Structural Capital

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Abstract

Intangible (knowledge) assets are the major drivers of corporate and national growth. Structural capital – business policies, processes and procedures that enable firms to efficiently use physical, human and other intangible resources to generate growth – is the least researched and understood yet probably the most potent type of intangible assets. We develop a methodology for estimating firm-specific structural capital, and examine the validity of our estimates with a widely-used equity valuation model which is a function of assets-in-place and the present value of abnormal earnings (growth potential).

These tests indicate that our structural capital estimate adds considerable explanatory power to these value drivers, and that while investors appear to incorporate some elements of structural capital in their stock valuations, they do not fully price the profit-enhancing potential of such capital. Portfolio analysis detects the existence of systematic, risk-adjusted returns to portfolios formed on the size of structural capital – an indication of capital market inefficiency. This market inefficiency can be attributed to poor and biased public information on corporate intangible assets in general, and structural capital in particular.

I. Introduction

Intangible (knowledge) capital – sources of future benefits that lack physical embodiment – is the hallmark of modern economies and business enterprises. Various estimates indicate the significance of such assets: For example, Nakamura (2000) estimates the value of U. S. corporate investment in intangibles during 2000 to be around $1.0 trillion, making it roughly equal to the total investment of the non-financial sector in property, plant and equipment. Hall (2000), based on the *q* ratio (market value to replacement cost of physical assets) estimates the total value of intangible capital to be between ½to of the total market value of publicly traded corporations. Nakamura (1999, 2000) argues that the major growth in value and impact of intangible capital started roughly in the mid-80s, and continues unabated, though with considerable fluctuations to the present. Gu and Lev (2001) show that firm-specific estimates of intangible capital improve significantly the association between capital market values and accounting-based measures of performance and value (e.g., earnings and book values). Overall, it is widely accepted that intangible assets are the major driver of national as well as corporate value and growth, as most forms of physical and financial assets are essentially commodities, yielding on average the cost of capital.[1]

A framework developed by Lev (2001) for analyzing and measuring intangible capital classifies intangible assets into the following four classes.

[1]Federal Reserve Board Chairman, Alan Greenspan, in a recent Congressional testimony noted: "...the ever-increasing proportion of our GDP that represents conceptual as distinct from physical value added may actually have lessened cyclical volatility. In particular, the fact that concepts cannot be held as inventories means a greater share of GDP is not subject to a type of dynamics that amplifies cyclical swings. But an economy in which concepts form an important share of valuation has its own vulnerabilities." (Semiannual Monetary Policy Report to the Congress, before the Committee on financial Services, U. S. House of Representatives, February 27, 2002.)

(a) Discovery/Learning intangibles – technology, know-how, patents, and other assets emanating from the discovery (R&D) and learning (e.g. “adaptive capacity”, “reverse engineering”) processes of business enterprises, universities, and national laboratories.

(b) Customer-Related intangibles – brands, trademarks, and unique (e.g. Internet-based) distribution channels, which create abnormal (above cost of capital) earnings.

(c) Human-Resource intangibles – specific human resource practices, such as training and compensation systems, which enhance employee productivity and reduce turnover.

(d) Organizational-design intangibles – unique structural and organization-specific processes, technologies and blueprints generating sustainable competitive advantages and value.

The demarcation lines between intangibles and physical assets are sometimes blurry: “Intangibles are frequently embedded in physical assets (e.g. new technology and knowledge contained in an airplane) and in labor (tacit knowledge of employees), leading to a considerable *interaction* between tangible and intangible assets in creation of value.” (Lev, 2001, p7). Structural-organizational capital – technologies, managerial process and designs – enable firms to efficiently use tangible and intangible inputs to create value and growth. Structural capital transforms inert assets into value creators.[2]

[2] The major decision of Louis Gerstner, IBM’s departing chairman, who is widely credited for IBM’s considerable success in the 1990s was recently described as: “First, he created a broad computer services unit [now accounting for half of IBM’s $90 billion annual revenues] that sold bundles of hardware, software, consulting and maintenance to manage business processes like manufacturing, purchasing or marketing.” (The New York Times, March 10, 2002, p. B11.) Gerstner thus created a new organizational

Anecdotal examples of structural capital, especially unique business processes abound: Wal-Mart's supply chain, where the reading of barcodes of purchased products at the checkout register is directly transmitted to suppliers who are in turn responsible for inventory management and product provision to Wal-Mart stores; Cisco's Internet-based product installation and maintenance system, estimated by Cisco's CFO to have saved $1.5 billion over three years (Economist, June 26, 1999); Dell's pioneering built-to-order sales system, where customers design their orders; Ford's outsourcing of its auto parts manufacturing; and Merck's extensive network of hundreds of R&D and marketing alliances and joint ventures, are but a few examples of structural capital. However, there is sparse systematic evidence on the magnitude and impact of structural capital.[3] Terms like firm's reputation, value of leadership, capacity to innovate, and the like, abound in the managerial literature, yet little in terms of direct empirical measurement and conceptual understanding is available.[4]

The objectives of this study are: (a) to develop a methodology for estimating firm-specific structural capital, (b) to generate empirical structural capital estimates and examine their validity within a widely used equity valuation model, and (c) assess the

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structure – structural capital – that generated substantial economic value from physical, human, and intangible (research and development, brands) assets.

[3] Exceptions are Brynjolfsson et. al. (1999), who estimate the impact of information technology investment on market value of companies, and ascribe the large estimated multiple (roughly 10:1) to the structural capital enabled by information technology, and Hall (2000).

[4] This statement is echoed in the conclusion of a recent study about technology divergence (Clark and Feenstra, 2001, p. 54, emphasis ours): "We have shown above that the fundamental cause of the divergence of income per capita experienced since the Industrial Revolution is a difference in the ability of countries to employ the same technology at equal levels of efficiency. Improvements in the mobility of goods and capital fall into relative unimportance when compared to the effects of differences in TFP (total factor productivity), both in historical periods and today. The sources of these differences in TFP remains mysterious." These sources, of course, lie in organization and business processes, namely structural capital.

extent to which stock prices fully reflect, or alternatively, systematically mis-price the value of firms' structural capital.

We find that structural capital is, in general, a very sizable asset for most firms (not reported, of course, on corporate balance sheets); that its earnings potential is not fully captured by financial analysts; and related to the latter finding – that the value of structural capital is systematically understated in stock prices. These findings have obvious implications for public disclosure policy aimed at reducing information asymmetries concerning intangibles in general, and structural capital in particular.[5]

II. The Development of a Firm-Specific Structural Capital Measure

We develop a procedure for estimating firm-specific structural capital by measuring the effectiveness with which the firm utilizes physical, human, discovery/learning, and marketing inputs to generate output growth. The output is the firm's revenues (SALE), while the inputs consist of plant, property and equipment (PPE), human capital   number of employees (EMP), research and development capital (RND), and marketing (brand) capital (SGA).[6]

We focus on firm sales – a size measure – rather than on a profitability measure, following recent findings in the economics literature, as summarized by Atkeson and Kehoe (2001, p. 20-22):

> "We argue that data support the view that plants accumulate a large amount of organization-specific capital [structural capital in our terminology] as they age.

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[5]Indeed, the Financial Accounting Standards Board (FASB) – the major U. S. rule-making body concerning financial disclosure – voted in January 2002 to add an intangibles disclosure project to its agenda.

[6]SGA stands for sales, general, and administrative expenses. Since most firms do not report brand creation/enhancement expenditures, we use selling, general, and administrative expenses, which include brand related expenses.

> This capital is reflected in their size and not in some measure of their average productivity. That plants grow in size with age is clear from the data on the employment shares of plants of different ages...That these differences in organization-specific capital are not reflected in average productivity of capital or labor is documented...An individual who learns shows increases in labor productivity. An organization that learns grows by adding variable factors so as to keep labor productivity constant. Hence, the key variable to look at to determine the amount of organizational-specific capital...[is] some measure of size."

Structural capital enables firms to combine inputs in order to generate output. The structural capital is of two types: (a) a common structural capital (A) that is available to all firms (e.g. a certain level of employee education, the prevailing legal and institutional setting, etc.), and (b) a firm-specific structural capital (FA) that is developed and restructured by each firm (e.g. coded knowledge, production blueprints, business processes and procedures, marketing networks and channels, etc.). Overall, successful firms are able to utilize certain levels of physical and human resources more effectively than others due to their firm-specific structural capital.

To capture the structural capital's attribute of being an enabler in converting physical and intangible inputs into outputs, we utilize a constant returns to scale production function (see Hall, 2000), specified as:

$$SALE_{it} = A_t\, FA_{it}\, PPE_{it}^{b1}\, EMP_{it}^{b2}\, SGA_{it}^{b3}\, RND_{it}^{b4}\, e_{it}, \qquad (1)$$

where $SALE_{it}$ is the revenues of firm i in year t, A_t is the common structural capital, FA_{it} is the firm-specific structural capital, PPE_{it} is net plant, property and equipment, EMP_{it} is number employees, SGA_{it} is the marketing capital, RND_{it} is research and development capital, and e_{it} is an error term. The contribution of the structural capital (SC_{it}) to generating output is a made-up of the common and firm-specific components, i.e., $SC_{it}=A_t\, FA_{it}$. Equation (1) appropriately reflects the enabling role of structural capital in value creation, since if either the common structural capital or the firm-specific structural capital is zero, no output is generated. Conversely, equation (1) depicts the inertness of the input resources without structural capital.

The production function in (1) leads to expression (2), stated in terms of growth of output and inputs (see Hall, 2000; Star and Hall, 1976):

$$LSALE_{it} = LA_t + LFA_{it} + b_1 LPPE_{it} + b_2 LEMP_{it} + b_3 LSGA_{it} + b_4 LRND_{it} + Le_{it}, \quad (2)$$

where $LSALE_{it} = Log[GSALE_{it}]$, where $GSALE_{it} = SALE_{it} / SALE_{i(t-1)}$, namely the annual growth of output; and similarly for all other variables on the right-hand-side of (2). Note that the log of growth in structural capital is made up of the common and firm-specific components, i.e., $LSC_{it} = LA_t + LFA_{it}$.

Research and development capital (RND) is measured by capitalizing and amortizing the annual research and development expenditures (RNDE) over five years. The growth in marketing capital (SGA) is measured by the growth in annual selling, general and administrative expense, SGAE. This yields consistent estimates of growth in marketing capital when SGAE and its amortization is a constant proportion of marketing capital at the beginning of the year.[7] Thus, $LSGA_{it} = Log[SGAE_{it} / SGAE_{i(t-1)}]$.

The output and the inputs in expression (2) other than the number of employees are deflated to constant 1996 dollars, to measure the real growth rates. Specifically, SALE is deflated using the general price deflator; PPE is deflated using the fixed

[7]To see this, consider the following evolution process, $SGA_t = SGA_{(t-1)} + [P+D]*SGA_{(t-1)} - D*SGA_{(t-1)}$,where, P is the proportion of the beginning SGA that is purchased and D is the proportion of the beginning SGA that is replaced because of depreciation. In essence, $[(P+D)*SGA_{(t-1)}]$ is the spending in period t and $[D*SGA_{(t-1)}]$ is the depreciation in period t. The growth in SGA is given by $GSGA_t = [SGA_t/SGA_{(t-1)}] = (1+P)$. The spending (SGAE) in period t and (t-1) are given by $SGAE_t = (P+D)*SGA_{(t-1)} = (1+P)*(P+D)*SGA_{(t-2)}$ and $SGAE_{(t-1)} = (P+D)*SGA_{(t-2)}$. Thus, $[SGAE_t/SGAE_{(t-1)}] = (1+P) = [SGA_t/SGA_{(t-1)}] = GSGA_t$.

investment deflator, RNDE is deflated using the average of the fixed investment and wage deflators, and SGAE is deflated using the average of the general price, fixed investment and wage deflators. Data on deflators were obtained from http://www.bea.doc.gov/bea/.

II. A. Descriptive Statistics and Expression (2) Estimation Results

The sample consists of all firms that appeared in the Information Week 500 list between 1991 and 1997. We use the Information Week 500 to define our sample space, because it provides data on information technology (IT) expenditures   a major component of structural capital   for the surveyed companies. These IT expenditure data are later used to validate our estimates of structural capital. Data for each sample firm on sales (Compustat data item # 12), plant, property and equipment (data item # 8), number of employees (data item # 29), selling, general and administrative expense (data item # 132), and research and development expense (data item # 46) are obtained from the Compustat Annual Database.

Expression (2) was estimated separately for each year t, over a rolling-panel of five years. Specifically, for each year t the following expression was estimated:[8]

$$LSALE_{ikt} = LA_t + \text{Ó}_i LFA_{it}\, D_{it} + b_{1t}LPPE_{ikt} + b_{2t}LEMP_{ikt} + b_{3t}LSGA_{ikt} + b_{4t}LRND_{ikt} + Le_{ikt}, \qquad (3)$$

for k=t,..,(t-4); t=1989,..,1997.[9] D_{it} is a firm-specific dummy variable. That is, we estimate expression (3) using five-year data spanning year t to year (t-4), for each year t. For example, to estimate expression (3) for 1991, we use data for the years 1987 to 1991

[8] See Caves and Barton (1990) and Jorgenson (1986) for details on estimating firm production functions with fixed effects. Hulten (1999) provides a review of the theoretical foundations of the Solow Divisia Index.

[9] We include 1989 and 1990 for testing the persistence of the residuals obtained from estimating expression (3).

(k=1987,..,1991). This procedure yields firm-specific coefficient estimates on the dummy variable, which is then used to develop our structural capital measure.

Research and development expense was set to zero when data were not available on Compustat. Expression (3) is estimated separately each year for two groups of firms – those with research and development expenditures and those without. The sample contains 814 (Non-RND), and 1,245 (RND) firm-years, spanning 1989 to 1997, representing 215 individual firms.

Table 1, Panel A provides descriptive statistics for the inputs and output variables in expression (3). Panel B of Table 1 provides the correlations among the variables. Panel C of Table 1 presents the mean of the annual estimates of expression (3) for the R&D and non-R&D firms. For the R&D firms the log of growth in common structural capital is 0.02, which represents about 2% [= exp(.02)] average growth. This is consistent with the aggregate Divisia index estimates in Hall (2000). For the R&D (non-R&D) firms, the marginal productivity of plant, property and equipment (b_1^*) is 0.11 (0.08), the marginal productivity of human capital (b_2^*) is 0.26 (0.21), the marginal productivity of marketing capital (b_3^*) is 0.45 (0.49), and the marginal productivity of research and development (b_4^*) is 0.11. The difference between the marginal productivities of EMP and SGA across the R&D and non-R&D firms is insignificant, while the difference between the marginal productivities of PPE across the R&D and non-R&D firms is statistically significant at the 0.05 percent level. This suggests that the research and development activity, particularly process research and development, contributes to improvements in manufacturing processes, which in turn helps to increase the productivity of plant, property and equipment. Marketing capital (SGA) appears to be the most productive input[10], followed by employees (EMP), physical capital (PPE) and research and development capital (RND). This highlights the role of marketing and human capital in generating outputs.

The firm-specific structural capital (LFA) estimates for the R&D and non-R&D firms are 0.09 and 0.06, respectively. This differential of 0.03 is statistically significant at the 1% level, and indicates that R&D firms have more effective firm-specific structural capital than non-R&D firms.

II. B. Examining Properties of the Structural Capital Estimates

We examine here the persistence of the estimated structural capital. The structural capital (LSC) measure is based upon the firm fixed effects (LFA_{it}^{*}), and the intercept (LA_t^{*}) obtained from expression (3), namely $LSC_{it}^{*} = LFA_{it}^{*} + LA_t^{*}$. If LSC_{it}^{*} captures the attributes of an enabler of other inputs (expression 1), then LSC_{it}^{*} should exhibit a certain persistence, namely, be correlated for firm i over a period of time. Stated differently, structural capital is not a random variable. The persistence of the structural capital estimate (LSC) is examined by regressing LSC estimates in year t on two lagged LSC estimates:

$$LSC_{it}^{*} = k_0 + k_1[\text{Year dummy}] + a_1 LSC_{it-1}^{*} + a_2 LSC_{it-2}^{*} + \text{error}. \quad (4)$$

Table 2, Panel A provides the descriptive statistics of the firm-fixed effect (LFA), the estimate of the firm-specific structural capital. The mean (median) LFA is 0.08 (0.08), with a minimum of –0.14 and a maximum of 0.16. About 15% of the firms in the

[10] A clue to the relatively strong performance of marketing capital (SGA) in expression (3) may be found in finance studies (e.g., Berger et. al., 1997) that use SGA to proxy for "product/service specificity." In particular, it is argued that the more specific (unique) the firm's product/service, the more the firm needs to spend to market it, hence the large SGA expenses. Product/service specificity may indicate monopoly power, which in turn may account for our finding of high marginal productivity (b_3^{*}) of SGA in expression (3), reflected in Table 1, Panel C.

sample have a negative LFA. Table 2, Panel B provides the results of estimating expression (4). The coefficient on lagged LSC (a_1) is 0.71, indicating first-order persistence (a_2, however, is insignificant). The fact that the coefficient is less than one indicates that firms, on average, converge to a mean structural capital.

The property of structural capital (LSC) obtained from expression (3) is illustrated in the top-panel of Figure 1. The sample is sorted each year into three groups based on LSC. The high (low) LSC group consists of the top (bottom) 30% LSC firms for each estimation year. The figure plots the mean LSC in the four years following the estimation year t, in which the portfolios of high, medium and low LSC are formed. The figure shows that, on average, firms in the high LSC group continue to have a high LSC for about 4 years, and the low and the high LSC groups converge.

The persistence of the residual estimates (Le_{it}) from expression (3) is examined to check whether the residuals contain some systematic elements of structural capital. We wish to make sure that Le_{it} is a "true" white noise residual, in contrast with the widely known "Solow residual" in traditional growth models, which reflects systematic factors like technology. To examine this issue, the mean firm-specific residual for each estimation year is computed as $LMe_{it}^* =$ Ó$_k Le_{ikt}^*$ for k=t,(t-4). In the rolling panel estimation of expression (3), five years spanning k=t,(t-4) are considered, and thus, five residual estimates, Le_{ikt}^* for k=t,..,(t-4), are obtained for each estimation year t. The persistence of the firm-specific residual is examined by regressing LMe^* estimates in year t on two lagged LMe^* estimates:

$$LMe_{it}^* = k_0 + k_1[\text{Year dummy}] + a_1 LMe_{it-1}^* + a_2 LMe_{it-2}^* + \text{error}. \quad (5)$$

If the estimated residuals from expression (3) do not capture any structural capital attributes, or other systematic factors, the estimates of a_1 and a_2 in expression (5) should be statistically insignificant. Table 2, Panel C provides the results of estimating expression (5). As expected a_1 and a_2 are insignificant, and hence, on average the residuals do not seem to capture attributes of structural capital.

The property of the residual (LMe) obtained from expression (3) is illustrated in the bottom-panel of Figure 1. The sample is sorted each year into three groups based on LMe. The high (low) LMe group consists of the top (bottom) 30% LMe firms for each estimation year. The figure plots the mean LMe during the four years following year t in which the portfolios of high, medium and low LMe are formed. The figure shows that, on average, firms in the high residual group in year t do not continue to have high residuals in the following years.

We, therefore, conclude that our structural capital estimate, LSC, exhibits the expected persistence over time, while the residual estimated from expression (3), LMe, is not serially correlated.

III. Deriving a Firm-Specific Structural Capital Measure

We move from regression estimates to <u>monetary</u> measures of structural capital. From expression (2) the expected output of firm i in year t is:

$$SALE_{it}^{*} = SALE_{i(t-1)} A_t^{*} FA_{it}^{*} GPPE_{it}^{b1*} GEMP_{it}^{b2*} GSGA_{it}^{b3*} GRND_{it}^{b4*},$$

where b_1^*, b_2^*, b_3^* and b_4^* are the coefficient estimates from expression (3).[11] It follows that firm i's expected output without the effect of structural capital is:

$$SALE_{it}^{**} = SALE_{i(t-1)}\, GPPE_{it}^{b1*}\, GEMP_{it}^{b2*}\, GSGA_{it}^{b3*} GRND_{it}^{b4*}.$$

Thus, the Abnormal Output (ASL), reflecting the impact of structural capital, is given by:[12]

$$ASL_{it} = SALE_{it}^{*} – SALE_{it}^{**}$$

$$= SALE_{i(t-1)}\, [A_t^{*} FA_{it}^{*} - 1] GPPE_{it}^{b1*} GEMP_{it}^{b2*} GSGA_{it}^{b3*} GRND_{it}^{b4*}$$

$$= SALE_{i(t-1)}\, [SC_{it}^{*} - 1] GPPE_{it}^{b1*} GEMP_{it}^{b2*} GSGA_{it}^{b3*} GRND_{it}^{b4*}, \qquad (6)$$

where structural capital $SC_{it}^* = A_t^* \, FA_{it}^* = \exp[LA_t^* + LFA_{it}^*]$. ASL_{it}, the difference between expected sales with and without structural capital, is our firm-specific measure of the impact of structural capital on output. ASL in expression (6) is in constant 1996 dollars. Accordingly, ASL is inflated to nominal value using the general price deflator. We turn to examining the properties of our measure of structural capital, ASL_{it}.

III. A. Validating the Structural Capital Estimate

Our measure of structural capital, ASL, is at this stage a black box. The remainder of this study is aimed at penetrating the black box. In this subsection we examine the association of ASL with the firm's market share and its investment in information technology (IT), both believed to reflect elements of structural capital. In the following sections we examine the extent to which investors recognize the value of structural capital, as reflected by ASL.

Effective structural capital leads to the establishment of unique marketing networks, innovations in distribution channels, strong customer acquisition and retention,

[11] For the non-R&D firms expression (3) does not include GRND and b_4^*.

which, in turn, result in large market share (MKSHR). Accordingly, MKSHR is expected to be positively associated with ASL. The market share of firm i, operating in the two-digit SIC code k in year t, is computed as the ratio of firm i's sales to the total sales of the two-digit SIC code k. Thus, $MKSHR_{ikt}= SALES_{ikt}/ \; _{j} \; SALES_{jkt}$, where the subscript j indicates all firms that belong to the two-digit industry code k in year t.

Brynjolffson and Yang (1999) argued that information technology creates value by enabling improvements and innovations in business processes and procedures. Thus, if ASL adequately measures structural capital, then it should be associated with information technology expenditures. To examine this, information systems budget (ISBUD) data were obtained from Information Week 500 lists for 1991 through 1997.[13] Combining the above arguments leads to the following expression:[14]

$$Log[ASL_{it}]= k_0 + k_1[\text{Year dummy}] + a_1 MKSHR_{it} + a_2 \, Log[ISBUD_{it}]. \qquad (7)$$

We expect a_1 and a_2 to be positive.

Table 3 provides the estimates of expression (7). Panel A presents the descriptive statistics for ASL, MKSHR and ISBUD. The mean (median) ASL is $720 ($309) million. The mean (median) change in sales is $456 ($183) million. Thus, on average, the abnormal sales (ASL) represents about twice the change in sales. The mean (median) MKSHR is 4% (2%) ranging from 0.1% to 51%. Thus, firms in the sample range from operating in highly competitive environments to wielding relatively high monopoly power. The mean (median) ISBUD is $196 ($77) million, ranging from $2 million to $4.4

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[12]Note that ASL is a flow measure. ASL can be capitalized into a stock measure by discounting the expected ASL at the firm-specific cost of capital for a specified number of years.
[13]The Information Week 500 list stopped providing the information systems budget data after 1997.
[14]To retain observations with negative ASL, we added the absolute value of the minimum ASL to each observation. Similar results were obtained when negative ASL firms are eliminated.

billion. Overall, this suggests that the sample firms vary considerably in terms of competitive environment and information technology intensity.

Panel B of Table 3 provides the estimates of expression (7). For the pooled (1991-1997) sample, market share (MKSHR) and information systems budget (ISBUD) explain 45% (adjusted R-square) of our measure of structural capital (ASL). Market share alone explains about 16%, while including the information systems budget increases the explanatory power by about three times. This supports the argument of Brynjolffson and Yang (1999) that information technology expenditures help to improve productivity by enhancing structural capital. The year-by-year estimates of expression (7) yields an interesting perspective. The contribution of ISBUD to ASL has been increasing overtime, from estimated coefficients of 0.35   0.52 in 1991-1994, to 0.70   0.79 in 1996-1997. This corroborates the notion that the contribution of information systems to structural capital has been increasing during the 1990s. Overall, the strong association between the structural capital measure, ASL, on the one hand, and firms' market share and IT investment on the other hand provides some validity to ASL reflecting the value of firms' organizational capital.

Figure 2, shows the behavior of the structural capital over time. The mean ASL increased from about $620 million to about $1,390 million over the seven-year period, 1991 to 1997; while the median has increased from $300 million to $600 million. This doubling of structural capital over seven years indicates an annual growth rate of about 12%. This growth rate corresponds quite well with the growth in the S&P500 stock index.

III. B. <u>Examples of Structural Capital (ASL) for Specific Companies</u>

We now provide preliminary insights into the relationship between the structural capital measure (ASL) and market values. Specifically, Figure 3 provides a comparison of the Market-to-Book ratio (MB) and the capitalized ASL-to-Book ratio (CASLB) of two firms – IBM and Johnson and Johnson.[15] The major difference between the panels in Figure 3 is that for IBM, the two relative value measures (MB and CASLB) are very close, while for Johnson and Johnson (a large pharmaceutical company), the structural capital measure (CASLB) is systematically lower than the market-to-book ratio. Furthermore, for J&J, CASLB is virtually flat over the examined period, while MB has been steadily increasing between 1993 and 1997. The reason for the difference seems to be that the market value of a pharmaceutical company mainly reflects the value of its patents and salesforce (both variables explicitly represented in our production function, by R&D and number of employees), leaving a relatively small share of value to structural capital. IBM in contrast, relies more heavily on structural capital to create value – roughly half of its revenues come from consulting activities (IBM's Global Division), which are essentially a form of structural capital.

We proceed to examine whether ASL, the contribution of structural capital to output, can explain the variations in stock prices above and beyond typical stock valuation measures.

[15]The capitalized ASL is computed as the present value of ASL for five years discounted at the cost of equity capital obtained from the Capital Asset Pricing Model (CAPM), i.e., $CASL_{it}=[\text{Ó}_{k=0,4}ASL_{it}/\{(1+r_{it})^{k}\}]$.

IV. Equity Valuation and Structural Capital

As a validity check on the methodology to estimate structural capital, we examine whether the ASL estimate of structural capital is recognized by investors and reflected in stock prices. This is an important issue, since capital market values affect the firms' cost of capital, as well as managers' compensation and incentives. For valuation, we use the residual earnings valuation (REV) model that is currently widely used in research and practice. The REV model was introduced by Preinreich (1938) and rigorously derived by Ohlson (1995). Specifically, the expression prescribes that the stock price is equal to assets-in-place plus the present value of residual (abnormal) earnings (growth potential), i.e., earnings in excess of the required rate of return (cost of capital):

$$V_{it} = BV_{it} + RE_{it} \tag{8}$$

where, V_{it} is firm i's market value of equity at the end of year t based on the REV model, BV_{it} is firm i's book value (balance sheet value of net assets) at the end of year t, representing assets-in-place and RE_{it} is firm i's present value of residual (abnormal) earnings at the end of year t.

To compute the present value of residual earnings we need estimates of expected earnings, and discount rates. Following Dechow, Hutton and Sloan (1999), Francis, Olsson and Oswald (2000) and Liu and Thomas (2000), we use for expected earnings firm-specific analysts' consensus forecasts of earnings. Specifically, we use the mean analyst earnings forecast for three years ahead (or two years when the third year ahead forecast is not available), and extend these forecasts to five years with the analysts' long-term growth forecast.[16] The current dividend payout ratio (dividends to earnings) was used to estimate expected dividends. The dividend payout ratio was winsorized at ten percent, if the current dividend payout ratio was greater than ten percent. A firm-specific discount rate is estimated using Capital Asset Pricing Model (CAPM) with Beta estimated from past returns. Accordingly, the discount rate (r_{it}) is computed as the twelve-month treasury-bill rate (risk-free rate) plus Beta times a risk premium of 5.5%.[17] Thus, the present value of residual earnings (RE) in the valuation expression (8) is given by:

$$RE_{it} = \sum_{k=1,5} [FE_{ikt} – r_{it}\, BV_{i(k-1)t}]\, (1+r_{it})^{-k} + [FE_{i6t} – r_{it}\, BV_{i5t}]\, (r_{it} – g_{it})^{-1}, \qquad (9)$$

where FE_{ikt} is the consensus analysts' k years ahead earnings forecast for firm i, four months after the fiscal year t, r_{it} is the discount rate, BV_{it} is the book value of firm i in year t [$BV_{ikt} = BV_{i(k-1)t} + FE_{ikt} – DIV_{ikt}$], DIV_{it} is the dividend, g_{it} is the growth of [$FE_{i6t} – r_{it}\, BV_{i5t}$] beyond five years.[18] Thus, residual earnings (the difference between analysts' earnings forecast and a charge for cost of equity, FE – r BV) are predicted for each company for the next five years, followed by a terminal value, based on a constant growth expression.[19]

To examine the extent to which our estimate of structural capital, ASL (expression 6), is reflected in stock prices, we estimate the following expressions:

$$[MV_{it}/SALE_{it}] = k_0 + k_1[\text{Year dummy}/SALE_{it}] + b_1[V_{it}/SALE_{it}] + b_2[ASL_{it}/SALE_{it}] + error \quad (10)$$

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[16]Analysts' consensus forecasts of earnings and long-term (up to five years) growth estimates were obtained from IBES.
[17]Similar results are obtained when a constant discount rate of either 10% or 12% is used for all firms.
[18]The growth rate, g_{it}, is set equal to r_{it} minus 3%, if $g_{it} > r_{it} - 0.03$.
[19]We also used RE without the terminal value and obtained similar results.

$$[MV_{it}/SALE_{it}] = k_0 + k_1[\text{Year dummy}/SALE_{it}]+b_1[V_{it}/SALE_{it}]+\text{error}, \quad (11)$$

where, MV_{it} is the market value of firm i four months after the fiscal year t, SALE is the sales of firm i in fiscal year t, ASL_{it} is firm i's estimated structural capital value using expression (6), and V_{it} (expression 8) is firm i's estimated equity value computed as the sum of its book value (BV_{it}) and the present value of residual earnings (RE_{it}, see expression 9). All variables are scaled by Sales, to account for scale (size) effects [see Brown, Lo and Lys (2000), Easton (1998) for scale effects and the appropriateness of using sales as the scaling variable]. Expression (11) is the benchmark expression, without the structural capital estimate, ASL, while in expression (10) we introduce the structural capital estimate, ASL_{it}. We expect the coefficient on ASL to be positive, and the explanatory power of expression (10) to be higher than that of expression (11), since current accounting rules (GAAP) exclude most intangibles from book value (BV), a component of V_{it}. Of course, if financial analysts fully incorporate the benefits of structural capital in their forecast of earnings (included in RE), then ASL in (10) will be statistically insignificant. So, in fact, we are indirectly assessing analysts' ability to value firms' structural capital. Note that RE, MV and BV in (10) and (11) are stock variables, while ASL is a flow variable. The estimate of b_2 obtained from expression (10) will also provide an idea about the horizon over which investors capitalize ASL, on average.

Stock prices (MV) for each sample firm were obtained from the CRSP database, and financial data on book value (data item # 11), and dividends (data item # 27) were obtained from the Compustat database. The financial data for year t were matched with stock prices four months subsequent to the fiscal year-end, to ensure that the financial information is available to the investors. Analysts' forecast data, four months subsequent to the fiscal year-end were obtained from IBES. We deleted observations with negative book value of equity, and negative three-years ahead earnings forecasts. To estimate Beta for CAPM, monthly stock return data was required for at least 24 months of the previous 60 months. The sample contains 1,244 firm-year observations, from 1991 to 1997.

Panel A, Table 4 provides descriptive statistics for the variables used in the equity valuation tests. The mean (median) market value (MV) is $8.4 ($3.66) billion, with a minimum of $41 million and a maximum of $123 billion. The mean (median) book value (BV) is $2.9 ($1.5) billion. Thus, the average market-to-book ratio of the sample companies is 2.8. The mean present value of residual earnings (RE) is $1.1 billion, while the median is $351 million. Thus, on average, the book value ($2.9 billion) and the present value of residual earnings (growth potential), $1.1 billion, constitute almost half of the market value of equity ($8.4 billion). The mean value of structural capital (ASL) is $834 million, while the median is $330 million. ASL is substantially smaller than RE and BV, because it is a flow measure.

Panel B of Table 4 provides the Spearman correlation coefficients among the variables. Market value is positively associated with RE and ASL, with correlation coefficients of 0.58 and 0.69, respectively, while RE is positively correlated with ASL, with a correlation coefficient of 0.59.

Panel A of Table 5 provides estimates of expressions (10) and (11), indicating that the addition of structural capital (ASL) to the valuation expression (11) increases explanatory power from 39% (expression 11 adjusted R-square) to 63% (expression 10 adjusted R-square) – a 62% increase. The coefficient estimate on ASL is 5.28, which suggests that the market expects the benefits of structural capital to persist for about five years, consistent with Figure 1 (persistence of structural capital). The yearly estimates in Panel A indicate that the considerable contribution of structural capital to the "explanation" of market values holds in every year (see also Figure 4). Furthermore, the inclusion of structural capital in the valuation model (expression 11) in the later periods leads to a substantially larger increase in adjusted R-square, than in earlier periods.

Panel B of Table 5 contains the results of estimating expressions (10) and (11) for the sample partitioned by the Market-to-Book (MB) ratio, a proxy for expected growth and intangibles intensity. The high (low) Market-to-Book ratio group contains the top (bottom) 30 percent of firms ranked by Market-to-Book ratio each year. The results indicate that ASL (structural capital) increases explanatory power for all the groups by about 20 percent, and that the coefficient of ASL for high MB firms (6.07) is substantially larger than for low MB firms. Thus, structural capital is clearly associated with growth, and investors' valuation of intangible assets.

Panel C of Table 5 provides estimates of expressions (10) and (11) when the sample is partitioned by firm size (market capitalization). The large (small) size group contains firms in the top (bottom) 30 percent of the sample firms ranked each year by market value of equity. ASL provides the highest incremental explanatory power for small firms: the adjusted R-square of expression (10) is 51 percent versus 27 percent for expression (11). This is consistent with the evidence that the accounting model and analysts' forecasts provide lower quality information for small firms than for larger ones.

Overall, the results in Table 5 indicate that our structural capital estimate, ASL, is a valid measure of value that complements both book value (assets-in-place) and analyst-based residual earnings, particularly, in settings where the accounting model does not perform well.[20] It is interesting to note that the statistical significance and large contribution to R^2 of ASL in Table 5 indicates that financial analysts fail to fully capture the impact of structural capital on firm value in their forecast of earnings, a highly visible output of analysts' activities.

Structural Capital and Analysts' Earnings Forecast

To further explore the extent to which the analysts' forecasted earnings (in expression 8) capture elements of structural capital, we estimate the following expression:

$$[CASL_{it}/SALE_{it}] = k_0 + k_1[Year\ dummy/SALE_{it}]+b_1[RE_{it}/SALE_{it}]+error, \quad (12)$$

where CASL is the capitalized value of structural capital (ASL), using the firm-specific discount rate (r_{it}) over five years, and RE_{it} is the residual earnings value (based on analysts forecasts) computed from expression (9). We capitalize ASL since RE (residual earnings value) is a stock variable. Expression (12) thus estimates directly analysts' ability to value structural capital.

Panel A of Table 6 presents estimates of expression (12) for the total sample. On average financial analysts "get" about 15% of the structural capital elements incorporated into their forecasts (in terms of R^2). Panel B of Table 6 presents estimates of expression (12), when the sample is partitioned by the Market-to-Book ratio (MB) and firm size. The high (low) group contains the top (bottom) 30 percent of firms ranked each year, by Market-to-Book ratio and market value of equity, respectively. Analysts appear to "get"

[20]We also estimate models following previous value-relevance research in the accounting literature. In these models, RE, the present value of residual earnings, is replaced by current earnings, IBE. $[MV_{it}/SALE_{it}]=k_0[1/SALE_{it}]+[Year\ dummy/SALE_{it}]+b_1[BV_{it}/SALE_{it}]+b_2[IBE_{it}/SALE_{it}]+b_3[ASL_{it}/SALE_{it}]$ +error , and $[MV_{it}/SALE_{it}]=k_0[1/SALE_{it}]+[Year\ dummy/SALE_{it}]+b_1[BV_{it}/SALE_{it}]+b_2[IBE_{it}/SALE_{it}]$+error, where, all other definitions are as before and IBE_{it} is the income before extraordinary items. The results are consistent with the findings in Table 5.

more of the structural capital value for the high MB firms – high intangible intensity companies (adjusted R-square of 36%), than the low MB firms – low intangible intensity companies (adjusted R-square of 6%). Similarly, analysts appear to "get" more of the structural capital value for the large firms (adjusted R-square of 28%), than the small firms (adjusted R-square of 4%), perhaps due to better information availability on large firms (e.g. most large firms routinely hold conference calls while providing their quarterly earnings reports).

To further examine whether financial analysts systematically miss out on elements of structural capital, or whether they "correctly" filter out the noise in our measure, we estimate the following expression:

$$ANER_{it}=k_0 + k_1[\text{Year dummy}]+a_1ANER_{it-1}+a_2ANER_{it-2}+\text{error}, \qquad (13)$$

where $ANER_{it}$ is the residual from estimating expression (12) annually. If analysts miss out important systematic elements captured by the structural capital measure, then the errors would be persistent. In such a case, we would expect a_1 in expression (13) to be positive. Panel C of Table 6, presents the estimates for expression (13). We find that the analysts appear to miss out a systematic portion of our structural capital measure. On average, analysts miss about one-third of the structural capital value each year. However, analysts appear to incorporate the value of structural capital with a one-year lag, since a_2 is not significant.

We conclude that: (a) current stock prices reflect, at least partially, the value of the firm's structural capital, as indicated by our measure, ASL, and (b) the contribution to earnings of the firm's structural capital is missed by the accounting model (represented by BV in (8)), and not fully captured by financial analysts in their forecasts of earnings and growth rates (represented by RE in (8)). Our estimates indicate that some of the benefits arising from structural capital that are missed by analysts, are nevertheless recognized contemporaneously by investors (ASL is positively correlated with market value). These lead to our last question: are these benefits fully recognized by investors?

V. Risk, Market Efficiency, and Future Returns: Is the Lemon Fully Squeezed?

The regression estimates reported in Tables 5 and 6 indicate that some of the benefits of structural capital in generating output are recognized by investors and incorporated in market values. But do investors fully recognize contemporaneously the benefits of structural capital? Is the lemon fully squeezed? After all, hardly any useful information is provided to investors about intangibles in general, and structural capital in particular (see Lev, 2001, Chapter 4). It will not be surprising, therefore, if invetors miss some of the value of structural capital. Obviously, a contemporaneous regression analysis, such as that reported above, cannot address this market efficiency question.

V. A. Stock Returns and Lagged Changes in Structural Capital

To examine whether investors incorporate the impact of structural capital value fully in stock prices, we examine the relationship between stock returns, and current and lagged changes in ASL by estimating the following expression:

$$RET_{it}=k_0+k_1[\text{Year dummy}]/P_{it-1}+a_1CHASL_{it}/P_{it-1}+a_2CHASL_{it-1}/P_{it-1}+a_3CHASL_{it-2}/P_{it-1}+\text{error}, \quad (14)$$

where RET_{it} is the annual returns of firm i's stock computed for the twelve months ending four months subsequent to the fiscal year t, P_{it} is the stock price of firm i four months subsequent to the fiscal year t, and $CHASL_{it} = (ASL_{it} - ASL_{it-1})/CSOS_{it}$, where

$CSOS_{it}$ is the number of common shares outstanding for firm i in fiscal year t. CHASL, thus, represents the per-share change in structural capital.[21] If investors fully incorporate the innovations in structural capital contemporaneously, then we expect only a_1 to be positive and significant.

Table 7 presents the descriptive statistics and estimates of expression (14). Coefficients a_1 and a_2 are positive and significant, indicating that investors do not fully recognize in a timely manner the impact of innovations in structural capital.

V. B. Risk-adjusted returns and Structural Capital

To examine market efficiency with respect to structural capital, we employ a standard methodology in finance research – the Fama-French (1993) "four-factor model." Specifically, future excess returns from portfolios structured on some publicly known attributes (e.g., an announcement of a merger or acquisition) are regressed on four systematic risk factors: market returns, firm size, book-to-market ratio, and stock returns momentum. These four factors are widely documented to be systematically associated with stock returns (see Fama and French, 1992 and 1993). If the intercept of such a regression is found to be statistically significant, it indicates that the information used to form portfolios was not fully captured by investors. This four-factor model is depicted thus:

$$R_i(t)–Rf(t) = a+b_1[Rm(t)–Rf(t)]+b_2SMB(t)+b_3HML(t)+b_4UMD(t) + error, \qquad (15)$$

where $R_i(t)$ is the month t value-weighted portfolio return subsequent to portfolio formation, Rf(t) is the corresponding one month treasury bill rate. $[R_i(t) - Rf(t)]$ is thus the excess portfolio returns. Rm(t) is the value-weighted monthly return on all stocks in

[21] We estimated expression (14) with the change in ASL scaled by stock price and also the change in

NYSE, AMEX and Nasdaq (the market factor), SMB(t) [Small Minus Big] is the difference between the small market value of equity and large market value of equity portfolio returns with about similar weighted average book-to-market in month t, HML(t) [High Minus Low] is difference between high book-to-market and low book-to-market portfolio returns with about the same weighted average market value of equity in month t, and UMD(t) [Up Minus Down] is the difference between the average return in month t on the high and low prior return portfolios and represents the risk factor associated with stock returns momentum. Monthly time series data on the risk-free rate (Rf(t)), market portfolio (Rm(t)), and the SMB, HML and UMD factors were obtained from Ken French's website (http://mba.tuck.dartmouth.edu/ pages/ faculty/ ken.french/data_library.html).

Three portfolios are formed each year based on the estimated structural capital (expression 6), scaled by sales [ASL/SALE], all sample firms, high and low ASL/SALE firms. Subsequent value-weighted excess monthly returns for each ASL/SALE portfolios and the overall sample are computed.[22] We estimate expression (15), for each portfolio using contemporaneous, one-year ahead, two-years ahead and three-years ahead monthly portfolio returns. For example, expression (15) with contemporaneous returns means that high and low portfolios are formed based on the size of ASL/SALE in, say, fiscal year 1991.[23] Then, value-weighted monthly portfolio returns are computed for the period September 1991 through August 1992 (contemporaneous with fiscal year 1991) and are

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capitalized ASL and obtained similar results.

[22]We believe that value-weighted (by total market capitalization) portfolio returns best reflect the purpose of our tests. We replicated the analysis with equally weighted portfolio returns, and obtained very similar returns to those reported in Table 8.

[23] Fiscal year 1991 includes all firms with fiscal years ending between June 1991 and May 1992.

regressed on the four factor returns for the same months.[24] Similarly, portfolios are formed for each year 1991 through 1997. For each of the structural capital portfolios (high and low) the regression includes 84 observations, corresponding to the 7 years and 12 months in each year.

One-year, two-years and three-years ahead regressions mean that the portfolios formed in, say, 1991 are used to form value-weighted monthly returns for the periods September 1992 to August 1993, September 1993 to August 1994, and September 1994 to August 1995, respectively.

The focus of the analysis is on the intercept term, a, in expression (15), which indicates the existence of abnormal portfolio returns after controlling for the four known risk factors. The implications of the contemporaneous and forward return analyses are, of course, different. If the contemporaneous return test yields a significant intercept, it indicates that structural capital generates systematic risk-adjusted returns – a reassuring, though not a highly unexpected result. If, however, the forward returns test yields a significant intercept (one to three years ahead), it indicates that the contribution of structural capital is not fully captured contemporaneously by investors (investors learn gradually about the benefits of structural capital) – a case consistent with market inefficiency, or alternatively, with an unknown risk-factor associated with structural capital.

Table 8 provides the estimates of expression (15). The risk adjusted abnormal returns (i.e., the intercept estimate) for high (low) structural capital portfolio for the

[24]We choose the period September of year t through August of year t+1, so that all the financial information that is required to estimate structural capital value (ASL) is available to the investors well before computing the one-year ahead portfolio returns.

contemporaneous, one-year ahead, two-years ahead, and three-years ahead are 0.39%, 0.21%, 0.18% and 0.10% (0.06%, 0.11, 0.09, 0.04), respectively.[25] Important for our study is the difference in the risk-adjusted abnormal returns between the high and the low ASL/SALE portfolios a hedge portfolio, long on high ASL/SALE and short on low ASL/SALE companies. In all cases (contemporaneous and subsequent returns), the returns on high structural capital (ASL) portfolios are higher than those on low ASL portfolios. The differences are significant for the contemporaneous and one-year ahead returns. The abnormal returns are also economically significant. For example, the monthly risk-adjusted return on large ASL firms in the year subsequent to portfolio formation is 0.21%, which is about 2.6% on an annual basis – a very substantial abnormal return indeed.

Thus, much of the value of structural capital in enhancing output is captured by investors contemporaneously with the publication of financial reports and other information, as indicated by the largest differential abnormal return (0.33%) between companies with high and low ASL/SALE (and the largest overall return – 0.21%). However, investors do not <u>fully</u> capture contemporaneously the potential of structural capital, as evidenced by the relatively large differential in the one-year ahead abnormal returns. There appears to be a certain degree of market inefficiency concerning structural

[25]The coefficient estimates of the four risk factors (not reported) are consistent with expectations. The estimated coefficient on Rm – Rf, excess market returns, (b_1^*) is 1.01, which is close to the average market beta of one. The sign of the SMB coefficient (b_2^*) is negative (small stock earn higher returns), the coefficient of the HML (b_3^*) is positive (consistent with the widely documented positive association between book-to-market and returns), and the sign of the UMD coefficient (b_4^*) is positive (consistent with the positive association between prior returns and subsequent returns).

capital, a not so surprising finding, given the poor disclosure to investors of information about intangible capital.[26]

Finally, to the perennial question of whether the abnormal returns subsequent to portfolio formation are due to market inefficiency or an omitted risk factor (a compensation for risk). In case of the latter, this risk should be associated with high levels of structural capital (ASL), and distinct from the four risk factors (market return, firm size, book-to-market and returns momentum), which are accounted for by the four-factors (expression 15). We do not know of such a risk factor. However, a practical way of distinguishing between inefficiency and risk explanations for abnormal returns is the persistence of such returns. Specifically, in active capital markets (where learning goes on), inefficiencies related to certain public information will not persist over long periods, since investors learn about the inefficiency and eliminate it by contrarian trading. In contrast, returns reflecting compensation for a systematic risk factor will persist, as long as the risk factor exists. The differential abnormal returns reported in Table 8, decrease sharply for the overall sample, and for the difference between high and low ASL portfolios. The returns essentially vanish in the third year after portfolio formation, a phenomena consistent with market inefficiency, rather than with an elusive risk factor (see Figure 5).

[26]The Financial Accounting Standards Board (FASB) has recently concluded a two-year study on voluntary information disclosure by public corporations, finding extensive voluntary disclosure, except for information on intangible assets (FASB, 2000). Relatedly, a public committee set up by the Securities and Exchange Commission (SEC) has recently recommended to the SEC to “Create a new framework for supplemental reporting of intangible assets and operating performance measures” (SEC, 2001). Finally, in January 2002, the FASB decided to add an intangibles disclosure project to its agenda.

VI Concluding Remarks

Intangible (knowledge) assets are major drivers of corporate and national growth. Structural capital enables interactions among various resources (both tangible and intangible) for creating economic value and growth. Structural capital – a major form of intangibles, embodied in unique organizational designs and processes – is the least documented type of intangible assets. We develop a methodology for estimating firm-specific structural capital, and examine the validity of our estimates with a widely used equity valuation model. These tests indicate that our structural capital estimate adds considerable explanatory power to the original independent variables of the model – assets-in-place and the present value of abnormal earnings. Further tests indicate that while investors appear to appreciate the existence of structural capital, they do not fully recognize and price the contribution of such capital in a timely manner, as evidenced by the existence of post-portfolio formation risk-adjusted returns to portfolios of firms ranked by the size of structural capital. This presumed market inefficiency may be related to poor and biased public information on intangible assets.

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Table 1: Estimating Expression (3)

Panel A: Descriptive Statistics

Variable	With RND						Without RND					
	Mean	**Min**	**Q1**	**Median**	**Q3**	**Max**	**Mean**	**Min**	**Q1**	**Median**	**Q3**	**Max**
SALE ($ millions)	9,206	191	2,271	4,872	10,045	79,609	5,582	3	1,702	2,965	5,329	117,958
PPE ($ millions)	3,502	18	570	1,351	3,707	27,578	1,593	2	258	589	1,532	25,162
EMP (thousands)	42	1	13	25	50	486	33	0.01	7	16	30	825
SGAE ($ millions)	1,588	6	352	703	1,715	22,977	1,082	1	276	545	1,046	19,308
RNDE ($ millions)	354	1	42	114	332	5,227						

Panel B: Correlation

Variable	With RND				Without RND		
	LSALE	**LPPE**	**LEMP**	**LSGA**	**LSALE**	**LPPE**	**LEMP**
LPPE	0.58				0.54		
LEMP	0.61	0.67			0.66	0.57	
LSGA	0.68	0.52	0.54		0.73	0.48	0.64
LRND	0.40	0.39	0.34	0.33			

Panel C: Estimating Expression (3)

	With RND			Without RND		
	Coefficient	**t-statistic**	**p-value**	**Coefficient**	**t-statistic**	**p-value**
Intercept (LA)	0.02	2.54	0.00	0.02	3.68	0.00
Firm-fixed (LFA)	0.09	5.67	0.00	0.06	4.51	0.00
LPPE (b_1)	0.11	2.83	0.00	0.08	2.68	0.00
LEMP (b_2)	0.26	6.55	0.00	0.21	4.78	0.00
LSGA (b_3)	0.45	14.56	0.00	0.49	11.81	0.00
LRND (b_4)	0.11	2.92	0.00			
R^2		78.49%			72.47%	

Notes:

1. The numbers in Panel A are in millions $ other than EMP which is in thousands.
2. The numbers in Panel B are the Pearson correlation coefficients.
3. Expression (3):$LSALE_{ikt} = LA_t+$ Ó$_i$$LFA_{it}\ D_{it} + b_{1t}LPPE_{ikt}+b_{2t}LEMP_{ikt}+b_{3t}LSGA_{ikt}+b_{4t}LRND_{ikt}+Le_{ikt}$, for k=t,..,(t-4); t=1989,..,1997.
4. Expression (3) is estimated over a rolling panel of five years for each year t. For example, to estimate expression (3) for 1991, we use data for the years k=1987 to 1991.
5. Panel C provides the mean coefficient estimates and statistics obtained from estimating expression (3) each year.
6. The sample contains 814 (Non-RND) and 1,245 (RND) firm-estimation year panels, spanning 1989 to 1997.

Variable Definitions

SALE is the net revenues. PPE is the plant, property and equipment net of depreciation. EMP is the number of employees. SGAE is the selling, general and administrative expenses. RNDE is the research and development expenditure. RND is the research and development capital computed by capitalizing and amortizing RNDE over five years. LSALE is the log of growth in sale, i.e., LSALE = Log[SALE(t)/SALE(t-1)]. Similarly, LPPE = Log[PPE(t)/PPE(t-1)], LEMP = Log[EMP(t)/EMP(t-1)], LRND = Log[RND(t)/RND(t-1)], LSGA = Log(SGAE(t)/SGAE(t-1)]. D_{it} is the dummy that equals 1 for each firm i in the estimation year t, and is zero otherwise. LFA is the estimate of the Firm-Fixed effect. LA is the estimate of the Intercept.

Table 2: Properties of Expression (3) Estimates

Panel A: Descriptive Statistics

Variable	Mean	Standard Deviation	Minimum	First quartile	Median	Third quartile	Maximum
LFA	0.08	0.05	-0.14	0.06	0.08	0.11	0.16

Panel B: Persistence of LSC_t Expression (4)

	Coefficient	t-statistic	p-value	Coefficient	t-statistic	p-value
$LSC_{(t-1)}$ (a_1)	0.71	28.88	0.00	0.72	13.20	0.00
$LSC_{(t-2)}$ (a_2)				0.00	0.03	0.98
Adj. R^2		56.89%			57.23%	

Panel C: Persistence of LMe_{it} Expression (5)

	Coefficient	t-statistic	p-value	Coefficient	t-statistic	p-value
$LMe_{(t-1)}$ (a_1)	0.06	1.36	0.18	0.05	1.32	0.58
$LMe_{(t-2)}$ (a_2)				-0.08	-0.30	0.72
Adj. R^2		5.19%			6.78%	

Notes:

1. Expression (4): $LSC_t = k_0 + k_1$[Year dummy] + $a_1\ LSC_{t-1} + a_2\ LSC_{t-2}$ + error.
2. Expression (5): $LMe_t = k_0 + k_1$[Year dummy] + $a_1\ LMe_{t-1} + a_2\ LMe_{t-2}$ + error.
3. The t-statistic is the White's heteroskedasticity adjusted t-statistic.
4. There are 1,544 firm-year observations spanning from 1991 to 1997.

Variable Definitions

LSC is the sum of LA and LFA estimates obtained from expression (3) – see Table 1. LMe_{it} is the mean residual for each estimation year t for firm i over the five-year panel, i.e., LMe_{it} = $Ó_{k=t,(t-4)}Le_{ikt}/5$, where the residuals are obtained from estimating expression (3).

Table 3: Properties of Structural Capital (ASL)

Panel A: Descriptive Statistics

Variable	Mean	Standard Deviation	Minimum	First quartile	Median	Third quartile	Maximum
ASL $ millions	803	1,736	-11,576	102	319	775	20,461
CHSALE $ millions	456	1,862	-27,425	30	183	601	23,119
MKSHR	0.04	0.06	0.00	0.01	0.02	0.04	0.51
ISBUD $ millions	196	406	2	33	77	180	4,432

Panel B: Properties of ASL Expression (7)

		Coefficient	t-statistic	p-value	Coefficient	t-statistic	p-value
Overall	MKSHR (a_1)	6.65	11.20	0.00	4.42	9.62	0.00
	ISBUD (a_2)				0.49	19.01	0.00
	Adj. R^2		15.73%			45.15%	
1997	MKSHR (a_1)	7.03	4.35	0.00	3.56	3.71	0.00
	ISBUD (a_2)				0.70	15.04	0.00
	Adj. R^2		12.33%			61.18%	
1996	MKSHR (a_1)	7.84	5.02	0.00	3.13	3.48	0.00
	ISBUD (a_2)				0.79	15.95	0.00
	Adj. R^2		13.74%			62.08%	
1995	MKSHR (a_1)	8.36	4.79	0.00	4.51	3.01	0.00
	ISBUD (a_2)				0.58	11.75	0.00
	Adj. R^2		13.45%			46.77%	
1994	MKSHR (a_1)	8.61	5.71	0.00	7.02	5.38	0.00
	ISBUD (a_2)				0.35	6.77	0.00
	Adj. R^2		18.38%			38.74%	
1993	MKSHR (a_1)	6.59	4.65	0.00	5.21	5.06	0.00
	ISBUD (a_2)				0.36	6.98	0.00
	Adj. R^2		12.63%			38.00%	
1992	MKSHR (a_1)	3.94	3.53	0.00	3.01	3.48	0.00
	ISBUD (a_2)				0.41	6.77	0.00
	Adj. R^2		7.12%			29.99%	
1991	MKSHR (a_1)	4.74	2.74	0.00	2.37	1.58	0.12
	ISBUD (a_2)				0.52	5.28	0.00
	Adj. R^2		8.09%			36.06%	

Notes:

1. Expression (7): $Log[ASL_{it}] = k_0 + k_1[\text{Year dummy}] + a_1 MKSHR_{it} + a_2 Log[ISBUD_{it}] + error$.
2. The t-statistic is the White's heteroskedasticity adjusted t-statistic.
3. There are 1,369 firm-year observations spanning from 1991 to 1997.

Variable Definitions

ASL_{it} is the Abnormal Sales computed as the difference between the predicted value of Sales from expression (3) and the predicted value of Sales from expression (3) without the estimated Intercept (LA_t) and the Firm-Fixed effect (FA_{it}) coefficients. $CHSALE_{it}$ is the change in SALE from year (t-1) to year t. SALE is the net revenue. $MKSHR_{it}$ is the percentage of market share of firm i in year t computed at the two-digit SIC level, $MKSHR_{ikt} = Sales_{ikt}/\Sigma_j Sales_{jkt}$ where firm i belongs to the two-digit SIC k and the sum of sales is over all firms in the two-digit SIC k. $ISBUD_{it}$ is the information systems budget of firm i in year t as reported in the Information Week 500 list.

Table 4: Descriptive Statistics for Structural Capital and Equity Valuation – Expressions (10) and (11)

Panel A: Descriptive Statistics

Variable	Mean	Standard Deviation	Minimum	First quartile	Median	Third quartile	Maximum
MV ($ millions)	8,402	13,730	41	1,702	3,622	8,002	123,470
BV ($ millions)	2,930	3,885	35	785	1,539	3,132	37,006
[MV/BV]	2.83	2.04	0.01	1.69	2.39	3.37	31.68
RE ($ millions)	1,107	2,358	-3,117	65	351	1,029	25,005
ASL ($ millions)	834	1,799	-11,576	127	330	800	20,461
r (%)	8	0.03	3	6	8	10	29

Panel B: Correlation

Variable	MV	BV	MV/BV	RE
BV	0.82			
[MV/BV]	0.28	0.10		
RE	0.58	0.69	0.27	
ASL	0.69	0.63	0.13	0.59

Notes:

1. The correlations in Panel B are the Spearman rank correlations.
2. All correlations are significant at the 0.05 percent level for a two-tailed test.
3. The sample contains 1,265 firm-year observations spanning 1980 to 1999.

Variable Definitions

MV is the market value four months subsequent to the fiscal year-end. BV is the stockholders' equity. The discount rate (r) is computed as Beta times risk premium of 5.5 percent plus the twelve-month treasury bill rate. The Beta is obtained from CAPM using the monthly returns for firm i from year (t-5) to (t-1). RE is the sum over five years of the discounted abnormal earnings plus a terminal value. Specifically, $RE_{it} = \Sigma_{k=1,5} [FE_{ikt} – r_{it} BV_{i(k-1)t}] (1+r_{it})^{-k} + [FE_{i6t} – r_{it} BV_{i5t}](r_{it} – g_{it})^{-1}$ where g_{it} is the growth in $[FE_{i6t} – r_{it} BV_{i5t}]$. FE_{ikt} is the consensus analysts' earnings forecast k years ahead for firm i, four months after the fiscal year t. ASL_{it} is the Abnormal Sales computed as the difference between the predicted value of Sales from expression (3) and the predicted value of Sales from expression (3) without the estimated Intercept (LA_t) and the Firm-Fixed effect (FA_{it}) coefficients.

Table 5: Structural Capital and Equity Valuation – Expressions (10) and (11)

Panel A: Expressions (10) and (11)

		Expression (10)			Expression (11)		
		Coefficient	**t-statistic**	**p-value**	**Coefficient**	**t-statistic**	**p-value**
Overall	V (b_1)	1.60	10.99	0.00	1.81	2.58	0.00
	ASL (b_2)	5.28	24.51	0.00			
	Adj. R^2		62.96%			38.51%	
1997	V (b_1)	2.22	5.89	0.00	2.47	6.98	0.00
	ASL (b_2)	6.32	11.22	0.00			
	Adj. R^2		68.01%			37.16%	
1996	V (b_1)	1.85	6.27	0.00	2.02	6.91	0.00
	ASL (b_2)	5.54	11.55	0.00			
	Adj. R^2		66.64%			42.40%	
1995	V (b_1)	1.71	4.76	0.00	1.89	5.46	0.00
	ASL (b_2)	4.97	10.61	0.00			
	Adj. R^2		63.86%			38.88%	
1994	V (b_1)	1.36	4.68	0.00	1.56	5.19	0.00
	ASL (b_2)	5.28	9.44	0.00			
	Adj. R^2		67.25%			42.23%	
1993	V (b_1)	1.39	4.96	0.00	1.52	5.77	0.00
	ASL (b_2)	4.85	8.69	0.00			
	Adj. R^2		60.45%			42.48%	
1992	V (b_1)	1.58	2.76	0.00	1.72	4.49	0.00
	ASL (b_2)	5.27	9.28	0.00			
	Adj. R^2		62.28%			36.76%	
1991	V (b_1)	1.81	3.31	0.00	1.82	3.58	0.00
	ASL (b_2)	4.32	6.32	0.00			
	Adj. R^2		43.30%			25.01%	

Panel B: Expressions (10) and (11) Partitioned by Market-to-book Ratio

		Expression (10)			Expression (11)		
		Coefficient	t-statistic	p-value	Coefficient	t-statistic	p-value
Low	V (b_1)	1.25	7.06	0.00	1.28	7.40	0.00
	ASL (b_2)	3.25	11.25	0.00			
	Adj. R^2		52.96%			35.83%	
Medium	V (b_1)	1.65	11.59	0.00	1.79	14.44	0.00
	ASL (b_2)	5.05	18.24	0.00			
	Adj. R^2		67.16%			44.94%	
High	V (b_1)	2.32	6.06	0.00	2.56	11.96	0.00
	ASL (b_2)	6.07	12.51	0.00			
	Adj. R^2		71.21%			53.21%	

Panel C: Expressions (10) and (11) Partitioned by Market Value of Equity [Size]

		Expression (10)			Expression (11)		
		Coefficient	t-statistic	p-value	Coefficient	t-statistic	p-value
Low	V (b_1)	1.42	2.64	0.00	1.51	3.42	0.00
	ASL (b_2)	3.58	10.92	0.00			
	Adj. R^2		51.43%			26.68%	
Medium	V (b_1)	1.52	6.54	0.00	1.76	8.18	0.00
	ASL (b_2)	4.94	9.01	0.00			
	Adj. R^2		72.65%			56.94%	
High	V (b_1)	1.77	9.13	0.00	2.05	12.55	0.00
	ASL (b_2)	5.75	13.18	0.00			
	Adj. R^2		68.71%			47.92%	

Notes:

1. Expression (10): $[MV_{it}/SALE_{it}] = k_0 + k_1[\text{Year dummy}/SALE_{it}] + b_1[V_{it}/SALE_{it}] + b_2[ASL_{it}/SALE_{it}]$ + error.
2. Expression (11): $[MV_{it}/SALE_{it}] = k_0 + k_1[\text{Year dummy}/SALE_{it}] + b_1[V_{it}/SALE_{it}]$ + error.
3. The t-statistic is the White's heteroskedasticity adjusted t-statistic.
4. The Low (High) Market-to-Book ratio group contains the bottom (top) 30% of the observations sorted each year based on the market-to-book ratio. The Medium group contains the remaining 40% of the observations.
5. The Low (High) Market Value of Equity group contains the bottom (top) 30% of the observations sorted each year based on the market value of equity. The Medium group contains the remaining 40% of the observations.
6. The sample contains 1,265 firm-year observations spanning 1991 to 1997.

Variable Definitions

MV is the market value four months subsequent to the fiscal year-end. BV is the stockholders' equity. The discount rate (r) is computed as Beta times risk premium of 5.5 percent plus the twelve-month treasury bill rate. The Beta is obtained from CAPM using the monthly returns for firm i from year (t-5) to (t-1). RE is the sum over five years of the discounted abnormal earnings plus a terminal value. Specifically, $RE_{it} = \Sigma_{k=1,5} [FE_{ikt} - r_{it} BV_{i(k-1)t}] (1+r_{it})^{-k} + [FE_{i6t} - r_{it} BV_{i5t}](r_{it} - g_{it})^{-1}$ where g_{it} is the growth in $[FE_{i6t} - r_{it} BV_{i5t}]$. FE_{ikt} is the consensus analysts' earnings forecast k years ahead for firm i, four months after the fiscal year t. V_{it} is the value of equity computed as the sum of RE_{it} and BV_{it}. ASL_{it} is the Abnormal Sales computed as the difference between the predicted value of Sales from expression (3) and the predicted value of Sales from expression (3) without the estimated Intercept (LA_t) and the Firm-Fixed effect (FA_{it}) coefficients. SALE is the net revenue.

Table 6: Structural Capital and Analysts' Forecast Expressions (12) and (13)

Panel A: Expression (12)

	Coefficient	t-statistic	p-value
RE (b_1)	0.57	5.70	0.00
Adj. R^2		15.10%	

Panel B: Expression (12) Partitioned by Market-to-book Ratio and Market Value of Equity

		Market-to-book			Market Value of Equity (Size)		
		Coefficient	t-statistic	p-value	Coefficient	t-statistic	p-value
Low	RE (b_1)	0.39	3.88	0.00	0.07	4.42	0.00
	Adj. R^2		6.11%			3.63%	
Medium	RE (b_1)	0.55	3.05	0.00	0.71	4.56	0.00
	Adj. R^2		15.19%			12.85%	
High	RE (b_1)	0.61	4.11	0.00	0.77	4.58	0.00
	Adj. R^2		35.36%			28.36%	

Panel C: Expression (13)

	Coefficient	t-statistic	p-value	Coefficient	t-statistic	p-value
$ANER_{t-1}$ (b_1)	0.36	7.65	0.00	0.34	6.49	0.00
$ANER_{t-2}$ (b_2)				0.03	0.71	0.00
Adj. R^2		12.31%			12.32%	

Notes:

1. Expression (12): $[CASL_{it}/SALE_{it}] = k_0 + k_1[\text{Year dummy}/SALE_{it}]+b_1[RE_{it}/SALE_{it}]+\text{error}$
2. Expression (13): $ANER_{it}= k_0 + k_1 [\text{Year dummy}]+b_1ANER_{it-1}+b_2ANER_{it-2} + \text{error}$.
3. The t-statistic is the White's heteroskedasticity adjusted t-statistic.
4. The Low (High) Market-to-Book ratio group contains the bottom (top) 30% of the observations sorted each year based on the market-to-book ratio. The Medium group contains the remaining 40% of the observations.
5. The Low (High) Market Value of Equity group contains the bottom (top) 30% of the observations sorted each year based on the market value of equity. The Medium group contains the remaining 40% of the observations.
7. The sample contains 1,265 firm-year observations spanning 1991 to 1997.

Variable Definitions:

RE is the sum over five years of the discounted abnormal earnings plus a terminal value, i.e., $RE_{it}=\Sigma_{k=1,5}[FE_{ikt}-r_{it}BV_{i(k-1)t}](1+r_{it})^{-k} + [FE_{i6t} - r_{it}\ BV_{i5t}](r_{it} - g_{it})^{-1}$ where g_{it} is the growth in $[FE_{i6t} - r_{it}\ BV_{i5t}]$. FE_{ikt} is the consensus analysts' earnings forecast k years ahead for firm i, four months after the fiscal year t. BV is the stockholders' equity. The discount rate (r) is computed as Beta times risk premium of 5.5 percent plus the twelve-month treasure bill rate. The Beta is obtained from CAPM using the monthly returns for firm i from year (t-5) to (t-1). ASL_{it} is the Abnormal Sales computed as the difference between the predicted value of Sales from expression (3) and the predicted value of Sales from expression (3) without the estimated Intercept (LA_t) and the Firm-Fixed effect (FA_{it}) coefficients. CASL is the capitalized value of ASL computed as $CASL_{it}$ = [Ó$_{k=,0,4}$ $ASL_{it}/\{(1+r)^k\}$]. ANER is the residual obtained by estimating expression (12) each year. SALE is the net revenue.

Table 7: Stock Returns and Lagged Changes in Structural Capital

Panel A: Descriptive statistics

Variable	Mean	Standard Deviation	Minimum	First quartile	Median	Third quartile	Maximum
RET	0.20	0.28	-0.71	-0.01	0.16	0.36	1.37
$CHASL_t$	0.75	8.82	-142.32	-1.46	0.50	2.72	50.35
$CHASL_{t-1}$	0.92	7.92	-48.15	-1.37	0.56	2.83	96.98
$CHASL_{t-2}$	0.41	7.77	-79.03	-1.48	0.44	2.51	39.81

Panel B: Correlation

Variable	RET	$CHASL_t$	$CHASL_{t-1}$
$CHASL_t$	0.10*		
$CHASL_{t-1}$	0.05*	-0.26*	
$CHASL_{t-2}$	-0.01	-0.04	-0.22*

Panel C: Expression (14)

	Coefficient	t-statistic	p-value	Coefficient	t-statistic	p-value
$CHASL_t$ (a_1)	0.12	3.94	0.00	0.13	3.91	0.00
$CHASL_{t-1}$ (a_2)	0.08	2.56	0.01	0.09	2.64	0.00
$CHASL_{t-2}$ (a_3)				0.02	0.69	0.49
Adj. R^2		4.48%			4.45%	

1. The correlations in Panel B are the Spearman rank correlations.
2. * indicates significance at the 0.01 percent level for a two-tailed test.
3. Expression (14): $RET_{it} = k_0 + k_1[\text{Year dummy}] + a_1 CHASL_{it}/P_{it-1} + a_2 CHASL_{it-1}/P_{it-1} + a_3 CHASL_{it-2}/P_{it-1}$ +error.
4. The sample contains 1,265 firm-year observations spanning 1991 to 1997.

Variable Definitions

RET_{it} is the annual returns of firm i in year t obtained by compounding monthly returns for 12 months ending four months after the firm's fiscal year-end. $CHASL_{it}$ is the change in ASL per share computed as $(ASL_{it} – ASL_{it-1})/CSOS_{it}$, where CSOS is the number of common shares outstanding. P_{it} is the stock price of firm i four months after the fiscal year t. ASL_{it} is the Abnormal Sales computed as the difference between the predicted value of Sales from expression (3) and the predicted value of Sales from expression (3) without the estimated Intercept (LA_t) and the Firm-Fixed effect (FA_{it}) coefficients.

Table 8: Abnormal Contemporaneous and Future Stock Returns on Portfolios Formed with Structural Capital – Expression (15)

	Contemporaneous	One-year ahead	Two-years ahead	Three-years ahead
Overall	0.21*	0.14**	0.11	0.05
High ASL	0.39*	0.21*	0.18*	0.10
Low ASL	0.06	0.11**	0.09	0.04
Difference	0.33*	0.10**	0.09	0.06

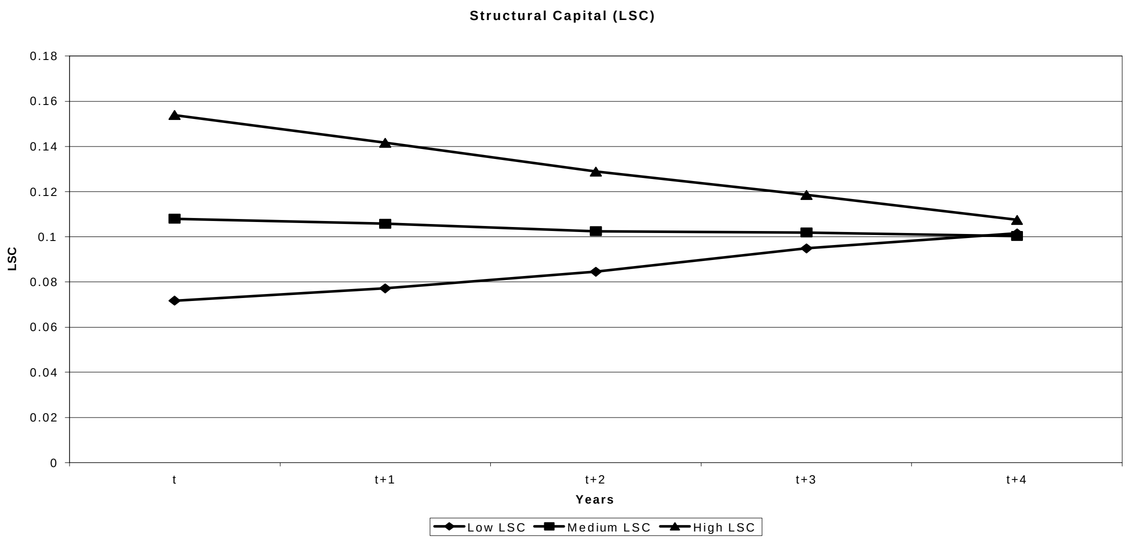
Notes:

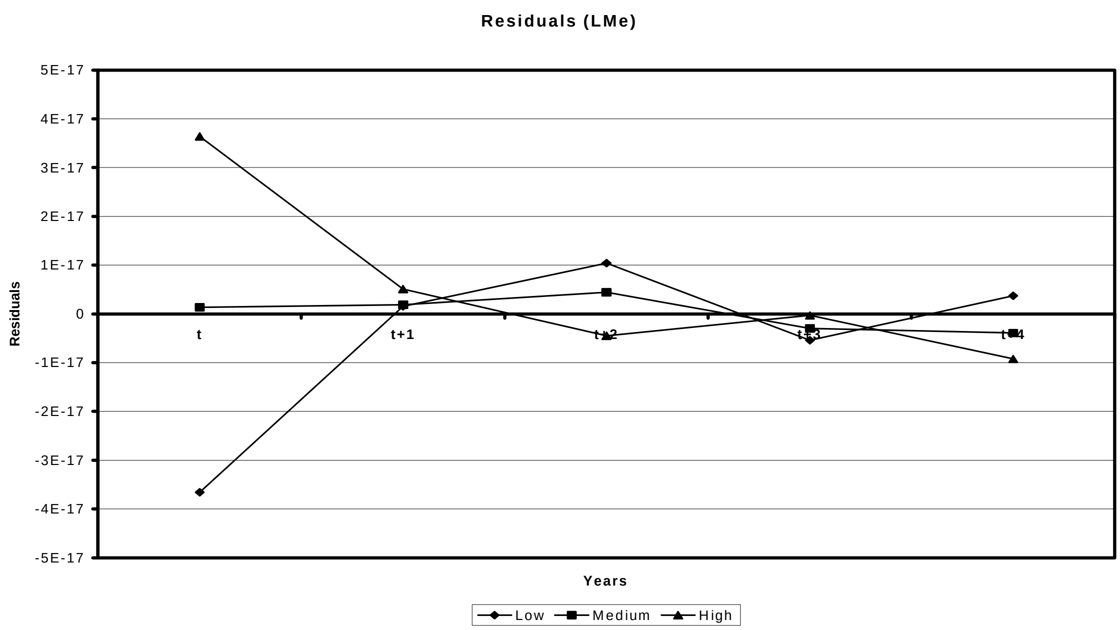
1. The * and ** indicate statistical significance at the .01% and 0.10% for a two-tailed test.
2. Expression (15): $R_i(t) - Rf(t) = a + b_1[Rm(t) – Rf(t)] + b_2SMB(t) + b_3[HML(t)] + b_4[UMD(t)] + error$.
3. The High (Low) ASL portfolio contains the bottom (top) 30% of the observations sorted each year based on the ASL scaled by SALE. The Medium group contains the remaining 40% of the observations.
4. The numbers in the Table are the coefficient estimates of the intercept (a) in expression (14).
5. The numbers in the Table are the percentage monthly returns. Hence, 0.10% monthly returns difference for the first year after portfolio formation represents 1.20% [=$(1.001)^{12}$] annual returns.
6. The portfolios are formed based on the ASL/SALE in each year (Y). Contemporaneous monthly returns span from year September Y-1 to August Y; one year ahead returns span from year September Y to August Y+1.

Variable Definitions

Rm is the value-weighted monthly return for the market. Rf is the one-month treasury bill rate. SMB is the difference in the value-weighted monthly return between the small and the big size firms. HML is the difference in the value-weighted monthly return between the high and the low book-to-market firms. UMD is the difference in value-weighted monthly return between firms with high prior returns and low prior return, i.e,, the momentum factor. $R_i(t)$ is the monthly value-weighted returns for the portfolio i. ASL_{it} is the Abnormal Sales computed as the difference between the predicted value of Sales from expression (3) and the predicted value of Sales from expression (3) without the estimated Intercept (LA_t) and the Firm-Fixed effect (FA_{it}) coefficients.

Figure 1: Persistence of Structural Capital and Residual Estimates of Expression (3)





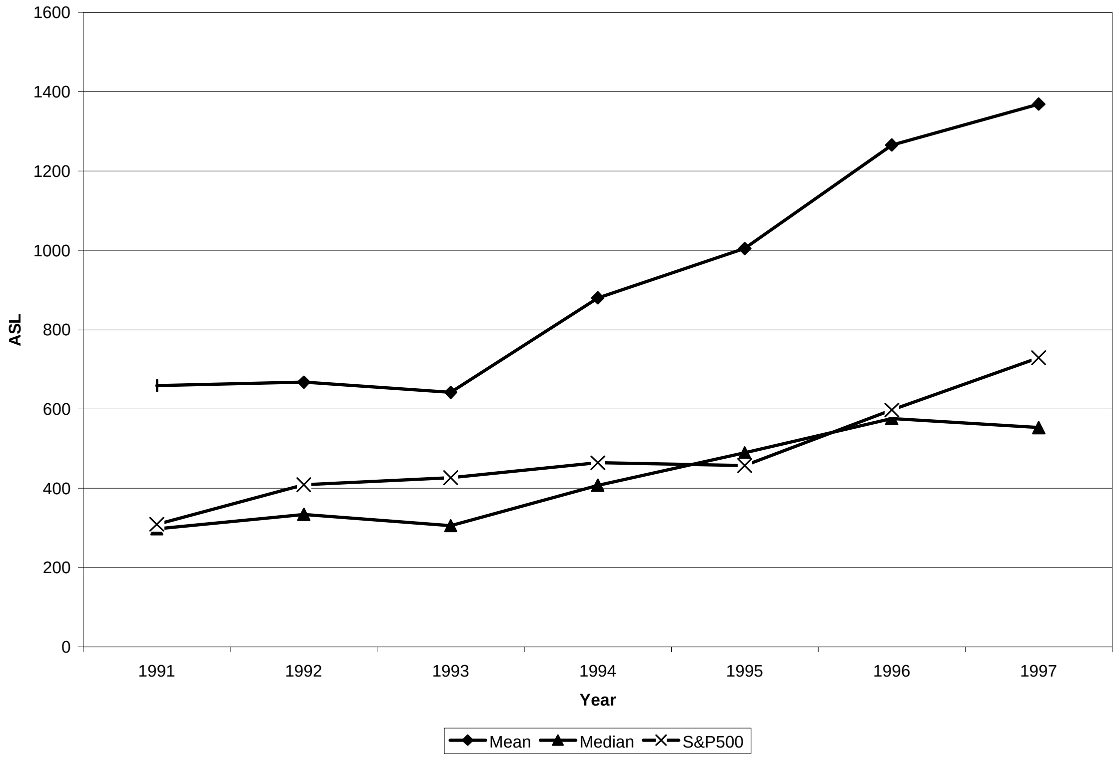
Notes: Portfolios are formed based on LSC = LA + LFA and LMe in year t. The High (Low) group contains the top (bottom) 30% of the observations sorted each year. The Medium group contains the remaining 40% of the observations.

Variable Definitions

$LSC_{it} = LA_t + LFA_{it}$, where LA_t is the Intercept estimate and LFA_{it} is the Firm-Fixed effect coefficient estimates obtained from estimating expression (3) – see Table 1. LMe_{it} is the mean residual for firm i in estimation year t over the five-year panel, i.e., $LMe_{it} = Ó_{k=t,..,(t-4)}Le_{ikt}/5$, where the residuals are obtained from estimating expression (3).

$LSC_{it} = LA_t + LFA_{it}$, where LA_t is the Intercept estimate and LFA_{it} is the Firm-Fixed effect coefficient estimates obtained from estimating expression (3) – see Table 1.

Figure 2: Behavior of Structural Capital (ASL) Over-Time



Notes:

Expression (3): $LSALE_{ikt}=LA_t+Ó_i LFA_{it}D_{it}+b_{1t}LPPE_{ikt}+b_{2t}LEMP_{ikt}+b_{3t}LSGA_{ikt}+b_{4t}LRND_{ikt}+Le_{ikt}$, for k=t,..,(t-4); t=1989,..,1997.

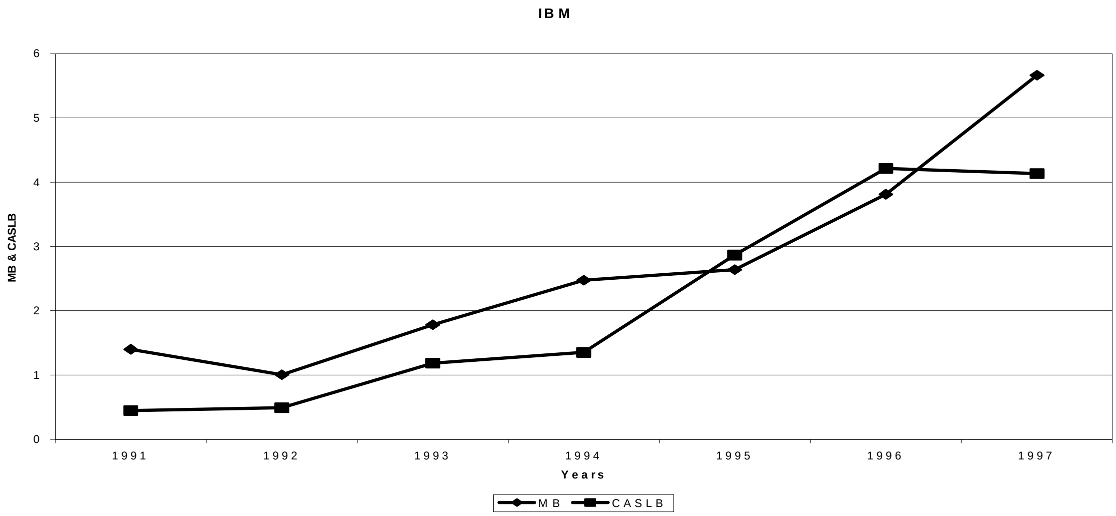
Expression (3) is estimated over a rolling panel of five years for each year t. For example, to estimate expression (3) for 1991, we use data for the years k=1987 to 1991.

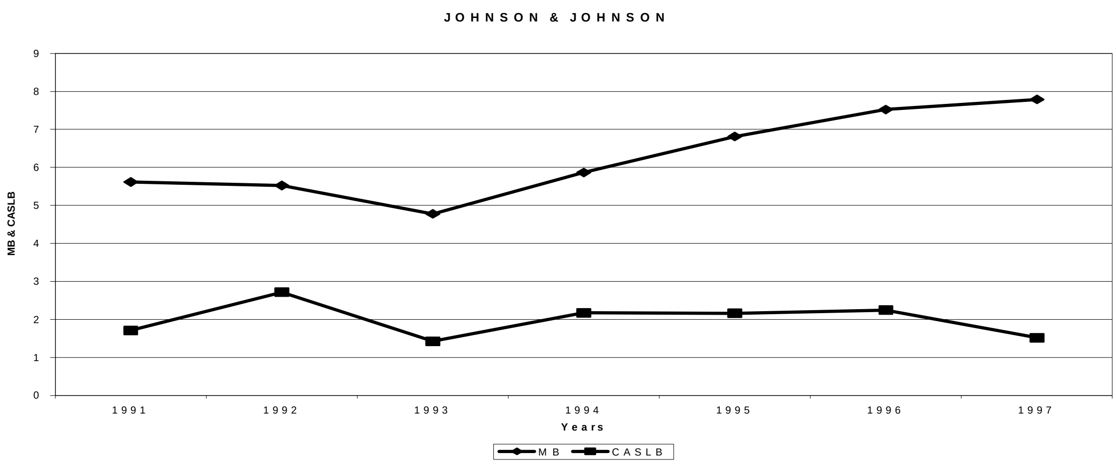
Expression (6): $ASL_{it}=SALE_{i(t-1)}\,[A_t^{*}\,FA_{it}^{*} - 1]GPPE_{it}^{b1*}GEMP_{it}^{b2*}GSGA_{it}^{b3*}GRND_{it}^{b4*}$.

Variable Definitions

SALE is the net revenues. PPE is the plant, property and equipment net of depreciation. EMP is the number of employees. SGAE is the selling, general and administrative expenses. RNDE is the research and development expenditure. RND is the research and development capital computed by capitalizing and amortizing RNDE over five years. LSALE is the log of growth in sale, i.e., LSALE = Log[SALE(t)/SALE(t-1)]. Similarly, LPPE = Log[PPE(t)/PPE(t-1)], LEMP = Log[EMP(t)/EMP(t-1)], LRND = Log[RND(t)/RND(t-1)], LSGA = Log(SGAE(t)/SGAE(t-1)]. D_{it} is the dummy that equals 1 for each firm i in the estimation year t, and is zero otherwise. LFA is the estimate of the Firm-Fixed effect. LA is the estimate of the Intercept. ASL_{it} is the Abnormal Sales computed as the difference between the predicted value of Sales from expression (3) and the predicted value of Sales from expression (3) without the estimated Intercept (LA_t) and the Firm-Fixed effect (FA_{it}) coefficients. S&P500 is the Standard and Poor’s Stock Index.

Figure 3: Market Value and Structural Capital for Some Companies





Notes:

Expression (3):$LSALE_{ikt}=LA_t+\text{Ó}_i LFA_{it}D_{it}+b_{1t}LPPE_{ikt}+b_{2t}LEMP_{ikt}+b_{3t}LSGA_{ikt}+b_{4t}LRND_{ikt}+Le_{ikt}$, for k=t,..,(t-4); t=1989,..,1997.

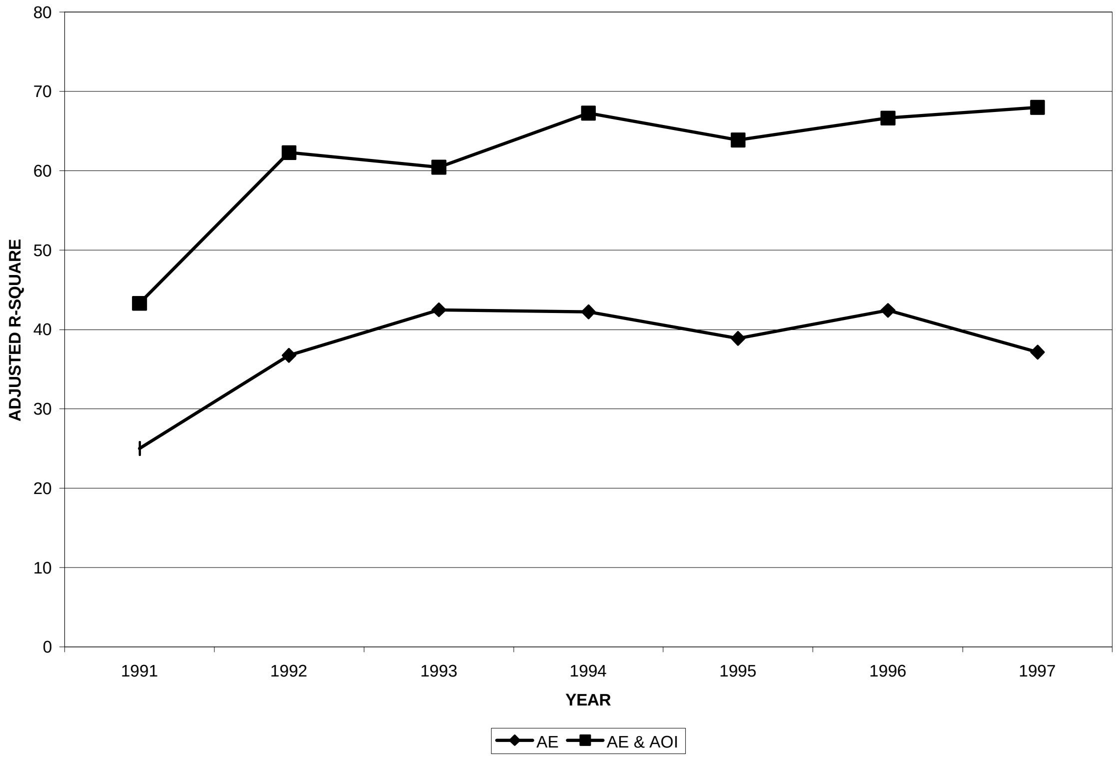
Expression (3) is estimated over a rolling panel of five years for each year t. For example, to estimate expression (3) for 1991, we use data for the years k=1987 to 1991.

Expression (6): $ASL_{it}=SALE_{i(t-1)}\,[A_t^{*}\,FA_{it}^{*} - 1]GPPE_{it}^{b1*}GEMP_{it}^{b2*}GSGA_{it}^{b3*}GRND_{it}^{b4*}$.

<u>Variable Definitions</u>

MV is the market value of equity four months after the fiscal year t. BV is the stockholders' equity in year t. The discount rate (r) is computed as Beta times risk premium of 5.5 percent plus the twelve-month treasure bill rate. The Beta is obtained from CAPM using the monthly returns for firm i from year (t-5) to (t-1). SALE is the net revenues. PPE is the plant, property and equipment net of depreciation. EMP is the number of employees. SGAE is the selling, general and administrative expenses. RNDE is the research and development expenditure. RND is the research and development capital computed by capitalizing and amortizing RNDE over five years. LSALE is the log of growth in sale, i.e., LSALE = Log[SALE(t)/SALE(t-1)]. Similarly, LPPE = Log[PPE(t)/PPE(t-1)], LEMP = Log[EMP(t)/EMP(t-1)], LRND = Log[RND(t)/RND(t-1)], LSGA = Log(SGAE(t)/SGAE(t-1)]. D_{it} is the dummy that equals 1 for each firm i in the estimation year t, and is zero otherwise. LFA is the estimate of the Firm-Fixed effect. LA is the estimate of the Intercept. ASL_{it} is the Abnormal Sales computed as the difference between the predicted value of Sales from expression (3) and the predicted value of Sales from expression (3) without the estimated Intercept (LA_t) and the Firm-Fixed effect (FA_{it}) coefficients. CASL is the capitalized value of ASL computed as $CASL_{it} =[\text{Ó}_{k=0,4}\, ASL_{it}/\{(1+r)^k\}]$.

Figure 4: Comparison of Expressions (10) and (11)



Notes:

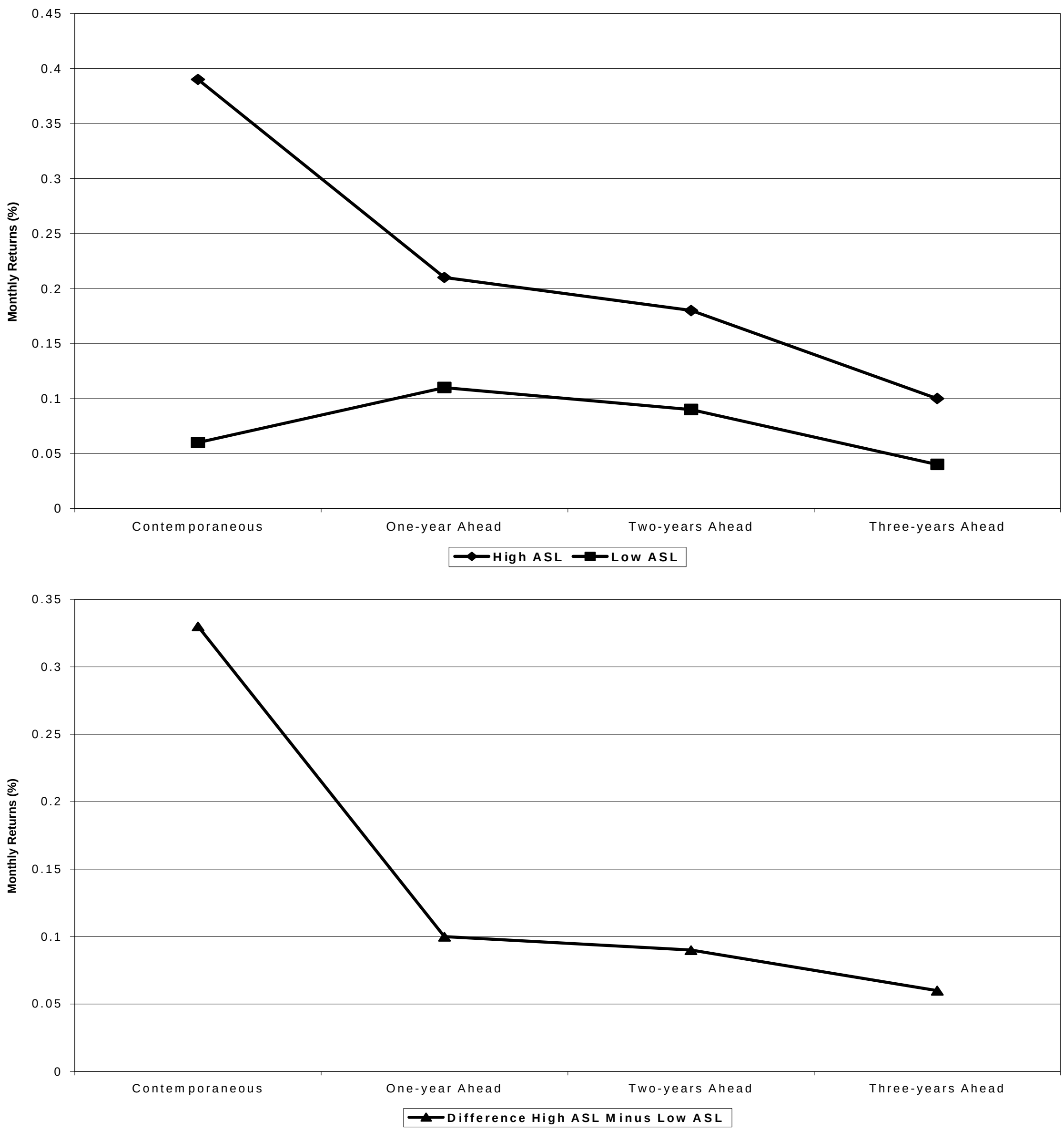
Expression (10): $[MV_{it}/SALE_{it}] = k_0 + k_1[\text{Year dummy}/SALE_{it}] + b_1[V_{it}/SALE_{it}] + b_2[ASL_{it}/SALE_{it}]$ + error.

Expression (11): $[MV_{it}/SALE_{it}] = k_0 + k_1[\text{Year dummy}/SALE_{it}] + b_1[V_{it}/SALE_{it}]$ + error.

Variable Definitions

MV is the market value four months subsequent to the fiscal year-end. BV is the stockholders' equity. The discount rate (r) is computed as Beta times risk premium of 5.5 percent plus the twelve-month treasury bill rate. The Beta is obtained from CAPM using the monthly returns for firm i from year (t-5) to (t-1). RE is the sum over five years of the discounted abnormal earnings plus a terminal value. Specifically, $RE_{it} = \Sigma_{k=1,5} [FE_{ikt} - r_{it} BV_{i(k-1)t}] (1+r_{it})^{-k} + [FE_{i6t} - r_{it} BV_{i5t}](r_{it} - g_{it})^{-1}$ where g_{it} is the growth in $[FE_{i6t} - r_{it} BV_{i5t}]$. FE_{ikt} is the consensus analysts' earnings forecast k years ahead for firm i, four months after the fiscal year t. V_{it} is the value of equity computed as the sum of RE_{it} and BV_{it}. ASL_{it} is the Abnormal Sales computed as the difference between the predicted value of Sales from expression (3) and the predicted value of Sales from expression (3) without the estimated Intercept (LA_t) and the Firm-Fixed effect (FA_{it}) coefficients. SALE is the net revenue.

Figure 5: Risk Adjusted Abnormal Returns



Notes:

1. Expression (15): $RET(t) - Rf(t) = a + b_1[Rm(t) – Rf(t)] + b_2SMB(t) + b_3[HML(t)] + b_4[UMD(t)] + error$.
2. The High (Low) ASL portfolio contains the top (bottom) 30% of the observations sorted each year based on the ASL scaled by SALE.
3. The portfolios are formed based on the ASL/SALE in each year (Y). Contemporaneous returns span from year September Y-1 to August Y; one year ahead returns span from year September Y to August Y+1.

Variable Definitions

Rm is the value-weighted monthly return for the market. Rf is the one-month treasury bill rate. SMB is the difference in the value-weighted monthly return between the small and the big size firms. HML is the difference in the value-weighted monthly return between the high and the low book-to-market firms. UMD is the difference in value-weighted monthly return between firms with high prior returns and low prior return, i.e,, the momentum factor. $R_i(t)$ is the monthly value-weighted returns for the portfolio i. ASL_{it} is the Abnormal Sales computed as the difference between the predicted value of Sales from expression (3) and the predicted value of Sales from expression (3) without the estimated Intercept (LA_t) and the Firm-Fixed effect (FA_{it}) coefficients. SALE is the net revenue.