Changing Business Environment and the Value Relevance of Accounting Information

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Abstract

The R^2 of yearly regressions of prices on Earnings Per Share (EPS) and Book Value Per Share (BVPS) has commonly been used to measure the value relevance of accounting information. However Brown, Lo & Lys (1999) analytically show that the scale effects present in levels regressions increase the R square value and this causes it to be an unreliable measure of relevance. Accordingly this study examines the value relevance of accounting using a different methodology that does not rely on R^2. Specifically, we measure value relevance using price deflated residuals derived from the estimation of the Ohlson (1995) valuation model. Empirical results based on this methodology clearly indicate the presence of a downward trend in the relevance of accounting during the past 51 years. Furthermore a comparison of High-Tech companies versus Low-Tech companies suggests accounting information being less value relevant for companies belonging to high technology industries.

1 Introduction

During the last decade the accounting literature experienced a noteworthy increase in the number of studies examining the value relevance of accounting. The popular belief that accounting is becoming decreasingly relevant to investors was often the main motivation of these studies. This common belief developed in response to claims of traditional financial statements losing relevance because of the move from an industrialized economy to a high-tech, service oriented economy (Collins, Maydew & Weiss (1997)).

A part of the research that emerged in reaction to the claims of accounting losing relevance examined the overall direction in the change in value relevance of financial statements. Among these studies were Collins, Maydew & Weiss (1997), Francis & Schipper (1999), and Brown, Lo & Lys (1999). Another part of the literature explored non-financial variables' significance in firm valuation. Studies by, Amir & Lev (1996), Aboody & Lev (1998), Lev & Sougiannis (1996), Lev & Zarowin (1999) and Riley, Pearson & Trompeter (2003) fit this category. These studies took on to identify areas that complemented accounting information.

Surprisingly contradicting inferences on the direction of the change in relevance and its source came into view. While Collins, Maydew & Weiss (1997), Francis & Schipper (1999), and Ely & Waymire (1999) showed value relevance to be in an increasing trend, Lev & Zarowin (1999), Brown, Lo & Lys (1999), Core, Guay & Buskirk (2003), and other studies found value relevance of accounting to be in a declining course. Further disagreement among researchers on the source of the change in accounting's relevance came about. Aboody & Lev (1998), Amir & Lev (1996) and Lev & Sougiannis (1996) pointed to the technology intensive industries as the source of the decline in relevance whereas Collins, Maydew & Weiss (1997) did not find accounting less relevant for technology intensive industries. To sum up, the value relevance literature gave mixed results on both the direction and source of the change in the value relevance of accounting information.

Indisputably, value relevance studies correspond to a momentous portion of the existing accounting literature. It is also evident that this literature is not free of problems and challenges that call for further examination. Holthausen & Watts (2001) discuss both theoretical and empirical weakness of this literature.

We hold the belief that, the contradicting nature of conclusions present in this literature is partially due to econometric problems associated with prior studies. Specifically, we believe that, it is the deviation of the characteristics of accounting data from the assumptions of the applied methods and the misuse of statistical indicators that led to contradicting inferences in this literature.

In this paper we deal with two main econometric issues present in the value relevance literature. These issues are the scale effects involved in the price and accounting data of firms and the misuse of R-square as a metric to compare how well accounting data explains cross-sectional price variation.

The scale effects present in accounting data cause coefficients bias and lead to heteroskedasticity. Several solutions are brought up to deal with the scale effects. Barth & Kallapur (1996), Brown, Lo & Lys (1999) suggest inclusion of a scale proxy to capture the scale effects and remedy undesirable properties of the used data. In contrast, Gu (2005) argues that controlling for scale is unnecessary if the scale-free relation is known, and impossible if the relation is not known. Finally Easton & Sommers (2003) propose weighted least squares (WLS) estimation in place of ordinary least squares (OLS). They demonstrate that the use of WLS mitigates the scale effects and generates more economically meaningful residuals.

Another weakness of the value-relevance literature is its reliance on the R^2 measure.[1] The econometrics literature strictly rejects the use of R^2 in making comparison across different samples (see Anderson-Sprecher (1994), Healy (1984), Hahn (1973), and Willett & Singer (1988)). And,

[1] Holthausen & Watts (2001) call the group of papers that are at least partially motivated by standard-setting purposes the value-relevance literature.

econometrics textbooks also warn researchers and practitioners not to rely on R-squares in making comparisons across different samples (see Greene (2003) and Kennedy (2003)). The unreliability of R^2 measure in comparisons across different samples stems from the fact that the R^2 only shows the explanatory power of the model for a specific sample relative to a model with an intercept. In short, the R^2 does not provide a metric to be used in comparing how well different samples fit a set of independent variables. In contrast to econometricians' stance on the use of R^2, a significant portion of the value-relevance literature's conclusions rely on R^2.

This research contributes to the existing literature by proposing the use of a different methodology to measure and examine the value relevance of accounting information. The proposed methodology does not innate the problems led by the characteristics of accounting data and does not rely on misused statistical indicators. Briefly, the used methodology succeeds to avoid such problems by not using the R^2 to measure value relevance and by adopting weighted least squares (WLS) estimation in place of ordinary least squares (OLS) to minimize scale effects. Moreover, the proposed methodology in this paper allows us to specifically investigate the cross-sectional variation in accounting information's explanatory power. Thus, the main contribution of this study is that it examines the change in value relevance using a methodology that mitigates scale effects and does not use R^2. In addition the used methodology allows us to cross-sectionally examine the value relevance of accounting across different types of firms and industries.

The rest of the paper is organized as follows: Section 2 introduces the methodology and describes the data. Section 3 discusses the empirical results and section 4 concludes.

2 Methodology

2.1 Valuation Model

The Ohlson (1995) valuation model derives the value of a firm using a function of the firm's earnings and book value per share:

$$P_{it} = \alpha + \beta_1 E_{it} + \beta_2 BV_{it} + \varepsilon_{it} \tag{1}$$

where P_{it} is the price of security i three months after the tth fiscal year's end, earnings per share of firm i on fiscal year t is E_{it}. BV_{it} denotes the book value per share of fiscal year t for firm i and ε_{it} is the residual from the regression of price on earnings per share (EPS) and book value per share (BVPS).[2]

The residual in this valuation framework represents the valuation error of the firm's price per share given that the information set consists of earnings per share and book value per share. In other words assuming that the set of values; EPS and BVPS compose the accounting information set, the residual (in $) indicates the unexplained portion of market prices using accounting information.

Under the assumption that EPS and BVPS comprise the accounting information set, we analyze the residuals obtained from Equation (1). Naturally the residuals of companies with higher prices are expected to be greater than companies with lower prices. Therefore we use price deflated residuals:

$$\frac{\hat{\varepsilon}_{it}}{p_{it}} = \frac{P_{it} - \hat{\alpha} - \hat{\beta}_1 E_{it} - \hat{\beta}_2 BV_{it}}{p_{it}}$$

However, ordinary least squares estimation of Equation (1) minimizes nominal value of residuals

[2]Price is the CRSP share price three months after the fiscal year end adjusted for stock splits and dividends between the fiscal year end and three months after, EPS is the earnings per share (Compustat item #172 divided by item #25), BVPS is the book value per share (item #60 for years between 1966-2004 and item #6 minus item #181 divided by item #25 for years before 1966).

which are in dollars, ε_{it}. The purpose of this study is to analyze the overall ability of accounting information to accurately explain cross variation in stock prices. Thus, the minimization of price deflated pricing errors is of greater significance.

Therefore we use the estimates derived from the minimization problem below. This minimization problem requires the derivation of the parameters that minimizes price deflated pricing errors subject to the constraint that the mean price deflated pricing errors is zero which is simply the weighted least squares (WLS) estimation with price as weight:

$$\begin{aligned} \min \left[var \left(\frac{\varepsilon_{it}}{P_{it}} \right) \right] &= \min \left[var \left(\frac{P_{it} - \alpha - \beta_1 EPS_{it} - \beta_2 BVPS_{it}}{P_{it}} \right) \right] \\ s.t.\ E \left[\frac{\varepsilon_{it}}{P_{it}} \right] &= 0 \end{aligned}$$

The price deflated residuals for each firm year indicate the relevant pricing error. For instance a predicted price of \$30 and an actual price of \$40 leads to a price deflated residual of 25 percent ((40-30)/40=0.25).

Having generated a series that proxies for the pricing error of using accounting information, we test whether there is an increasing trend in the magnitude of the pricing errors accross the past years. We investigate the increase using three indicators of the magnitude of the price deflated residuals: (1) the inter-quartile range (IQ_t) of the price deflated residuals for each year, (2) the median of the absolute value of the price deflated residuals (MAE_t), (3) mean absolute price deflated residuals (AAE_t), and (4) adjusted R^2 ($Adj.\ R_t^2$).

$$
\begin{aligned}
IQ_t &= \alpha_0 + \alpha_1 Time_t + \varepsilon_t && (2) \\
MAE_t &= \beta_0 + \beta_1 Time_t + \upsilon_t && (3) \\
AAE_t &= \mu_0 + \mu_1 Time_t + \nu_t && (4) \\
Adj.R_t^2 &= \phi_0 + \phi_1 Time_t + \eta_t && (5)
\end{aligned}
$$

Equations (2) - (5) are estimated using ordinary least squares (OLS). $Time_t$ equals $t = 1, 2, \ldots 51$ for the years 1953 ... 2003. The coefficients of the $Year_t$ variable: $\alpha_1,\ \beta_1,\ \mu_1,$ and ϕ_1 in Equations (2) - (5), respectively, indicate the coefficient of the Time variable, and test the following hypothesis:

H_0: Time has no effect on the magnitude of the pricing errors.

In order to explore whether price deflated residuals are significantly greater for firms with higher intangibles and R&D expenditures we estimate the following equation using ordinary least squares (OLS):

$$
\left|\frac{\varepsilon_{it}}{p_{it}}\right| = \gamma_0 + \gamma_1 \frac{Int.Assets_{it}}{Tot.Assets_{it}} + \gamma_2 \frac{R\&D_{it}}{Net\ Sales_{it}} + \gamma_3 \log\left(Tot.Assets\right) + \nu_{it} \qquad (6)
$$

Here we regress the absolute values of deflated pricing errors of each firm year on its R&D and Intangible asset intensity and also a size variable to control for size.

2.2 Data

The accounting data is obtained from the Primary, Supplementary and Tertiary COMPUSTAT files. Only companies with annual earnings, book value, share information and positive total assets and stockholders' equity are included. The security price comes from Center for Research and Security Prices (CRSP) monthly file. The initial sample consists of 178,635 firm-year observations that are available in both COMPUSTAT and CRSP files.

For consistency and comparability we follow the same outlier removal process applied by Collins, Maydew & Weiss (1997). More specifically we remove firm year data, that is in the top and bottom one-half percent of either earnings-to-price or book value-to-market value or in the top one-half percent of firms with the extreme values of one-time items as a percent of income. Furthermore firm year observations with studentized residuals greater than four or less than negative four in any of the regressions of price on EPS; price on BVPS and price on EPS and BVPS are removed. The final sample consists of 164,545 firm-year observations.

3 Empirical Results

3.1 Time and Value Relevance

As discussed previously the literature gives mixed results on both the direction and source of the change in the value relevance of accounting information. This calls for a reexamination of this issue. Accordingly we reinvestigate the direction of the change in accounting's explanatory power over the past five decades using the methodology proposed in the previous section.

Table 2 reports the estimation results of Equation (1). The use of adjusted R-squares measure is inappropriate in this context. However we report the Adjusted R-square statistics to allow comparison with the rest of the literature that relies on the R-squares. And to evaluate the difference in inference that this measure can yield in comparison to our metrics.

We study the direction of accounting's explanatory power using three measures: mean absolute price deflated residual (in Column 4 of Table 2), median absolute price deflated residual (in Column 5 of Table 2) and standard deviation of annual price deflated residuals (in Column 6 of Table 2). The three measures depict different properties of the price deflated residuals for each year. By using a combination of the three measures we aim to strengthen our results and allow an analysis of different aspects of the series. In addition we use the adjusted R-square measure to provide a comparison between the inferences based on the three measures and the traditional approach taken in the value relevance literature.

All three measures, mean $\left|\frac{\varepsilon_{it}}{p_{it}}\right|$, median $\left|\frac{\varepsilon_{it}}{p_{it}}\right|$ and standard deviation of $\left|\frac{\varepsilon_{it}}{p_{it}}\right|$ follow an increasing trend during the past 51 years as a whole. This is evident in both Table 2 and Figure 1. This empirical characteristic of the data supports the hypothesis that accounting's explanatory power was in a declining trend in the past half century. This inference is consistent with the findings of Lev & Zarowin (1999), Brown, Lo & Lys (1999), Core, Guay & Buskirk (2003) and the views of practitioners.

On the other hand the adjusted R^2s tell a different story than the three measures we propose do. Specifically according to this metric, if there is any change at all, it is an increase in the value relevance. Except for the year 1999, the adjusted R-squares remain to be within the 50% - 70% range in both the early and late periods of the second half of the 20th century. We do not try to point to the inappropriateness of the use of adjusted R^2 based on the empirical results we report in Table 2. Econometric theory is sufficient to indicate its unworthiness. However it is also interesting to see adjusted R^2 measure's stability despite uncountable changes in both the business environment and the accounting world during the past five decades.

Based on a general overview of the variation in residuals across the years we observe support for the argument that accounting has lost relevance. We also estimate Equations (2) - (5) to test whether such a change statistically exists. Table 3 reports the estimation results. The results of Equation (2) − (4) all indicate an increase in the magnitude and variation of absolute price deflated residuals. On all three models, the Time variable is significantly positive at the 0.5% significance level. The coefficients are also economically significant. The coefficient of Model (1) indicates an average 0.5% increase in the mean absolute price deflated residuals over the past

51 years. Similarly Table 3 documents an average 0.46% increase in the median absolute price deflated residuals. Finally the interquartile range expands on average 0.71% every year. These results altogether suggest a growth in the pricing error that accounting information generates. This implies that accounting has lost significant relevance over the past 51 years.

Furthermore the difference between the estimation results of Model (4) and Models (1) – (3) in Table 3 is striking. The Time variable is insignificant at the 5% significance level when the dependent variable is adjusted R-square. Thus, using adjusted R-square, along with Collins, Maydew & Weiss (1997), Francis & Schipper (1999), and Ely & Waymire (1999), we also fail to document a decline in value relevance.

To sum up we find empirical results consistent with the argument that accounting has lost relevance. On the other hand we are unable to find the same results when we use the adjusted R-square measure.

3.2 Cross Sectional Analysis of Pricing Errors

A significant body of the literature suggests that experienced technological developments dramatically changed the business structures of companies during the past century. Because of these transformations it is argued that the current reporting model designed to measure the value of companies composed mainly of tangible assets has become less capable of accurately providing information to today's investors. Also practitioners' suspicion of accounting system's ability to handle investors' demands for financial information supports this argument.

In order to test whether technology is the driving force behind the decline in accounting's relevance we estimate Equation (6). In this equation we regress the absolute price deflated residuals on two technology proxies: R&D intensity and Intangible Asset intensity and control for the size effect. With these two technology proxies we aim to capture the aggregate technological intensity of each firm-year.

The results reported in Table 4 indicate a significant positive association between the absolute price deflated residuals and the technology proxies. The coefficients of both R&D and Intangible Asset intensity levels are significant at the 0.5 percent significance level. The positive coefficients of the two variables suggest that pricing errors for companies with greater intangible assets and/or R&D intensity are greater for companies with less of these intensities.

In short, using a pooled cross-sectional analysis of the absolute price deflated errors we find a significant positive association between pricing errors and the technological level of a firm.

3.3 High Technology Industries versus Low Technology Industries

The activities of certain industries distinguish the structure of their member firms from firms of other industries. It is difficult to argue that a steel company is valued through the same valuation method used to value an internet company. Two companies from two different industries can differ in numerous ways; in terms of their most valuable assets, their methods of profits, their relationships with other business entities, growth rates and in terms of other features.

The argument of accounting loosing its value relevance has often been supported with the idea of high tech industries playing an influential role in this decline of relevance. Various studies classify certain industries as having a business structure potentially difficult for the current accounting system to accurately measure and argue that the decline in accounting information's relevance was experienced more intensely in these types of industries.

To assess whether there is a significant difference between High-Technology and Low-Technology industries in terms of accounting's relevance, we classify industries as High-Technology, Low-Technology and Other. For comparability we use the same classification by Francis & Schipper (1999). Table 5 lists the name and SIC code of each industry classified as High and Low technology. Industries not listed as either High or Low Technology are classified as Other.

Table 6 reports the comparative statistics for the two types of industries and other industries (High and Low Technology and Other). The magnitude of absolute price deflated residuals is the greatest for High Technology industries. Both the Mean and Median values of absolute price deflated residuals are greater for High Technology firms. Overall the results obtained from this analysis are consistent with the argument of accounting being less relevant for technology intensive firms.

3.4 Analysis of Quintiles Based on R&D Intensity

Besides the cross-sectional analysis in section 4.2 we also form quintiles of firms for each year based on their R&D expense intensity and report summary statistics for each of the quintile. The relative distribution of the quintiles are consistent with the results we obtained in section 4.2. Table 7 documents a monotonic increase in the mean absolute price deflated residuals moving from Quintile 1 (consisting of firm-years with the least level of R&D intensity) to Quintile 5 (composed of firm-years with the greatest R&D intensity).

The results reported in Table 7 are of the pooled dataset, this prevents us from examining the variation across the years. Moreover the difference in Quintiles (1)-(5) could be influenced by a particular set of years. Therefore, in Table 8, we also report annual statistics for each year and quintile. A positive relationship between R&D intensity and pricing errors exists for all years. Quintile 5 has the highest median pricing error for all years implying accounting's low relevance for these types of firms not just for the period as a whole but for each individual year.

In addition Figure 1 illustrates the change in median annual absolute price deflated residual of both Quintile 1 and Quintile 5. The curves of the two quintiles are distantly apart from each other suggesting a strong decline in accounting's explanatory power moving from a firm with lower technology intensity to a one-with higher.

4 Conclusion

Using a different methodology based on distributions of residuals we document a strong decline accounting value relevance during the past 51 years. Moreover we find a statistically significant relationship between the technology proxies and the level of pricing errors. This suggests that accounting is particularly less relevant for firms that are technologically intensive. In other words accounting information leads to more accurate valuation for low-tech companies than it does for high-tech firms. Also using a cross industry analysis we demonstrate that firms members of technology intensive industries have greater pricing errors. Finally the results using the quintiles based on the R&D intensity level confirm the findings of the study's general findings.

In conclusion a decrease in the value relevance of accounting information is evident. Furthermore the decline in the relevance of accounting information is more intense in firms involved in technology related activities. The evident differentiation across industries and across high and low-tech firms suggests the exploration of new reporting models or standards to enhance the business reporting model to better suit and measure such companies.

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Table 1

Descriptive Statistics

The initial sample consists of all firm year observations with positive Book Value Per Share (BVPS) that are in the intersection of CRSP and COMPUSTAT. Firm year observations that are (1) in the bottom or top 1.5 percentile of Earnings Per Share (EPS) to Price or BVPS to price, and (2) in the top 1.5 percentile One-Time Items to net income are removed. Also firm year observations with absolute value of studentized residuals greater than 4 on any yearly regression of Price on EPS, Price on BVPS and Price on EPS and BVPS are eliminated. Price is the CRSP share price three months after the fiscal year end adjusted for stock splits and dividends between the fiscal year end and three months after, EPS is the earnings per share (Compustat item #172 divided by item #25), BVPS is the book value per share (item #60 for years between 1966-2004 and item #6 minus item #181 divided by item #25 for years before 1966), and One-time items is the sum of special items (item #17) and extraordinary items and discontinued operations (item #48). R&D expense per dollar sales is defined as Research and Development expenses (item #46) divided by net sales (item #12); Advertising Expense Per Dollar Sales is advertising expense (item #45) divided by net sales (item #12); and Intangible Assets Per Share is Intangible assets (item #33) divided by total assets (item #6).

Variable	**N**	**Mean**	**Std. Dev.**	**10th Percentile**	**Lower Quartile**	**Median**	**Upper Quartile**	**90th Percentile**
Price (P)	164,545	19.143	19.451	2.219	5.625	13.875	26.595	42.250
Earnings Per Share (EPS)	164,545	1.182	1.934	-0.496	0.075	0.862	2.006	3.367
Book Value Per Share ($BVPS$)	164,545	11.972	12.814	1.121	3.498	8.245	16.390	26.893
One-Time Items	151,668	-7.411	138.169	-3.984	0	0	0	0.480
R&D Expense Per Dollar Sales	71,026	1.025	30.813	0	0.004	0.023	0.082	0.226
Advertising Expense Per Dollar Sales	48,018	0.063	2.237	0.004	0.010	0.019	0.037	0.077
Intangible Assets Per Share	142,674	0.054	0.112	0	0	0.003	0.051	0.173

Table 2

Distribution of Absolute Price Deflated Errors

Absolute value of the residuals obtained from the yearly estimations based on the estimators derived from the minimization problem: $\min\left[var\left(\frac{P_{it}-\beta_1 EPS_{it}-\beta_2 BVPS_{it}}{P_{it}}\right)\right]$ $s.t.\ E\left[\frac{\varepsilon_{it}}{P_{it}}\right]=0$. The descriptive statistics for the yearly distributions of price deflated errors are provided along with the Adjusted R-Squared of a regression of prices on earnings per share (EPS) and book value per share (BVPS) for the years between 1953 - 2003.The first two columns indicate the year and the number of observations, respectively. The third column presents the Adjusted R-Square of the regression of prices on EPS and BVPS. The last six columns provide descriptive statistics of the yearly distribution of price deflated errors. The median, standard deviation, Intercept, coefficients of EPS and BVPS are available.

Year	Obs.	Adj. R^2	Mean $\left\lvert\frac{\varepsilon_{it}}{p_{it}}\right\rvert$	Median $\left\lvert\frac{\varepsilon_{it}}{p_{it}}\right\rvert$	σ	Intercept	EPS	BVPS
1953	376	0.5941	0.2976	0.2532	0.2119	4.3288	6.4357	0.0602
1954	335	0.7296	0.2376	0.1944	0.1910	3.0243	9.8625	0.1111
1955	359	0.7018	0.2452	0.2103	0.1951	3.4513	10.5579	−0.0501
1956	374	0.6718	0.2573	0.2267	0.1966	3.0921	9.2586	−0.0202
1957	383	0.5880	0.2771	0.2294	0.2125	4.2440	7.9304	0.0261
1958	397	0.6012	0.2780	0.2250	0.2167	8.7601	10.6922	0.1681
1959	428	0.5710	0.2708	0.2096	0.2176	8.1329	10.5605	−0.0662
1960	503	0.5804	0.3203	0.2604	0.3078	7.8821	11.1829	0.1089
1961	662	0.6575	0.2794	0.1981	0.3126	7.7111	12.4495	0.1160
1962	1,066	0.8042	0.3292	0.2479	0.3488	2.1512	10.4531	0.2172
1963	1,179	0.8091	0.3390	0.2512	0.3579	1.8222	11.4687	0.2117
1964	1,289	0.7832	0.3442	0.2726	0.3184	2.0308	10.5360	0.2319
1965	1,350	0.7876	0.3015	0.2269	0.2933	3.0649	11.4041	0.0793
1966	1,254	0.7126	0.3258	0.2606	0.3036	3.2451	10.1542	0.0708
1967	1,425	0.6519	0.2917	0.2396	0.2908	7.2517	9.9364	0.1713
1968	1,577	0.6122	0.2695	0.2247	0.2306	10.0980	10.2042	0.1321
1969	1,770	0.5725	0.3299	0.2589	0.2842	5.6939	6.7446	0.2541
1970	1,953	0.5915	0.3654	0.2900	0.3267	5.9291	5.0740	0.5347
1971	2,039	0.5680	0.3939	0.3157	0.3574	5.4416	5.5002	0.5117
1972	3,008	0.5925	0.3813	0.3048	0.3273	2.6582	5.7475	0.3019
1973	3,494	0.5960	0.4015	0.3205	0.3271	1.0936	3.6904	0.2906
1974	3,712	0.6239	0.4242	0.3360	0.3697	0.9443	2.0224	0.3327
1975	3,701	0.6982	0.3879	0.3041	0.3419	0.9835	2.7308	0.4401
1976	3,736	0.7544	0.3706	0.2847	0.3563	0.8969	3.4338	0.3645
1977	3,691	0.7738	0.3418	0.2571	0.3340	1.3797	3.6144	0.3274
1978	3,706	0.7512	0.3636	0.2797	0.3732	1.6005	3.5932	0.3089
1979	3,681	0.6845	0.4383	0.3351	0.6823	1.7296	3.0817	0.2594
1980	3,788	0.6778	0.4860	0.3683	0.7606	2.1299	3.7042	0.3958
1981	4,030	0.7676	0.5209	0.3495	1.0074	0.7448	2.2782	0.4910
1982	4,037	0.7216	0.5964	0.4225	1.1902	0.7223	1.9935	0.8345

Table 2

(continued)

Year	Obs.	Adj. R^2	Mean $\left\|\frac{\varepsilon_{it}}{p_{it}}\right\|$	Median $\left\|\frac{\varepsilon_{it}}{p_{it}}\right\|$	σ	Intercept	EPS	BVPS
1983	4,419	0.7802	0.5464	0.3761	1.1215	0.7349	1.6055	0.9170
1984	4,465	0.7939	0.5427	0.3636	1.0399	0.6223	2.0219	0.9233
1985	4,400	0.7747	0.5523	0.3782	0.9149	0.6004	1.9168	1.2028
1986	4,553	0.7517	0.5395	0.3775	0.9256	0.7261	1.7794	1.2591
1987	4,671	0.7573	0.5258	0.3844	0.7793	0.5090	1.5495	1.0657
1988	4,526	0.7714	0.5498	0.3699	0.8628	0.5276	2.0238	1.0239
1989	4,385	0.7311	0.5934	0.4216	0.8744	0.5013	1.8257	1.0147
1990	4,321	0.6868	0.6345	0.4468	0.8785	0.4953	1.9737	0.9119
1991	4,426	0.6771	0.6028	0.4479	0.8669	0.6810	1.7275	1.1187
1992	4,641	0.6768	0.5378	0.4044	0.7360	0.9493	1.6566	1.2694
1993	5,587	0.6619	0.5024	0.3997	0.6997	1.6279	1.5857	1.1120
1994	5,890	0.6762	0.4979	0.3856	0.6543	1.6425	2.0424	1.0499
1995	6,018	0.6286	0.5167	0.4010	0.6971	2.1781	2.4007	1.1200
1996	6,383	0.6781	0.4971	0.3726	0.5909	2.0234	2.4343	1.2124
1997	6,237	0.6640	0.5193	0.3904	0.5910	1.9374	2.4772	1.5673
1998	5,773	0.5334	0.5553	0.4394	0.5907	1.5155	1.6005	1.1209
1999	5,587	0.3076	0.6029	0.5057	0.5606	3.1002	1.8511	0.8312
2000	5,404	0.5161	0.6457	0.4859	0.7436	1.2625	1.2899	0.9440
2001	4,795	0.5996	0.5910	0.4579	0.6475	0.9092	0.8840	1.2399
2002	4,462	0.6648	0.5523	0.4040	0.6492	0.7224	1.0196	1.1011
2003	4,299	0.7064	0.4511	0.3356	0.5738	2.7748	3.0395	1.2976

Table 3

Prais-Winsten Regression of Relevance Indicators on Time

Four proxies of the value relevance of accounting, Mean Percentage Error, Median Percentage Error, Interquartile Range of Percentage Error and the Adjusted R-squared values are seperately regressed on a Time variable that takes a value of 1 for the year 1953 and 51 for the year 2003.

$$
\begin{aligned}
AAE_t &= \alpha_0 + \alpha_1 Time_t + \nu_t \\
MAE_t &= \beta_0 + \beta_1 Time_t + \upsilon_t \\
IQ_t &= \alpha_0 + \alpha_1 Time_t + \varepsilon_t \\
Adj.R^2_t &= \alpha_0 + \alpha_1 Time_t + \eta_t
\end{aligned}
$$

The estimation results for each proxy are reported in the columns 2 - 4. The symbols *,**,***, indicate 5%, 1% and 0.5% significance levels, respectively.

	Model (1)	*Model (2)*	*Model (3)*	*Model (4)*
	Dependent Variable			
	Mean Percentage Error	Median Percentage Error	Interquartile Range of Percentage Error	Adjusted R^2
Intercept	0.2754	0.2063	0.4236	0.6669
t-ratio	5.62***	10.80***	14.63***	11.21***
Time	0.0057	0.0046	0.0071	0.0001
t-ratio	3.62***	7.29***	7.39***	0.06
Adj.R^2	21.05%	51.08%	52.96%	16.59%

Table 4

Cross Sectional Analysis of Percentage Residuals

The absolute value of percentage errors are regressed on the logarithm of total assets, intangible intensity (Intangible Assets / Total Assets), and R&D Intensity (R&D Expense / Total Assets) The first column indicates the dependent variable and the following four columns report the coefficients and t-ratios of the parameters of the independent variables. Finally the r-squared values and number of observations are reported in the last column. The symbols *,**,***, indicate 5%, 1% and 0.5% significance levels, respectively.

Dependent Variable	**Intercept**	**Size**	**Intangible Intensity**	**R&D Intensity**	**Adj.** R^2	N
Abs. Perc. Errors	0.5065	−0.0220	0.2447	0.5521	5.71%	58,113
t-ratio	138.77***	−30.19***	17.29***	43.71***		
Abs. Perc. Errors	0.5600	−0.0338	0.3800	–	4.77%	133,411
t-ratio	243.56***	−75.30***	40.09***	–		

Table 5

High-Tech and Low-Tech Industry Classification

For comparability, the same classification used by Francis and Schipper (1999) is used to classify industries into High and Low Technology groups. This table lists, in two parts, the SIC codes and names of the industries classified to be High and Low Technology. The first column indicates the three-digit SIC code and the second column reports the name of the industry.

High-Technology Industries	
283	Drugs
357	Computer and Office Equipment
360	Electrical Machinery and Equipment, Excluding Computers
361	Electrical Transmissions and Distribution Equipment
362	Electrical Industrial Apparatus
363	Household Appliances
364	Electrical Lighting and Wiring Equipment
365	Household Audio, Video Equipment, Audio Receiving
366	Communication Equipment
367	Electronic Components, Semiconductors
368	Computer Hardware (Including Mini, Micro, Mainframes,Terminals, Discs, Tape Drives, Scanners, Graphics Systems, Peripherals, and Equipment
481	Telephone Communications
737	Computer Programming, Software, Data Processing
873	Research, Development, Testing Services
Low-Technology Industries	
020	Agricultural Products - Livestock
160	Heavy Construction, Excluding Building
170	Construction - Special Trade
202	Dairy Products
220	Textile Mill Products
240	Lumber and Wood Products, Excluding Furniture
245	Wood Buildings, Mobile Homes
260	Paper and Allied Products
307	Miscellaneous Plastics Products
324	Cement Hydraulic
331	Blast Furnaces and Steel Works
356	General Industrial Machinery and Equipment
371	Motor Vehicles and Motor Vehicle Equipment
399	Miscellaneous Manufacturing Industries
401	Railroads
421	Trucking, Courier Services, Excluding Air
440	Water Transportation
451	Scheduled Air Transportation, Air Courier
541	Grocery Stores

Table 6

Low - Technology Firms vs. High - Technology Firms

Firm year observations are classified into Low and High Technology industry groups with respect to the industry classification made in Francis and Schipper (1999). Firms not belonging to either of the industry types are classified as Other. The first column indicates the type of firms the subsequent statistics refer to. The following eight columns present the number of observations, mean, median, standard deviation, 10th, 25th, 75th and 90th percentiles of the percentage error distribution of the three groups, respectively.

Industry	**N**	**Mean**	**Median**	**Std. Dev.**	**10th Percentile**	**Lower Quartile**	**Upper Quartile**	**90th Percentile**
Low - Technology	11,279	0.4248	0.3212	0.4586	0.0598	0.1485	0.5634	0.8426
High - Technology	29,620	0.5709	0.4803	0.6278	0.1017	0.2508	0.7200	0.9435
Other	123,646	0.4817	0.3409	0.7362	0.0615	0.1576	0.5857	0.8700

Table 7

R&D Quintiles and Percentage Errors

Firms are annually ranked based on their Research and Development Intensity $\left(\frac{R\&D_{it}}{Tot.\ Assets_{it}}\right)$ and distributed to five groups. The first quintile is composed of firms with the least R&D intensity and the fifth one is composed of companies with the greatest intensity. The median value of absolute percentage errors $\left(\left|\frac{\varepsilon_{it}}{p_{it}}\right|\right)$ for each year along with the number of firms in each quintile are presented below. The first column indicates the year of which the following columns describe. The first row is of firms that have missing values for the Research and Development expense data item.

Quintiles	**N**	**Mean**	**Std. Dev.**	**10th Percentile**	**Lower Quartile**	**Median**	**Upper Quartile**	**90th Percentile**
Missing	90,182	0.5139	0.3515	0.8093	0.0627	0.1614	0.6077	0.9390
1st Quintile	11,117	0.4673	0.3544	0.6090	0.0698	0.1716	0.5888	0.8410
2nd Quintile	11,135	0.4738	0.3762	0.5907	0.0721	0.1832	0.5972	0.8386
3rd Quintile	11,133	0.4980	0.4081	0.5864	0.0829	0.2050	0.6413	0.8464
4th Quintile	11,135	0.5137	0.4523	0.5153	0.0920	0.2361	0.6723	0.8611
5th Quintile	11,124	0.6451	0.5810	0.6611	0.1409	0.3196	0.8012	1.0185

Table 8

R&D Quintiles and Pricing Errors

Each year firms are ranked based on their Research and Development Intensity $\left(\frac{R\&D_{it}}{Net\ Sales_{it}}\right)$ and distributed to five groups. The median value of absolute price deflated errors $\left(\left|\frac{\varepsilon_{it}}{p_{it}}\right|\right)$ for each year along with the number of firms in each quintile are presented below. The first column indicates the year of which the following columns describe. The first of the six pairs of columns is of firms that have missing for the Research and Development expense data item. The first quintile is composed of firms with the least R&D intensity and the fifth one is composed of companies with the greatest level.

	Missing		*Quintile 1*		*Quintile 2*		*Quintile 3*		*Quintile 4*		*Quintile 5*	
Year	**Obs.**	**Median**	**Obs.**	**Median**	**Obs.**	**Median**	**Obs.**	**Median**	**Obs.**	**Median**	**Obs.**	**Median**
1972	1,853	0.2988	231	0.2655	231	0.2999	231	0.2590	231	0.3396	231	0.4191
1973	2,135	0.3189	272	0.3180	271	0.2935	272	0.3161	272	0.3381	272	0.3915
1974	2,267	0.3265	289	0.3654	289	0.3076	289	0.3149	289	0.3707	289	0.4174
1975	2,251	0.2883	290	0.3034	290	0.3316	290	0.2999	290	0.3089	290	0.4081
1976	2,285	0.2701	290	0.2710	290	0.2945	291	0.2828	290	0.2872	290	0.3834
1977	2,323	0.2471	273	0.2275	275	0.2567	273	0.2454	274	0.2793	273	0.3573
1978	2,371	0.2761	267	0.2752	267	0.2378	267	0.2286	267	0.3041	267	0.4321
1979	2,366	0.3141	263	0.3072	263	0.2751	263	0.3350	263	0.4026	263	0.5114
1980	2,460	0.3597	265	0.3070	266	0.2790	266	0.3576	266	0.4175	265	0.5702
1981	2,605	0.3185	285	0.3141	285	0.3110	285	0.3474	285	0.4700	285	0.5835
1982	2,593	0.3955	288	0.3567	289	0.3781	289	0.3965	289	0.5541	289	0.6510
1983	2,746	0.3529	334	0.2771	335	0.3152	335	0.4010	335	0.4940	334	0.5832
1984	2,753	0.3516	342	0.3044	343	0.3005	342	0.3299	343	0.4531	342	0.6006
1985	2,690	0.3661	342	0.3046	342	0.3348	342	0.3624	342	0.4026	342	0.5948
1986	2,802	0.3659	350	0.3564	350	0.3169	351	0.3593	350	0.4300	350	0.5339
1987	2,906	0.3795	353	0.3157	353	0.3335	353	0.3904	353	0.3922	353	0.5602
1988	2,808	0.3625	343	0.2969	344	0.3057	344	0.3714	344	0.4203	343	0.5861
1989	2,733	0.4124	330	0.3694	331	0.4182	330	0.4017	331	0.4451	330	0.5935
1990	2,672	0.4087	329	0.4217	330	0.4478	330	0.4999	330	0.5041	330	0.7055
1991	2,727	0.3992	339	0.4026	340	0.4574	340	0.5186	340	0.5457	340	0.6506

Table 8

(continued)

	Missing		*Quintile 1*		*Quintile 2*		*Quintile 3*		*Quintile 4*		*Quintile 5*	
Year	**Obs.**	**Median**	**Obs.**	**Median**	**Obs.**	**Median**	**Obs.**	**Median**	**Obs.**	**Median**	**Obs.**	**Median**
1992	2,825	0.3686	363	0.3742	363	0.4416	364	0.4407	363	0.4853	363	0.5665
1993	3,611	0.3563	395	0.3773	395	0.4452	396	0.4697	395	0.4456	395	0.5828
1994	3,851	0.3421	407	0.3714	408	0.3893	408	0.4731	408	0.4928	408	0.6348
1995	3,821	0.3501	439	0.3553	440	0.4168	439	0.4730	440	0.5077	439	0.6636
1996	3,944	0.3290	487	0.3762	488	0.3923	488	0.4403	488	0.4673	488	0.6318
1997	3,808	0.3505	485	0.3503	486	0.3958	486	0.4433	486	0.4785	486	0.6393
1998	3,531	0.3973	448	0.4253	449	0.4425	448	0.5316	449	0.5396	448	0.6561
1999	3,360	0.4403	445	0.4727	446	0.5232	445	0.6213	446	0.6967	445	0.7180
2000	3,161	0.4262	448	0.4520	449	0.5331	449	0.5810	449	0.5760	448	0.6579
2001	2,759	0.3934	407	0.5134	407	0.4896	408	0.5248	407	0.5712	407	0.6331
2002	2,628	0.3520	366	0.4494	367	0.4578	367	0.4617	367	0.5029	367	0.6482
2003	2,537	0.2831	352	0.3634	353	0.3653	352	0.4070	353	0.4243	352	0.6014

Figure 1

Median Percentage Errors During the Past Five Decades

The thick line illustrates the median of annual percentage errors obtained from the Weighted Least Squares estimation of the Ohlson's model, accross the years. The dashed line illustrates the median percentage error of the firms within the first quintile of R&D Intensity (Companies with least R&D Expenses) and finally the dotted line represents the median percentage error of companies within the 5th quintile (consisting of firms with the greatest R&D Expense intensity).