrieved from http://www.ssrn.com.