NBER WORKING PAPER SERIES

THE MEASUREMENT OF FIRM-SPECIFIC ORGANIZATION CAPITAL

Baruch Lev
Suresh Radhakrishnan

Working Paper 9581
http://www.nber.org/papers/w9581

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
March 2003

We are grateful to Rashad Abdel-Khalik, Jason Cummins, Rebecca Hendersson, James Myers, Konduru Sivaramkrishnan, Shivaram Rajagopal, Theodore Sougiannis, and participants of the 2001 Strategy Conference–Harvard University, Texas Symposium–University of Texas at Dallas, Berkeley Conference–University of California at Berkeley, the National Bureau of Economic Research 2002 Conference on Research in Income and Wealth, and seminars at University of Illinois, Urbana– Champaign, and Purdue University. We are also grateful to Omer Pamukcu for his research assistance. The views expressed herein are those of the authors and not necessarily those of the National Bureau of Economic Research.

The Measurement of Firm-Specific Organization Capital
Baruch Lev and Suresh Radhakrishnan
NBER Working Paper No. 9581
March 2003
JEL No. G0, M0, M1, M4, O0, O3

ABSTRACT

We develop a firm-specific measure of organization capital and estimate it for a sample of approximately 250 companies. We test the validity of the organization capital measure within a widely used investment valuation model and show that our organization capital estimate contributes significantly to the explanation of market values of firms, beyond assets in place and expected abnormal earnings (growth potential). We then examine whether capital markets are efficient with respect to organization capital, namely whether stock prices fully reflect the value of this resource. We find that while investors recognize the importance of organization capital, they do not fully factor its value into equity prices. We ascribe this fault or market inefficiency to poor disclosure of information about intangible capital.

Baruch Lev
New York University
blev@stern.nyu.edu

Suresh Radhakrishnan
University of Texas at Dallas
sradhakr@utdallas.edu

I. Introduction

It is widely observed that within industries or economic sectors some firms systematically outperform others. Wal-Mart in retail, Dell in PCs, IBM in computers and related services, Microsoft in software, Intel in semiconductors, DuPont in chemicals, UPS and Federal Express in shipping, Goldman Sachs in investment banking, Southwest among airlines, and so on in practically every industry. Such super-normal performance, generally manifested by sustained growth in sales, earnings, and market value, is only rarely the result of a natural monopoly or competition-constraining regulation, but rather is the consequence of the organization of the enterprise—generally referred to as "organization capital." This resource is often the only factor of production that is unique to the firm and is thus capable of yielding above the cost of capital returns. Most other factors of production, labor, and capital in particular, are *commodities* in the modern economy, since competitors have equal access to them. Consequently, such commoditized factors yield, at best, the cost of capital.[1] Organization capital, in contrast, is the major value creator of business enterprises.

While organization capital can be intuitively conceptualized as an extra, often unmeasured factor of production responsible for abnormal firm performance—somewhat akin to Solow's residual—and examples of specific business processes and designs making up organization capital are easy to provide, there are no operational measures of firms' organization capital.[2] Such measures will be highly useful to a multitude of

---

[1] Even R&D yields, on average, the cost of capital. Chan et al. (2001) reported that the performance of firms conducting R&D is not superior, on average, to that of firms without R&D. See also Hall (1993) for similar results.
[2] Examples of specific business processes and designs that are components of organization capital include the following: Wal-Mart's supply chain, where the reading of the barcodes of purchased products at the

decision makers. Managers, for example, will obviously be interested in tracking the size and growth of organization capital, which is the most important of the firm's assets, and benchmark it against competitors. Furthermore, valuing organization capital will enable managers to estimate return on investment for this factor to optimize overall resource allocation. Investors will similarly be eager to incorporate the value of organization capital in their firm valuation models. In merger and acquisition cases, the value of organization capital should play a prominent role, particularly because, as will be discussed below, such capital is predominately tacit and difficult to transfer across firms, and hence of questionable value in acquisitions. Organization and management researchers, along with consultants, in search of quantifying the elusive concept of "quality of management" will find an answer in an operational measure of organization capital.

In this study, we develop a firm-specific measure of organization capital and estimate it for a sample of approximately 250 companies. We test the validity of the organization capital measure within a widely used investment valuation model and show that our organization capital estimate contributes significantly to the explanation of market values of firms, beyond assets in place and expected abnormal earnings (growth

---

checkout register is directly transmitted to suppliers who are in tum largely responsible for inventory management and product provision to the thousands of 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, p. 12); Dell's pioneering built-to-order distribution system, where customers design their products; Ford's outsourcing of its auto parts manufacturing; and Merck's extensive network of hundreds of R&D and marketing alliances and joint ventures, aimed at facilitating technology transfer and risk-sharing. Sometimes the absence of organization capital is mentioned as a potential source of future value: In an interview with Bill Miller (*Barron's*, February 3, 2003, p. 26), this most successful fund manager (an average annual return of 14.5% over the past 10 years) said the following about Home Depot: "People are talking about its problems…but all these problems are getting fixed. This is a company that didn't have any perpetual inventory, didn't have any point-of-sales terminals, didn't have pay scales for their employees, and didn't have any centralized purchasing. It was remarkable what they didn't have, which tells you how powerful the economics of the business were."

potential). We then examine whether capital markets are efficient with respect to organization capital, namely whether stock prices fully reflect the value of this resource. This is an important issue, since systematic mispricing of securities leads to excessive cost of capital to organization capital-intensive enterprises, adversely affecting investment and growth. We find that while investors recognize the importance of organization capital, they do not fully factor its value into equity prices. We ascribe this fault or market inefficiency to poor disclosure of information about intangible capital.

Section II of the paper discusses concepts of organization capital and related research, while Section III presents our first measure of firm-specific organization capital, derived from residual output, and discusses the properties of the measure. Section IV presents our second measure of organizational capital based on an instrumental variable. Section V incorporates organizational capital in a widely used valuation model to validate its usefulness. Section VI examines whether investors in capital markets fully price the value of organizational capital. Section VII concludes the paper.

II. What Exactly is Organization Capital?

A succinct definition of organization capital was provided by Evenson and Westphal (1995, p. 2237): "…organization capital …[is] the knowledge used to combine human skills and physical capital into systems for producing and delivering want-satisfying products."[3] Specifically, organization capital according to Evenson and Westphal relates to the following: (a) *operating capabilities*, such as product design

[3] In a similar vein, Atkeson and Kehoe (2002, p. 1) wrote: "At least as far back as Marshall, economists have argued that organizations store and accumulate knowledge that affects their technology of production.

systems, production management and engineering (e.g., just-in-time inventory), input outsourcing (supply channels), and marketing technologies (e.g., on-line distribution channels); (b) *Investment capabilities*, such as new project selection mechanisms (e.g., using real-options methodologies for project selection), personnel training, and financial engineering in fund raising (e.g., issuing convertible securities with put options); and (c) *innovation capabilities*, such as enhanced R&D capabilities (e.g., a scientific approach to drug development), adaptive capacity for learning from others, communities of practice to share information among employees, managerial and legal procedures for appropriating maximal benefits from intellectual property (e.g., patent licensing and technology turf protection), technology transfer and risk-sharing mechanisms (e.g., R&D alliances).[4] Organization capital is thus an agglomeration of technologies—business practices, processes and designs, including incentive and compensation systems—that enable some firms to consistently extract out of a given level of resources a higher level of product and at lower cost than other firms.

Some writers on organization capital view this resource as embodied in employees (e.g., Jovanovic, 1979; Becker, 1993). Elaborating on this view, Prescott and Visscher (1980, pp. 447–448) include the following factors in organization capital: (a) "what the firm knows about the abilities of its personnel…improving matches between employees and jobs by measuring performance…," (b) what "the firm learns about its employees to improve the match between employees working in teams," and (c) "the human capital of the firm's employees." Others view organization capital as "a firm-

This accumulated knowledge is a type of unmeasured capital that is distinct from the concepts of physical or human capital in the standard growth model."

[4] The specific details and examples in each of the three categories are ours, not Evenson and Westphal's.

specific capital good jointly produced with output and embodied in the organization itself." (Atkeson and Kehoe, 2002, p. 3). Proponents of this approach include Arrow (1962), Rosen (1972), Tomer (1987), and Ericson and Pakes (1985). In the present study, we follow the latter—firm-embodied—concept of organization capital.

The competitive advantages conferred on firms by organization capital are mainly due to the fact that this resource cannot be completely codified and hence transferred to other organizations or imitated by them. As Evenson and Westphal (1995, p. 2213) stated: "Much of the knowledge about how to perform elementary processes and about how to combine them in efficient systems is tacit, not physically embodied and neither codified nor readily transferable. Thus, though two producers in the same circumstances may use identical material inputs in conjunction with equal information, they may nonetheless employ what are really two distinct techniques owing to differences in understanding of the tacit elements."

For example, with all that has been written about Japanese car manufacturers' efficiency systems (e.g., just-in-time production process), and the vast efforts to imitate these systems by other car producers that took place since the mid-1980s (including joint Japanese–U.S. production facilities, such as the GM–Toyota Nummi plant in Freemont, California), Japanese car manufacturers are still the world leaders in profitability and quality. Clearly, some essential elements of organization capital are not transferable across firms, even over extended time periods.

The partially tacit nature of organization capital is among the major reasons this resource is hard to measure. Much of the investment (input) in organization capital is not fully tracked by firms. For example, the cost of on-the-job training, particularly the mentoring of young employees by senior ones, is generally not recorded by the accounting system. Also not recorded is the extensive effort of employees to better educate themselves and improve the efficiency of firms' production, research, and selling processes (the "suggestions box"). In general, the smaller the firm, the less of the investment in organization capital that is systematically recorded. Consequently, firms and investors lack reliable input (cost) measures of organization capital. Nor is the output of organization capital easy to quantify. This output—business designs and processes—is essentially an intermediate product without a market price (see Aghion and Howitt, 1998, Ch. 12, for discussion of similar difficulties in measuring knowledge). Moreover, the contribution of organization capital to the firm's final output (sales, profits) is not segregated by the accounting system from the contribution of other inputs.

Finally, to cap the measurement difficulties, a quantification of organization capital requires an estimate of the rate of obsolescence of this resource. New systems and processes along with imitation by competitors reduce the value of the firm's organization capital. But, reliable estimates of the obsolescence of organization capital are not available. Thus, given the daunting challenges in measuring organization capital, we are not surprised that firm-specific measures of this resource are not available.

Absent reliable input or output measures of organization capital, our first estimate of the value of this resource is based on *unaccounted firm output*. Specifically, we model the firm's output as a function of physical capital, labor, and R&D (representing innovative activities, i.e., intangible assets). The estimated residual of this model captures the portion of output unaccounted for by capital, labor and R&D. We then estimate the systematic component of the residual output by a fixed firm-specific effect and ascribe the contribution of organization capital to output to this systematic component of the residual output. This attribution of residual (unaccounted) output to organization capital opens us to the well-known criticism leveled at Solow's residual as a "measure of ignorance." Indeed, in our case, the estimated residual output left after accounting for capital, labor and R&D may reflect various missing resources beyond organization capital. To address this concern, we correlate the estimated residual output with two variables that are known to be correlated with organization capital: (1) the firm's sales, general, and administrative expenses (SGA), which include most of the cost items related to organization capital (e.g., information systems, employee training, brand promotion, distribution channels, etc.); and (2) the cost of information systems that are embedded in most of the technologies and processes that compose organization capital.[5] We indeed find a strong correlation between the estimated residual output (proxying for organization capital) and SGA expenses, as well as with information technology (IT) costs, lending a certain support to our first estimate of organization capital as unaccounted output. This also suggests using SGA expenses as an instrumental variable for developing an organization capital measure, which is our second methodology of estimating this resource.

Our second estimate of organization capital uses SGA expenditures as an instrumental variable that affects the total factor and asset (resource) productivities. The contribution of organization capital in generating abnormal output is assessed as the difference between expected sales with the organization capital and the expected sales

[5] For example, Brynjolfsson et al. (1999) ascribe the high impact they documented of information technology on market values of companies to the fact that IT expenditures in fact represent organization capital.

considering only the sample's average asset productivities (i.e., without the organization capital). We examine the properties of this estimate of organization capital and find that it is associated strongly with IT costs and firms' market share. In the following discussion we describe in detail our two estimates of organization capital.

III. First Estimate: Organization Capital as a Residual

We model the firm's output—sales (SALE)—as a function of physical capital (PPE: property, plant, and equipment), labor (EMP), and R&D capital (RND), where R&D represents innovative activities, that is, intangible assets. We allow for two types of organization capital: (a) a common organization 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 organization capital (FA) that is developed and enhanced by each firm (e.g., coded knowledge, production blueprints, business processes and procedures, marketing networks and channels, etc.). We use for estimation the following constant returns to scale production function (see Hall, 2000):

$$\mathrm{SALE}_{it} = A_t \mathrm{FA}_{it} \mathrm{PPE}_{it}^{b1} \mathrm{EMP}_{it}^{b2} \mathrm{RND}_{it}^{b3} e_{it}, \tag{1}$$

where SALE_{it} is the revenues of firm i in year t, A_t is the common organization capital, FA_{it} is the firm-specific organization capital, PPE_{it} is net plant, property, and equipment, EMP_{it} is number employees, RND_{it} is research and development capital (the latter three variables are at year-end), and e_{it} is an error term.

The sample consists of all firms that appeared in the Information Week 500 list between 1991 and 1997. We use the Information Week 500 list to define our sample space because it provides unique data on IT expenditures—a major component of organization capital—for the surveyed companies. These IT expenditures are later used to validate our estimates of organization capital. Data for each sample firm on sales (Compustat data item no. 12), plant, property, and equipment (data item no. 8), number of employees (data item no. 29), and research and development expense (data item no. 46) are obtained from the Compustat Annual Database. Research and development capital (RND) is estimated by capitalizing and amortizing the annual research and development expenditures (RNDE) over five years (a 20% annual amortization rate). Other than the number of employees, the output and inputs in expression (1) are deflated to constant 1996 dollars. Specifically, SALE is deflated using the general price deflator; PPE is deflated using the fixed-investment deflator, and RNDE is deflated using the average of the fixed-investment and wage deflators. Data on deflators were obtained from <http://www.bea.doc.gov/bea>.

We estimate the systematic component of the residual output of expression (1) by a fixed firm-specific effect, using an annual growth equation:[6]

$$\log(\mathrm{SALE}_{ikt}/\mathrm{SALE}_{ik,t-1}) = b_{0t} + \mathrm{S}_i b_{0it} D_{it} + b_{1kt}\log(\mathrm{PPE}_{ikt}/\mathrm{PPE}_{ik,t-1}) + b_{2kt}\log(\mathrm{EMP}_{ikt}/\mathrm{EMP}_{ik,t-1})$$
$$+ b_{3kt}\log(\mathrm{RND}_{ikt}/\mathrm{RND}_{ik,t-1}) + \log(e_{ikt}/e_{ik,t-1}), \qquad (2)$$

for $k = t,\ldots,(t-4)$; $t = 1987,\ldots,2000$.[7] D_{it} is a firm-specific dummy variable proxying for organization capital. That is, we estimate expression (2) using five-year panel data spanning year t back to year $(t-4)$, for each year t (1987–2000). For example, to estimate expression (2) for 1991, we use data for the years 1987–1991 ($k = 1987,\ldots,1991$). This

[6] See Caves and Barton (1990) and Jorgenson (1986) for details on estimating firm production functions with fixed effects. Hulten (2000) provides a review of the theoretical foundations of the Solow residual and Divisia Index.
[7] We estimate expression (2) for the years 1987–2000, to examine the persistence properties of the organization capital estimates that will be discussed later.

procedure yields firm-specific coefficient estimates on the dummy variable, which are then used to develop our first firm-specific organization capital measure. Admittedly, this introduces a certain ad hoc persistence to our organization capital estimate, since four years of data are common to every adjacent estimate (e.g., for t = 1991 and 1992, data for 1988–1991 are common). Since organization capital, composed of business technologies and processes, is by nature persistent, this feature of our estimate may indeed reasonably reflect real world conditions. An alternative procedure for estimating organization capital as a residual output would be to eliminate the dummy variable from expression (2) and attribute organization capital to the model residuals, e_{ikt}. Then one could use a moving average or similar process to extract a systematic component from the residuals. We implemented this approach and obtained similar results to those of expression (2), reported below.

We set R&D expense to zero when data were not available on Compustat. Expression (2) is estimated separately each year for two groups of firms—those with R&D expenditures and those without. The sample contains 1,246 (non-RND), and 1,952 (RND) firm-years, spanning 1987–2000.

Panel A of Table 1 provides descriptive statistics for the input and output variables in expression (2), while Panel B provides the correlations among the variables. Panel C presents the mean of the annual estimates of expression (2) for the R&D and non-R&D firms. For the R&D (non-R&D) firms, the logarithm of growth in common organization capital (intercept) is 0.03 (0.02), which represents approximately 3% (2%) average output 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 0.20 (0.12), the marginal productivity of human capital (b_2^*) is 0.38 (0.44), and the marginal productivity of research and development (b_3^*) is 0.19 (where the asterisk indicates the coefficient estimates). The difference between the marginal productivities of PPE and EMP across the R&D and non-R&D firms is statistically significant at the $P < 0.05$ percent level, which suggests that R&D, particularly process R&D, improves the efficiency of manufacturing processes, enhances the productivity of plant, property, and equipment of R&D firms. The most productive input is employees (EMP) for both the R&D and non-R&D firms, highlighting the significant role of human capital in generating output. The mean growth estimate of the firm-specific organization capital (b_{0i}^*)—the focus of this procedure—for both the R&D and non-R&D firms is 0.02, indicating that the firm-specific organization capital is important for both groups of firms.

To transform coefficient estimates to a monetary measure of organization capital, we define two expectations of firm's output from expression (2): the first output expectation (expression (2A)), incorporates organization capital, and the second output expectation (expression (2B)) abstracts from organization capital. The difference between these expectations (expression (3)) yields an estimate of the impact of organization capital on output:

$$\mathrm{SALE}_{it}^* = \mathrm{SALE}_{i,t-1}\exp\{b_{0t}^*\}\exp\{\mathrm{b}_{0it}^*\}(\mathrm{PPE}_{it}/\mathrm{PPE}_{i,t-1})^{b1^*}(\mathrm{EMP}_{it}/\mathrm{EMP}_{i,t-1})^{b2^*}(\mathrm{RND}_{it}/\mathrm{RND}_{i,t-1})^{b3^*} \quad (2A)$$

$$\mathrm{SALE}_{it}^* = \mathrm{SALE}_{i,t-1}\,(\mathrm{PPE}_{it}/\mathrm{PPE}_{i,t-1})^{b1^*}(\mathrm{EMP}_{it}/\mathrm{EMP}_{i,t-1})^{b2^*}(\mathrm{RND}_{it}/\mathrm{RND}_{i,t-1})^{b3^*}, \quad (2B)$$

where b_0^*, b_{0i}^*, b_1^*, b_2^*, and b_3^* are the coefficient estimates obtained by estimating expression (2).[8] Thus, the residual output (RO), reflecting the contribution of organization capital to output, is given by the difference:[9]

$$RO_{it} = SALE_{it}^{*} - SALE_{it}^{**}. \qquad (3)$$

The quantity RO_{it}, the difference between expected sales *with* and *without* organization capital, is our first firm-specific measure of organization capital. (Since the data used to estimate expression (2) are in constant 1996 dollars, RO_{it} is inflated to nominal value using the general price deflator.)

Table 2, Panel A (top row), provides descriptive statistics for the RO (organization capital) estimate. The mean RO is $251 million, representing three percent of the output (SALE in Table 1), on average. A little more than 25% of the firms have a negative RO value, indicating that organization capital can be counter productive. Our estimate of three percent average contribution of organization capital to output is strikingly close to Atkeson and Kehoe's (2002, Table 1) estimate of the share of organization capital in aggregate output, which ranges from 2.7–4.0%. Since the mean annual change in sales is $576 million (Panel A, Table 2), the contribution of organization capital to sales *growth* is 43%, indicating the importance of organization capital in generating growth of output.

[8]For the non-R&D firms, expression (2) does not include RND and b_3*.
[9]Note that RO is a flow measure, thus RO can be capitalized into a stock measure by discounting the expected RO at the firm-specific cost of capital for a specified number of future years.

Correlating Organization Capital with Known Proxies

Confidence in the validity of our estimate of organization capital will obviously increase if it is found to be correlated with known proxies of this resource. Accordingly, we report here the correlation of the organization capital estimated by expression (2) with firms' IT expenditures, firm's market share, and their sales, general, and administrative expenses (SGA). Effective organization capital is achieved through the establishment of unique marketing networks, innovations in distribution channels, and strong customer acquisition and retention. These, in turn, result in a large market share (MKS). Accordingly, MKS is expected to be positively associated with RO, our first estimate of organization capital. The market share of firm *i*, operating in the two-digit SIC code *m* in year *t*, is computed as the ratio of firm *i*'s sales to the total sales of firms belonging to code *m*. Thus, $\text{MKS}_{imt} = \text{SALES}_{imt}/?_j\text{SALES}_{jmt}$, where the subscript *j* indicates all firms that belong to the two-digit industry code *m* in year *t*.

Brynjolffson and Yang (1999) argued that information technology creates firm value by enabling improvements and innovations in business processes and procedures, namely organization capital. Thus, if our RO adequately measures organization capital, then it should be associated with IT expenditures. To examine this conjecture, firm-specific information systems expenditures (ISE) were obtained from *Information Week* 500 surveys for 1991–1997.[10] Combining the above arguments concerning market share and IT expenditures leads to the following cross-sectional regression:[11]

$$\log[\text{RO}_{it}] = m_0 + m_1[\text{Year dummy}] + a_1\text{MKS}_{it} + a_2\log[\text{ISE}_{it}] + e_{it}. \quad (4)$$

[10] *Information Week* stopped providing the information systems budget data after 1997.
[11] To retain observations with negative RO, we added the absolute value of the minimum RO to each observation. Similar results were obtained when negative RO firms are eliminated.

We expect a_1 and a_2 to be positive.

Table 2, Panel C (left box), provides the results of estimating expression (4). The coefficients on MKS and ISE are both positive and highly significant, explaining 31% (adjusted R^2) of our measure of organization capital (RO). This suggests that our estimation procedure captures real elements of organization capital.

The right box of Table 2, Panel C, provides the estimates of regressing log(RO) on log(SGA), where SGA is the sales, general, and administrative expenses. The firm's SGA expenses include many outlays related to organization capital, such as information systems, employee training, brand promotion, and distribution channels, and thus should be correlated with RO if the latter measures organization capital. (Note that SGA is data item no. 132, obtained from the Compustat Annual Database.) The coefficient estimate in Panel C on log(SGA) is 0.75 and highly significant, with an adjusted R^2 of almost 40%. This reaffirms the validity of our estimate of organization capital (RO), and further suggests that SGA may be a good instrument to model organization capital in expression (1).[12] We accordingly turn to our second methodology of estimating organization capital.

[12] We do not consider market share as an instrument, because conceptually it is an intermediate output. While IT spending is an input, and hence can serve as an instrument, it is largely contained in SGA and thus, if SGA tums out to be associated with RO, then using SGA should subsume the IT spending. More

III. A Second Estimate of Organization Capital – the Instrumental Variable Approach

For our second estimate of organization capital, we consider the following production function with firm-specific productivity parameters:[13]

$$\mathrm{SALE}_{it} = b_{0it}\,\mathrm{PPE}_{it}^{b1it}\mathrm{EMP}_{it}^{b2it}\,\mathrm{RND}_{it}^{b3it}\,e_{it}. \tag{5}$$

The productivity parameters are modeled as a function of the instrumental variable, SGA as follows:

$$\log(b_{0it}) = c_{0t} + g_{0t}\log(\mathrm{SGA}_{it}) \tag{6}$$

$$b_{nit} = c_t + g_{nt}\log(\mathrm{SGA}_{it})\,, \qquad \text{for } n = 1,2,3. \tag{7}$$

We estimate expression (5) by taking logarithms of annual changes, after substituting expressions (6) and (7) into (5):[14]

$$\begin{aligned}\log(\mathrm{SALE}_{it}/\mathrm{SALE}_{i,t-1}) = {} & c_{0t} + g_{0t}\log(\mathrm{SGA}_{it}/\mathrm{SGA}_{i,t-1}) \\ & + g_{1t}[\log(\mathrm{SGA}_{it})\log(\mathrm{PPE}_{it}) - \log(\mathrm{SGA}_{i,t-1})\log(\mathrm{PPE}_{i,t-1})] \\ & + g_{2t}[\log(\mathrm{SGA}_{it})\log(\mathrm{EMP}_{it}) - \log(\mathrm{SGA}_{i,t-1})\log(\mathrm{EMP}_{i,t-1})] \\ & + g_{3t}[\log(\mathrm{SGA}_{it})\log(\mathrm{RND}_{it}) - \log(\mathrm{SGA}_{i,t-1})\log(\mathrm{RND}_{i,t-1})] \\ & + c_{1t}\log(\mathrm{PPE}_{it}/\mathrm{PPE}_{i,t-1}) + c_{2t}\log(\mathrm{EMP}_{it}/\mathrm{EMP}_{i,t-1}) \\ & + c_{3t}\log(\mathrm{RND}_{it}/\mathrm{RND}_{i,t-1}) + \log(e_{it}/\mathrm{e}_{i,t-1}). \end{aligned} \tag{8}$$

Expression (8)—our second method of estimating organization capital—addresses the limitation of the residual approach in expression (1) of not allowing the individual asset productivities to differ across firms. That is, in addition to the total factor productivity,

---

importantly, while SGA data are available readily through the firm's annual reports, the IT spending is typically not publicly available.

[13] Considering firm-specific asset productivity parameters in the former residual approach (1) would require a longer panel. Expression (5) is a more general specification that subsumes the specification in expression (1).

b_{0it}, being firm-specific and influenced by SGA (as in expression (6)), we now allow the productivities of the individual inputs (PPE, EMP, and RND) to be affected by SGA (as in expression (7)). Expression (8) is estimated each year for R&D and non-R&D firms separately. Note that the common organization capital, b_{0t}, in expression (2) corresponds to c_{0t} in expression (8); whereas the firm-specific organization capital in expression (2) corresponds to the following in expression (8):

$$
\begin{aligned}
b_{0it} = {} & g_{0t}\log(\mathrm{SGA}_{it}/\mathrm{SGA}_{i,t-1}) \\
& + g_{1t}[\log(\mathrm{SGA}_{it})\log(\mathrm{PPE}_{it}) - \log(\mathrm{SGA}_{i,t-1})\log(\mathrm{PPE}_{i,t-1})] \\
& + g_{2t}[\log(\mathrm{SGA}_{it})\log(\mathrm{EMP}_{it}) - \log(\mathrm{SGA}_{i,t-1})\log(\mathrm{EMP}_{i,t-1})] \\
& + g_{3t}[\log(\mathrm{SGA}_{it})\log(\mathrm{RND}_{it}) - \log(\mathrm{SGA}_{i,t-1})\log(\mathrm{RND}_{i,t-1})].
\end{aligned}
$$

Table 3 presents the means of the annual cross-sectional estimates of expression (8) for the R&D and non-R&D firms. For R&D and non-R&D firms, the logarithm of growth in common organization capital is 0.02 and 0.01, respectively. For the R&D (non-R&D) firms, the marginal productivity of plant, property, and equipment (c_1^*) is 0.21 (0.21), the marginal productivity of human capital (c_2^*) is 0.26 (0.30), and the marginal productivity of research and development (c_3^*) is 0.11. The difference between the marginal productivities of PPE and EMP across the R&D and non-R&D firms is not statistically significant at the $P = 0.05$ percent level. The marginal productivity of SGA (g_0^*), our instrument for organization capital, is 0.41 and 0.51 for R&D and non-R&D firms, respectively. For the R&D firms, the organization capital enhances R&D productivity by about 2% ($g_{3t}^* = 0.02$), although it does not have a significant impact on PPE and EMP productivity. This indicates that organization capital is important for

[14] We also measure organization capital without expression (7) and obtain qualitatively similar measures.

sustaining R&D productivity, while the firm-specific productivity of the physical capital and employees, on average, corresponds to the sample average productivity of those resources. On the other hand, for the non-R&D firms, the organization capital enhances the employee productivity by approximately 3% ($g_{2t}^* = 0.03$), but does not affect the firm-specific PPE productivity. This indicates that for non-R&D firms organization capital is important for sustaining firm-specific human capital productivity.

We compute the contribution of organization capital to output by using the estimates obtained from expression (8) and by comparing the expected output (sales) computed with and without the common and firm-specific organization capital measured through the instrument of SGA. From expression (8), the expected output of firm *i* in year *t* with organization capital is as follows:

$$
\begin{aligned}
\text{SALE}_{it}^* = \text{SALE}_{i,t-1}\exp\{ & c_{0t}^* + g_{0t}^*\log(\text{SGA}_{it}/\text{SGA}_{i,t-1}) \\
& + g_{1t}[\log(\text{SGA}_{it})\log(\text{PPE}_{it}) - \log(\text{SGA}_{i,t-1})\log(\text{PPE}_{i,t-1})] \\
& + g_{2t}[\log(\text{SGA}_{it})\log(\text{EMP}_{it}) - \log(\text{SGA}_{i,t-1})\log(\text{EMP}_{i,t-1})] \\
& + g_{3t}[\log(\text{SGA}_{it})\log(\text{RND}_{it}) - \log(\text{SGA}_{i,t-1})\log(\text{RND}_{i,t-1})] \\
& + c_{1t}^*\log(\text{PPE}_{it}/\text{PPE}_{i,t-1}) + c_{2t}^*\log(\text{EMP}_{it}/\text{EMP}_{i,t-1}) \\
& + c_{3t}^*\log(\text{RND}_{it}/\text{RND}_{i,t-1}). \qquad \text{(8A)}
\end{aligned}
$$

where c_{nt}^* and g_{nt}^* for $n = 0,1,2,3$ are the coefficient estimates obtained by estimating expression (8). The expected output of firm *i* without the effect of organization capital is

$$\text{SALE}_{it}^{**} = \text{SALE}_{i,t-1}(\text{PPE}_{it}/\text{PPE}_{i,t-1})^{c1^*}(\text{EMP}_{it}/\text{EMP}_{i,t-1})^{c2^*}(\text{RND}_{it}/\text{RND}_{i,t-1})^{c3^*}. \qquad \text{(8B)}$$

Similar to the residual-based RO_{it}, the instrument-based estimate of organization capital (ISO) is the difference between expected sales *with* and *without* organization capital, given by

$$\mathrm{ISO}_{it} = \mathrm{SALE}_{it}^{*} - \mathrm{SALE}_{i,t-1}^{**}, \tag{9}$$

where SALE_{it}^{*} and SALE_{it}^{**} are given by (8A) and (8B), respectively. The quantity ISO is inflated to nominal value using the general price deflator.

Table 4, Panel A, provides the estimated value of the contribution to output of organization capital (ISO), estimated by the instrumental variable. The mean (median) ISO is $411 ($286) million, considerably larger than the organization capital estimated by our first approach—mean (median) RO of $251 ($72) million, see Table 2. The standard deviation of ISO ($667 million) relative to the mean is substantially smaller than the standard deviation of the RO ($777 million), our first estimate of organization capital. Examining the contribution of ISO to the change in output—the mean change in SALE is $576 million (see Table 2, Panel A)—we find that ISO contributes 71% toward change in sales, on average. This highlights the importance of organization capital in sustaining growth of output. We turn now to an examination of some properties of our second measure of organization capital, ISO.

<u>Properties of ISO</u>

We first examine the persistence of ISO, since organization capital is expected to be persistent over time. Figure 1 illustrates the persistence of ISO. The sample is sorted each year into three equal groups based on the firm's ISO, scaled by sales in the previous year ($\mathrm{SALE}_{i,t-1}$). The figure plots the group mean of $\mathrm{ISO}_{it}/\mathrm{SALE}_{i,t-1}$ for the five years preceding and five years following the estimation year t, in which the groups of high, medium, and low organization capital firms are formed. The figure shows that, on average, firms in the high-ISO group continue to have a high ISO for at least five years; the medium and low ISO (organization capital) also persist.[15]

Table 4, Panel B, provides the results of estimating expression (4) with ISO as the dependent variable. Market share (MKS) and information systems budget (ISE) explain 34% (adjusted R^2) of ISO suggesting that our second estimate of organization capital captures real elements of this resource.

V. Equity Valuation and Organization Capital

Having developed two estimates of organization capital, we now examine the validity of these estimates by incorporating our second estimate (ISO, derived from the instrumental variable) in a widely used equity (stock) valuation model, known as the residual earnings valuation (REV) model. This model, introduced by Preinreich (1938) and rigorously derived by Ohlson (1995), relates the stock price to the firm's assets-in-place and the present value of residual (abnormal) earnings (growth potential). Residual earnings are earnings in excess of the required rate of return (cost of capital). The REV model is

$$V_{it} = \mathrm{BV}_{it} + \mathrm{RE}_{it}, \tag{10}$$

where, V_{it} is firm i's value of equity at the end of year t, 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.

[15] We examine the residuals of our estimate defined as $\mathrm{RES}_{it} = \mathrm{SALE}_{it} - \mathrm{SALE}_{it}^*$ where SALE_{it}^* is given by (8A), to verify whether any systematic component of abnormal output is contained in the residuals, and find that the residuals are not persistent.

To operationalize the model in expression (10), we need estimates of expected earnings, and discount rates. For this purpose, we use the mean of analyst earnings forecasts 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 forecasts.[16] A firm-specific discount rate is estimated using the capital asset pricing model (CAPM) with beta (systematic risk) estimated using previous 60 months 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 (abnormal) earnings (RE) in the valuation expression (10) is given by

$$\mathrm{RE}_{it} = \textstyle\sum_{k=1,5} [\mathrm{FE}_{ikt} - r_{it}\mathrm{BV}_{i(k-1)t}](1 + r_{it})^{-k} + [\mathrm{FE}_{i6t} - r_{it}\mathrm{BV}_{i5t}](r_{it} - g_{it})^{-1}, \qquad (11)$$

where FE_{ikt} is the consensus analysts' earnings forecast for firm i, k years ahead, made four months after the fiscal year t (to allow financial analysts access to the annual report of year t); r_{it} is the discount rate; BV_{it} is the book value (net assets) of firm i at the end of year t [$\mathrm{BV}_{ikt} = \mathrm{BV}_{i,(k-1)t} + \mathrm{FE}_{ikt} - \mathrm{DIV}_{ikt}$]; DIV_{it} is the dividend, g_{it} is the growth rate of [$\mathrm{FE}_{i6t} - r_{it}\mathrm{BV}_{i5t}$] beyond five years.[18] Thus, residual earnings for each future year—the difference between analysts' earnings forecast (FE) and a charge for cost of equity (rBV)—are predicted for each company for the next five years, followed by a terminal

[16] Most public companies are followed by financial analysts who, among other things, predict future earnings. These earnings forecasts are commercially available from various sources. Analysts generally forecast the next two to three years of earnings along with a long-term growth rate. Analysts' consensus (mean) forecasts of earnings (in case of multiple forecasts per firm) and long-term (up to five years) growth estimates were obtained from I/B/E/S (now a part of First Call).

[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 $g_{it} > (r_{it} - 0.03)$. The current dividend payout ratio (dividends to earnings) was used to estimate expected dividends. The dividend payout ratio was winsorized at 10% if the current dividend payout ratio was greater than 10%.

value, based on a constant growth expression.[19] The present value of residual earnings, RE, based on firm-specific earnings forecasts and discount rates, is added to the firm's net assets (BV), to provide an estimate of firm value of equity—expression (10).

To examine the extent to which our second estimate of organization capital, ISO (expression 9), is reflected in firm values as indicated by stock prices, we estimate the following two expressions:

$$[MV_{it}/SALE_{it}] = q_0 + q_1[\text{Year dummy}/SALE_{it}] + b_1[V_{it}/SALE_{it}] + b_2[ISO_{it}/SALE_{it}] + e_{it} \tag{12}$$

$$[MV_{it}/SALE_{it}] = q_0 + q_1[\text{Year dummy}/SALE_{it}] + b_1[V_{it}/SALE_{it}] + e_{it}, \tag{13}$$

where, MV_{it} is the total market value of firm *i* four months after fiscal year *t*, SALE is the sales of firm *i* in fiscal year *t*, ISO_{it} is firm *i*'s estimated organization capital using expression (9), and V_{it} (expression 10) is firm *i*'s estimated equity value computed as the sum of its book value (BV_{it}), the present value of residual earnings (RE_{it}, see expression (11)). All variables are scaled by SALE, to account for size effects.[20] Expression (13) provides the benchmark estimation *without* organization capital, ISO, whereas expression (12) includes the organization capital. We expect the coefficient on ISO (b_2) to be positive, and the explanatory power of expression (12) to be higher than that of expression (13), since current accounting rules exclude most intangibles from book value (BV), a component of V_{it}. Stated differently, organization capital is an unmeasured resource by accountants. Of course, if financial analysts fully incorporate the benefits of organization capital in their forecast of earnings (included in RE), then ISO in expression (12) will be statistically insignificant. In this manner, in fact, we indirectly assess

[19]We also used RE without the terminal value and obtained similar results.

analysts' ability to value firms' organization capital. Note that RE, MV, and BV in expressions (12) and (13) are stock variables, while ISO is a flow variable (contribution of organization capital to annual sales). The estimate of b_2 obtained from expression (12) will therefore indicate the horizon over which investors capitalize organization capital, on average.

Stock prices (MV) for each sample firm were obtained from the CRSP database, and financial data on book value (data item no. 11), and dividends (data item no. 27) were obtained from Compustat. 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 from published annual reports. We deleted from the estimations firms with negative book value of equity and negative three-years ahead earnings forecasts. The sample contains 2,037 firm-year observations, spanning 1987–2000.

Panel A of Table 5 provides descriptive statistics for the variables used in the equity valuation tests (expressions (10)–(13)). The mean (median) market value (MV) is \$7.4 (\$3.1) billion, with a minimum of \$41 million and a maximum of \$258 billion (Wal-Mart). The mean (median) book value (BV) is \$2.8 (\$1.4) billion. Thus, the average market-to-book ratio of the sample companies is 2.7. The mean present value of residual earnings (RE) is \$0.9 billion, while the median is \$264 million. Thus, on average, the firm's book value (\$2.8 billion) plus the present value of residual earnings (growth potential), \$0.9 billion, constitute about half of the mean market value of equity (\$7.4 billion), indicating that the two components of the REV valuation model miss a

[20] See Brown et al. (1999) for the appropriateness of using sales as the scaling variable.

substantial portion of market value. The mean value of the estimated organization capital (ISO) is $411 million in Table 5, and the median is $286 million. This value of ISO accounts for a small part of the gap between market value and *V*, because it is a flow measure.

Panel B of Table 5 provides estimates of expressions (12) and (13), indicating that the addition of organization capital (ISO) to the valuation expression (12) almost doubles its explanatory power from 34% (expression (13), adjusted R^2) to 66% (expression (12), adjusted R^2). The coefficient estimate on the flow variable ISO is 7.33, representing investors' assessment of the present value of the benefits of organization capital. This suggests that the market expects the benefits of organization capital to persist for approximately ten years (a one-time addition to capital should produce a market multiple of one).

Panel C of Table 5 provides estimates of expressions (12) and (13) when the sample is partitioned into three equal groups of firms ranked by size (market capitalization). The quantity ISO provides the highest improvement in explanatory power for small firms: the adjusted R^2 of expression (12) is 70% versus 28% for expression (13). This is consistent with the evidence that the accounting model and analysts' forecasts provide low-quality information for small firms relative to larger ones.

The yearly estimates of explanatory power for expressions (12) and (13) are presented in Figure 2: the top line is the R^2 value of the model that includes organization capital, and the bottom line is without organization capital. The figure indicates that the impact of organization capital as a stand-alone variable in the explanation of equity values has decreased during the 1990s. The probable reason: financial analysts, whose forecasts determine V in expression (13), have become increasingly sophisticated in incorporating the benefits of organization capital in their earnings forecasts.

Overall, the results in Table 5 indicate that our organization capital estimate, ISO, is a valid measure of an important component of corporate value. It complements book value (assets-in-place) and analyst-based abnormal earnings (growth potential), particularly in settings where the accounting model does not perform well (e.g., small firms).

VI. Market Efficiency and Future Returns: Is the Lemon Fully Squeezed?

The regression estimates reported in Table 5 and Figure 2 indicate that some of the benefits of organization capital in generating output are recognized by investors and incorporated in market values of companies. But do investors contemporaneously *fully recognize* the benefits of organization capital? After all, hardly any useful information is provided by firms to investors about intangibles in general, or about organization capital in particular (see Lev, 2001: Chapter 4). It will not be surprising, therefore, if investors overlook some of the value of organization capital.

This is an important question for managers, investors, and policymakers. If the benefits of an asset are not fully priced by investors, then the firms' cost of capital is excessively high, impeding investment and growth. This should obviously be of concern to managers and shareholders. For investors, any systematic mispricing of securities provides opportunities for profitable investment strategies. Policymakers in charge of corporate reporting constantly search for ways to improve the information provided to capital markets. Thus, identifying capital asset mispricing is of considerable social and private value.

The standard methodology in finance research and practice to examine whether security prices fully reflect an information item (organization capital, in our case) is to form portfolios of stocks based on the examined information (e.g., firms with high and low organization capital) and trace the behavior of the risk-adjusted returns on these portfolios *subsequent* to portfolio formation. If stock prices fully capture the value or implications of the examined information, namely the market is efficient with respect to this information, subsequent risk-adjusted portfolio returns should average to zero. If, on the other hand, stocks are mispriced regarding the examined information, subsequent returns should exhibit systematic patterns, as investors gradually learn about the information and its consequences, and adjust stock prices accordingly.

The key to this test is the proper adjustment of subsequent returns for risk. Without such adjustment, systematic return patterns and differences may result simply from the compensation for risk bearing in capital markets. For example, if companies with high organization capital also happen to be of above-average risk, then one would expect efficient markets to yield returns on high organization capital stocks that are systematically higher than on low organization capital stocks, thus compensating investors for the high risk of the former. Accordingly, in our test we employ the state-of-the-art adjustment for risk in finance—the "four-factor model."

In the four-factor model, future excess returns of portfolios structured on some publicly known attributes are regressed on four systematic risk factors: the market return (beta), firm size, the book-to-market ratio, and the stock return momentum (past stock performance). These four factors were widely documented to be systematically associated with subsequent stock returns, accounting for various risk factors (e.g., market risk, bankruptcy risk, liquidity risk, etc.)—see Fama and French (1992 and 1993). This four-factor model is depicted thus:

$$R_i(t) - R_f(t) = a + b_1[R_m(t) - R_f(t)] + b_2\mathrm{SMB}(t) + b_3\mathrm{HML}(t) + b_4\mathrm{UMD}(t) + e_{it}, \tag{14}$$

where $R_i(t)$ is the month t value-weighted portfolio return of firm i subsequent to portfolio formation, $R_f(t)$ is the corresponding one-month treasury bill rate. $[R_i(t) - R_f(t)]$ is thus the excess portfolio returns. $R_m(t)$ is the value-weighted monthly return on all stocks in NYSE, AMEX, and Nasdaq, representing the market return; SMB(t) (small minus big) is the difference between returns on small and large companies' stocks, representing the effect of firm size on returns; HML(t) (high minus low) is the difference between returns on high book-to-market stocks and low book-to-market stocks, representing the return to firms' book-to-market value; UMD(t) (up minus down) is the difference between the average return in month t on the high and low prior return portfolios, representing return momentum (the tendency of stock returns to persist). Monthly time series data on the risk-free rate ($R_f(t)$), market portfolio ($R_m(t)$), 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>.

The focus of this analysis is on the estimated regression intercept, a, in expression (14). A statistically significant intercept indicates that the post-portfolio formation excess returns ($R_i(t) - R_f(t)$), after being adjusted for risk (the four independent variables in expression (14)), still exhibit systematic patterns. This is consistent with the conjecture that the information used to form portfolios was not fully captured in contemporaneous stock prices.

To examine whether investors fully comprehend the potential of organization capital, we form two portfolios in each year based on the estimated organization capital, scaled by sales [ISO/SALE], that is, high and low ISO/SALE firms. Subsequent value-weighted excess monthly returns for each ISO/SALE portfolio are computed.[21] We then estimate expression (14) for each portfolio using the following set of monthly portfolio returns: (a) contemporaneous, (b) one year ahead, (c) two years ahead, and (d) three years ahead. For example, expression (14) with contemporaneous returns means that the high and low organization capital portfolios are formed based on the size of ISO/SALE in, say, fiscal year 1991.[22] Then, monthly portfolio returns are computed for the period September 1991–August 1992 (contemporaneous with fiscal year 1991) and are regressed on the four-factor returns for the same months.[23] Similarly, portfolios are formed for each year 1989 through 1997. For each of the organization capital portfolios (high and low) the regression includes 108 observations, corresponding to the 9 sample years and the 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–August 1993, September 1993–August 1994, and September 1994–August 1995, respectively. Each of these regressions is also run on 108 observations.

---

[21]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.
[22] Fiscal year 1991 includes all firms with fiscal years ending between June 1991 and May 1992.

As mentioned earlier, the intercept estimate, *a*, in expression (14) 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 different. A significant intercept yielded by a contemporaneous return regression indicates that organization 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), this indicates that the contribution of organization capital is *not* fully captured contemporaneously by investors (investors learn gradually about the benefits of organization capital)—a case consistent with market inefficiency, or alternatively, with an unknown risk factor associated with organization capital.

Table 6, Panel A, provides the intercept estimates of expression (14) for the contemporaneous as well as for the subsequent-returns regressions. The annualized risk-adjusted abnormal returns (i.e., the monthly intercept estimate converted to an annual estimate) for high organization capital portfolio for the contemporaneous, one-year-ahead, two-years-ahead, and three-years-ahead regressions are 1.80%, 2.60%, 1.29%, and 0.46%, respectively. For the low organization capital portfolio the abnormal returns are –0.11%, 1.05%, 0.68%, and 0.12%, respectively—substantially lower than for the high organization capital portfolio.[24] Important for our study is the difference in the risk-adjusted abnormal returns between the high and the low ISO/SALE portfolios—a hedge

---

[23]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 organization capital value (ISO) is available to the investors well before computing the one-year-ahead portfolio returns.
[24]The coefficient estimates of the four risk factors (not reported) are consistent with expectations. The estimated coefficient on $R_m - R_f$, excess market returns, (b_1^*) is 0.98, which is close to the average market beta of 1. 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-

portfolio: long on high ISO/SALE and short on low ISO/SALE companies. In all cases (contemporaneous and subsequent returns), the returns on high organization capital (ISO) portfolios are higher than those on low-ISO portfolios. The differences are significant for the contemporaneous and one-year-ahead returns. The abnormal returns are also economically significant. For example, the annual risk-adjusted return on high- minus low-ISO firms in the year subsequent to portfolio formation is 1.55%—a fairly substantial abnormal return.

Thus, much of the value of organization 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 (1.91%) between companies with high and low ISO/SALE. However, investors do not fully capture contemporaneously the potential of organization capital, as evidenced by the relatively large differential in the one-year-ahead abnormal returns (1.55%). There appears to be a certain degree of market inefficiency concerning organization capital, a not-so-surprising finding, given the poor disclosure to investors of information about intangible capital (e.g., no data on employee training, brand enhancement, IT expenditures, among others).

VI. Concluding Remarks

Intangible (knowledge) assets are major drivers of corporate and national growth. Organization capital—a major form of intangibles, embodied in unique organization designs and processes—is the least documented type of intangible assets. We develop a

---

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).

methodology for estimating firm-specific organization capital, and examine the validity of our estimates with a widely used equity valuation model. These tests indicate that our organization capital estimate adds considerable explanatory power to the original independent variables of the equity valuation model: assets-in-place and the present value of abnormal earnings. Further tests indicate that while investors incorporate the value of organization 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 organization capital. This presumed market inefficiency might be related to poor and biased public information on intangible assets.

References

Aghion, P. and P. W. Howitt. 1997. *Endogenous Growth Theory*. MIT Press, Cambridge, MA.

Arrow, K. J. 1962. "The economic implications of learning by doing." *Review of Economic Studies*, 29(3): 155–173.

Atkeson, A. and P. J. Kehoe. 2002. "Measuring organizational capital." *Working Paper 8722*, NBER, Cambridge, MA.

Becker, G. S. 1993. *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*. University of Chicago Press, Chicago, IL.

Brown, S., K. Lo, and T. Lys. 1999. "Use of R^2 in accounting research: Measuring changes in value relevance over the last four decades." *Journal of Accounting and Economics*, 28(2): 83–116.

Brynjolfsson, E. and S. Yang. 1999. "The intangible benefits and costs of computer investments: Evidence from the financial markets." *Working Paper,* Sloan School, MIT, Cambridge, MA.

Caves, R. E. and D. R. Barton. 1990. *Efficiency in U.S. Manufacturing*. MIT Press, Cambridge, MA.

Chan L. K. C., J. Lakonishok, and T. Sougiannis. 2001. "The stock market valuation of research and development expenditures." *Journal of Finance*, 56(6): 2431–2456.

Ericson, R. and A. Pakes. 1995. "Markov-perfect industry dynamics: A framework for empirical work." *Review of Economic Studies*, 61(1): 53–82.

Evenson, R. E. and L. E. Westphal. 1995. "Technological change and technological strategy." In *Handbook of Development Economics*, edited by J. Behrman and T. N. Srinivasan, North-Holland, Amsterdam, 3A: 2209–2299.

Fama, E. F. and K. R. French. 1992. "The cross-section of expected stock returns." *Journal of Finance* 47 (3): 427–465.

Fama, E. F. and K. R. French. 1993. "Common risk factors in the returns on stocks and bonds." *Journal of Financial Economics* 33 (1): 3–56.

Hall, B. H. 1993. "Industrial research during the 1980s: Did the rate of return fall?" *Brooking Papers on Economic Activity, Microeconomics*, 1993(2): 289–330.

Hall, R. E. 2000. "e-capital: The link between the stock market and the labor market in the 1990s." *Working Paper, Hoover Institution and Department of Economics,* Stanford University, CA.

Hulten, C. R. 2000. “Total factor productivity: A short biography.” *Working Paper 7471*, NBER, Cambridge, MA.

Jorgenson, D. W. 1986. “Econometric methods for expressioning producer behavior.” in *Handbook of Econometrics*, Volume 3, Editors: Z. Griliches and M. D. Intriligator, North Holland, NY.

Jovanovic, B. 1979. “Job matching and the theory of turnover.” *Journal of Political Economy*, 87(5): 972–990.

Lev, B. 2001. *Intangibles: Management, Measurement and Reporting*, The Brookings Institution Press, UK.

Ohlson, J. 1995. “Earnings, book values and dividends in security valuation,” *Contemporary Accounting Research*, 11(2): 1–23.

Preinreich, G. A. D. 1938. “Annual survey of economic theory: The theory of depreciation.” *Econometrica*, 6(3): 219–241.

Prescott, E. C. and M. Visscher. 1980. “Organization capital.” *Journal of Political Economy*, 88(3): 366–382.

Rosen, S. 1972. “Learning by experience as joint production.” *Quarterly Journal of Economics*, 86(3): 366–382.

Tomer, J. F. 1987. *Organizational Capital: The Path to Higher Productivity and Well-being*. Praeger Publishing Co.

Table 1: Estimating Organization Capital—the Residual Approach

Panel A: Descriptive Statistics

Variable	With RND						Without RND					
	Mean	**Min**	**Q1**	**Median**	**Q3**	**Max**	**Mean**	**Min**	**Q1**	**Median**	**Q3**	**Max**
SALE ($ millions)	9,123	146	2189	4,678	10,056	101,781	6,532	3	1,711	3,104	6,068	191,329
PPE ($ millions)	3,433	17	571	1,302	3,437	51,161	1,808	2	270	632	1,858	40,934
EMP (thousands)	42	2	12	25	50	813	39	1	7	16	35	1,244
RNDC ($ millions)	1,036	1	119	323	957	16,439						

Panel B: Correlation

Variable	With RND			Without RND	
	$\log(SALE_t/SALE_{t-1})$	$\log(PPE_t/PPE_{t-1})$	$\log(EMP_t/EMP_{t-1})$	$\log(SALE_t/SALE_{t-1})$	$\log(PPE_t/PPE_{t-1})$
$\log(PPE_t/PPE_{t-1})$	0.61			0.56	
$\log(EMP_t/EMP_{t-1})$	0.67	0.70		0.65	0.63
$\log(RND_t/RND_{t-1})$	0.41	0.34	0.33		

Panel C: Expression (2)

	With RND			Without RND		
	Coefficient	***t*-statistic**	***P***	**Coefficient**	***t*-statistic**	***P***
Intercept	0.03	5.41	0.00	0.02	5.58	0.00
$\log(FA_t/FA_{t-1})$	0.02	5.61	0.00	0.02	6.16	0.00
$\log(PPE_t/PPE_{t-1})$	0.20	8.87	0.00	0.12	4.39	0.00
$\log(EMP_t/EMP_{t-1})$	0.38	12.47	0.00	0.44	16.12	0.00
$\log(RND_t/RND_{t-1})$	0.19	6.61	0.00			
R^2		62.53%			58.13%	

Notes:

1. The numbers in Panel A are in millions of dollars, other than EMP, which is in thousands.
2. The numbers in Panel B are the Pearson correlation coefficients.
3. Expression (2): $\log(SALE_{ikt}/SALE_{ik,t-1}) = b_{0t} + S_i b_{0it} D_{it} + b_{1kt}\log(PPE_{ikt}/PPE_{ik,t-1}) + b_{2kt}\log(EMP_{ikt}/EMP_{ik,t-1}) + b_{3kt}\log(RND_{ikt}/RND_{ik,t-1}) + \log(e_{ikt}/e_{ik\,t-1})$, for $k = t,\ldots,(t-4)$; $t = 1989,\ldots,1997$
4. Expression (2) is estimated over a rolling panel of five years for each year t. For example, to estimate expression (2) for 1991, we use data for the years k = 1987–1991.
5. Panel C provides the mean coefficient estimates and alternative *t*-statistics obtained from estimating expression (2) each year.
6. The sample contains 1,246 (non-RND) and 1,952 (RND) firm-estimation year panels, spanning 1987–2000.

Variable Definitions

SALE is the net revenues; PPE is the plant, property, and equipment net of depreciation; EMP is the number of employees; RNDE is the research and development expenditure; RND is the research and development capital computed by capitalizing and amortizing RNDE over five years; D_{it} is the dummy that equals 1 for each firm i in the estimation year t, and is 0 otherwise.

Table 2: Organization Capital: Descriptive Statistics

Panel A: Descriptive Statistics

Variable	Mean	Standard Deviation	Minimum	First quartile	Median	Third quartile	Maximum
RO $ millions	251	777	–2,724	–7	72	233	8,654
$SALE_{it} - SALE_{i,t-1}$ $ millions	576	1,876	–27,425	29	207	656	27,379
ISE $ millions	192	421	1	31	71	179	4,679
MKS	0.04	0.06	0.00	0.01	0.02	0.04	0.51
SGA $ millions	1,608	2,650	1	367	707	1,662	22,977

Panel B: Correlations

	RO	ISE	MKS
ISE	0.35		
MKS	0.26	0.29	
SGA	0.53	0.76	0.29

Panel C: Expression (4)

	Dependent variable = log(RO)			Dependent variable = log(RO)		
	Coefficient	*t*-statistic	*P*	Coefficient	*t*-statistic	*P*
log(SGA)				0.75	21.65	0.00
log(ISE)	15.16	6.43	0.00			
MKS	0.47	15.16	0.00			
Adj. R^2		31.30%			39.22%	

Notes:

1. Expression (4): $\log[RO_{it}] = m_0 + m_1[\text{Year dummy}] + a_1 MKS_{it} + a_2 \log[ISE_{it}] + e_{it}$
2. The sample contains 1,246 (non-RND) and 1,952 (RND) firm-estimation year panels, spanning 1989–2000.

Variable Definitions

RO is the abnormal output computed as the predicted value of sales and the predicted value without the contribution of b_{0t}^* and b_{0it}^* obtained by estimating expression (2). MKS_{it} is the percentage of market share of firm i in year t computed at the two-digit SIC level, $MKS_{imt} = SALE_{imt}/\Sigma_j SALE_{jmt}$ where firm i belongs to the two-digit SIC m and the sum of sales is over all firms in the two-digit SIC m. ISE_{it} is the information systems expenditure of firm i in year t as reported in the *Information Week* 500 survey.

Table 3: Estimating Organization Capital with Instrumental Variable, SGA

	With RND			Without RND		
	Coefficient	***t*-statistic**	***P***	**Coefficient**	***t*-statistic**	***P***
Intercept	0.02	3.02	0.01	0.01	1.06	0.31
$\log(PPE_t/PPE_{t-1})$	0.21	3.24	0.01	0.21	5.54	0.00
$\log(EMP_t/EMP_{t-1})$	0.26	2.26	0.04	0.30	2.68	0.04
$\log(RND_t/RND_{t-1})$	0.11	2.87	0.03			
$\log(SGA_t/SGA_{t-1})$	0.41	6.65	0.00	0.51	12.62	0.00
$\log(SGA_t)\log(PPE_t) - \log(SGA_{t-1})\log(PPE_{t-1})$	–0.02	–1.53	0.15	–0.01	–1.99	0.07
$\log(SGA_t)\log(EMP_t) - \log(SGA_{t-1})\log(EMP_{t-1})$	0.01	0.15	0.88	0.03	2.07	0.06
$\log(SGA_t)\log(RND_t) - \log(SGA_{t-1})\log(RND_{t-1})$	0.02	2.61	0.03			
R^2		77.61%			78.44%	

Notes:

1. Expression (8):
$$\log(SALE_{it}/SALE_{i,t-1}) = c_{0t} + g_{0t}\log(SGA_{it}/SGA_{i,t-1}) + g_{1t}[\log(SGA_{it})\log(PPE_{it}) - \log(SGA_{i,t-1})\log(PPE_{i,t-1})] + g_{2t}[\log(SGA_{it})\log(EMP_{it}) - \log(SGA_{i,t-1})\log(EMP_{i,t-1})] + g_{3t}[\log(SGA_{it})\log(RND_{it}) - \log(SGA_{i,t-1})\log(RND_{i,t-1})] + c_{1t}\log(PPE_{it}/PPE_{i,t-1}) + c_{2t}\log(EMP_{it}/EMP_{i,t-1}) + c_{3t}\log(RND_{it}/RND_{i,t-1}) + \log(e_{it}/e_{i,t-1})$$
2. Expressions (8) are estimated annually.
3. The sample contains 1,246 (non-RND) and 1,952 (RND) firm-estimation year panels, spanning 1987–2000.

Variable Definitions

SALE is the net revenues; PPE is the plant, property, and equipment net of depreciation; EMP is the number of employees; SGA 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.

Table 4: Properties of Organization Capital Estimate

Panel A: Descriptive Statistics

Variable	**Mean**	**Standard deviation**	**Minimum**	**First quartile**	**Median**	**Third quartile**	**Maximum**
ISO $ millions	411	667	–4,415	213	286	445	8,036

Panel B: Expression (4)

	Dependent variable = ISO		
	Coefficient	***t*-statistic**	***P***
MKS	5.30	9.02	0.00
log(ISE)	0.41	16.16	0.00
Adj. R^2		34.30%	

Notes:

1. Expression (4): log[RO_{it}]= m_0 + m_1[Year dummy] + a_1MKS_{it} + $a_2$log[ISE_{it}] + e_{it}
2. The sample contains 1,246 (non-RND) and 1,952 (RND) firm-estimation year panels, spanning 1987–2000.

Variable Definitions: see Table 2 notes.

Table 5: Organization Capital and Equity Valuation

Panel A: Descriptive Statistics

Variable	Mean	Standard deviation	Minimum	First quartile	Median	Third quartile	Maximum
MV ($ millions)	7,404	14,362	41	1,559	3,118	6,883	258,333
BV ($ millions)	2,763	4,053	35	729	1,428	2,789	42,832
[MV/BV]	2.66	1.93	0.01	1.54	2.21	3.38	31.68
RE ($ millions)	882	2,243	–3,117	22	264	805	30,023
ISO ($ millions)	411	667	–4,415	213	286	445	8,036
r (%)	10	0.03	3	8	10	12	29

Panel B: Contribution of Organization Capital to Valuation

	Expression (12)			Expression (13)		
	Coefficient	***t*-statistic**	***P***	**Coefficient**	***t*-statistic**	***P***
V (b_1)	1.09	8.81	0.00	1.75	10.50	0.00
ISO (b_2)	7.33	31.83	0.00			
Adj. R^2		65.75%			33.69%	

Panel C: Partitioned by Market Value of Equity [Size]

		Expression (12)			Expression (13)		
		Coefficient	***t*-statistic**	***P***	**Coefficient**	***t*-statistic**	***P***
Low	V (b_1)	1.70	2.69	0.00	4.23	3.71	0.00
	ISO (b_2)	4.82	18.36	0.00			
	Adj. R^2		70.44%			28.13%	
Medium	V (b_1)	3.79	18.24	0.00	6.51	27.86	0.00
	ISO (b_2)	7.24	15.96	0.00			
	Adj. R^2		79.78%			63.56%	
High	V (b_1)	0.78	7.28	0.00	1.44	10.63	0.00
	ISO (b_2)	10.11	14.61	0.00			
	Adj. R^2		67.57%			43.35%	

Notes:

1. Expression (12): $[\mathrm{MV}_{it}/\mathrm{SALE}_{it}] = q_0 + q_1[\text{Year dummy}/\mathrm{SALE}_{it}] + b_1[V_{it}/\mathrm{SALE}_{it}] + b_2[\mathrm{ISO}_{it}/\mathrm{SALE}_{it}] + e_{it}$
2. Expression (13): $[\mathrm{MV}_{it}/\mathrm{SALE}_{it}] = q_0 + q_1[\text{Year dummy}/\mathrm{SALE}_{it}] + b_1[V_{it}/\mathrm{SALE}_{it}] + e_{it}$
3. The t-statistic is the White's heteroskedasticity adjusted t-statistic.
4. The low, medium, and high market value of equity groups contain the bottom, middle, and top one-third of the observations sorted each year based on the market value of equity, respectively.
5. The sample contains 2,037 firm-year observations spanning 1987–2000.

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% plus the twelve-month treasury bill rate. The beta value 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, $\mathrm{RE}_{it} = \Sigma_{k=1,5}\,[\mathrm{FE}_{ikt} - r_{it}\mathrm{BV}_{i,(k-1)t}](1 + r_{it})^{-k} + [\mathrm{FE}_{i6t} - r_{it}\mathrm{BV}_{i5t}](r_{it} - g_{it})^{-1}$, where g_{it} is the growth in $[\mathrm{FE}_{i6t} - r_{it}\mathrm{BV}_{i5t}]$. 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}; ISO_{it} is the abnormal output computed as the predicted value of sales obtained by estimating expression (8) and the predicted value of sales with asset productivities alone in expression (8) estimates.

Table 6: Annual Risk-Adjusted Stock Returns on Portfolios Formed by Size of Organization Capital

Fame–French four-factor risk model

	Contemporaneous	One year ahead	Two years ahead	Three years ahead
High ISO	1.80*	2.60*	1.29**	0.46
Low ISO	–0.11	1.05**	0.68	0.12
Difference	1.91*	1.55*	0.61	0.34

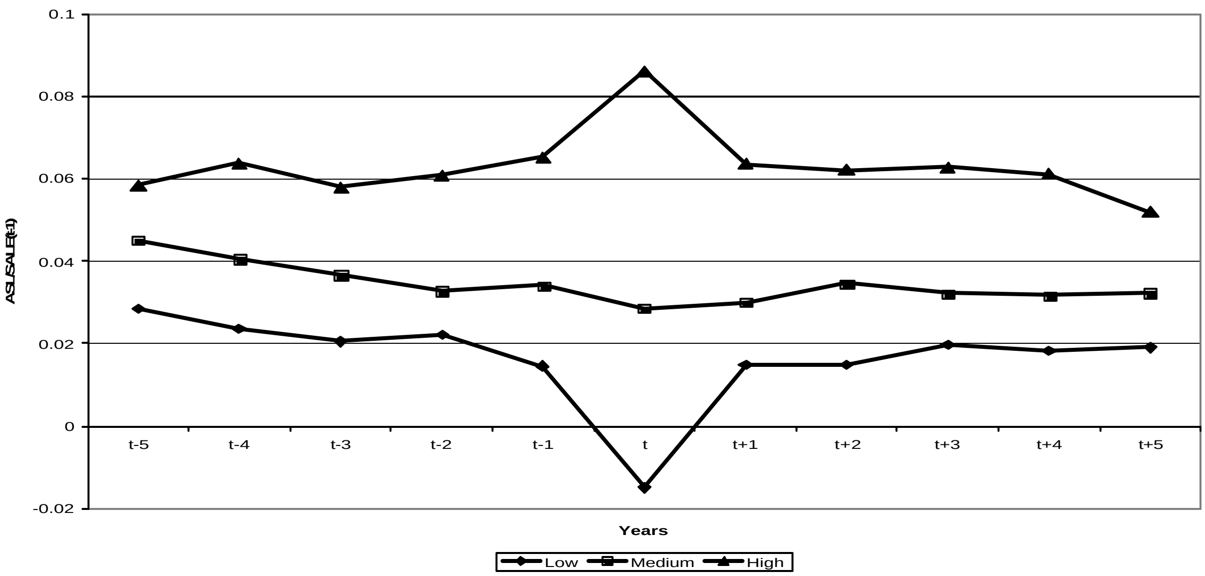
Notes:

1. The * and ** indicate statistical significance of $P < 0.0001$ and $P < 0.0005$, respectively, for a two-tailed test.
2. Expression (14): $R_i(t) - R_f(t) = a + b_1[R_m(t) - R_f(t)] + b_2\text{SMB}(t) + b_3\text{HML}(t) + b_4\text{UMD}(t) + e_{it}$
3. The high (low) ISO portfolio contains the bottom (top) 50% of the observations sorted each year based on the ISO scaled by SALE.
4. Table entries are the percentage annual returns obtained by compounding the monthly abnormal risk adjusted stock returns obtained as the coefficient estimates of the intercept (a) in expression (14).
5. The portfolios are formed based on the ISO/SALE in each year (Y). Contemporaneous monthly (t) 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

R_m is the value-weighted monthly return for the market; R_f 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; ISO_{it} is the abnormal output computed as the predicted value of sales obtained by estimating expression (8) and the predicted value of sales with asset productivities alone in expression (8) estimates.

Figure 1: Persistence of Organization Capital Estimate (ISO)

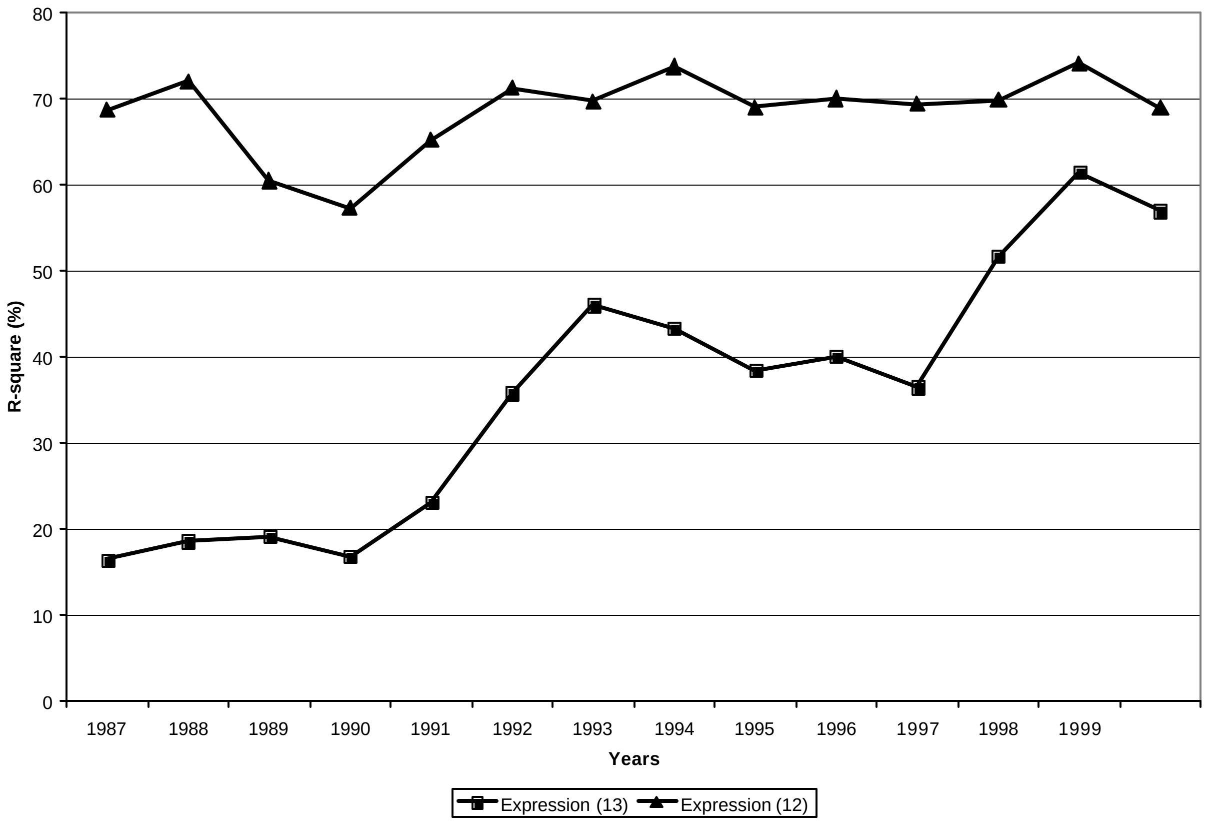


Note: Three portfolios with equal number of observations are formed based on $ISO_{it}/SALE_{i,t-1}$ each year.

Variable Definitions

ISO is the abnormal output computed as the predicted value of sales obtained by estimating expression (8) and the predicted value with the contribution of asset productivities alone in expression (8).

Figure 2: Explanatory Power of Expressions (12) and (13)



Notes:

1. Expression (12): $[MV_{it}/SALE_{it}] = q_0 + q_1[\text{Year dummy}/SALE_{it}] + b_1[V_{it}/SALE_{it}] + b_2[ISO_{it}/SALE_{it}] + e_{it}$
2. Expression (13): $[MV_{it}/SALE_{it}] = q_0 + q_1[\text{Year dummy}/SALE_{it}] + b_1[V_{it}/SALE_{it}] + e_{it}$

Variable Definitions: see Table 5 notes.