From IT Investment to Firm Market Value: The Mediating Role of Stock Analysts’ Recommendation

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From IT Investment to Firm Market Value: The Mediating Role of Stock Analysts’ Recommendation

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Abstract
This study provides a new perspective to the long-standing debate on the business value of IT. Advancing prior research on the internal perspectives of IT value creation, we take an external view and investigate the role of stock analysts in facilitating the market evaluation of firms’ IT investments. Stock analysts collect information about firms’ IT investments and provide informed recommendations to investors in the financial market. As IT investments are known for their complexity and inherent risks, stock analysts can reduce information asymmetry between the firm and investors in the financial markets, thus helping discovering the business value of IT investments. On the basis of Fortune 1000 firms between 1996 and 2007, our analysis suggests that stock analysts play an intricate mediating role in the stock market evaluation of IT investments. Analyst recommendations have a strong mediating role in the effects of enterprise IT systems (ERP and CRM) on firm market value, but a weak to insignificant mediating role in the effects of function IT systems (DSS, HR and AIS). In addition, we find that the mediating role of financial analysts for IT investments is more salient when the firm’s market environments are more uncertain and unpredictable. These findings suggest that analyst recommendations play a critical role in the stock market valuation of firms’ IT investments in situations where the value of such investments is difficult to assess.

Keywords: IT investment, stock analyst, market value
1. INTRODUCTION

IT investment is an important element in the firm value creation process and has grown to be the largest category of capital expenditures in businesses. Research has extensively investigated the effect of IT investments on firm performance (see Kohli and Grover (2008); Melville et al. (2004) for a review of the related literature). A key insight of prior research is the “general purpose” nature of IT (Bapna et al. 2013; Brynjolfsson and Hitt 2000). As such, the value of IT investments depends on how firms leverage the technology and cannot be assessed without a full understanding of a firm’s business strategies and organizational resources. Substantial research has been conducted to look inside the firm to identify the strategies, processes and resources that help generate value from IT investments.

What is often neglected in this internal view is that IT and its complementary strategies and processes within a firm are difficult to assess for external investors who determine firms’ market value. Echoing this, Brynjolfsson et al. (2002) lamented: “many firms do not report the IT intangible assets on their balance sheets, forcing investors to rely on other sources of information to value these assets.” This lack of observability creates significant information asymmetry in the financial market. Without bridging this information asymmetry, it is challenging for the financial market to assess the value of IT investments.

Thus, there is a demand for information intermediaries to aid the external financial market to better understand firms’ IT investments and their value. A key information intermediary that affords such responsibility is stock analysts. Stock analysts are employed by stock brokerages, banks and financial consulting firms to compile information from various sources, examine firm fundamentals, provide informed recommendations and forecast firm future earnings for institutional and/or retail investors (Jegadeesh et al. 2004; Kimbrough et al. 2009). The stock analysts’ role in interpreting firm behavior suggests that they could play an important role in facilitating and certifying the stock market evaluation of IT investments.

The goal of our study, therefore, is to investigate the following three questions: (1) Do analysts help the stock market discover the business value of firm IT investments, i.e., mediate the effects of firms’ IT investments on stock market value? (2) What types of IT systems rely more or less on the mediating role of stock analysts? And (3) is this mediating role more or less salient for firms in uncertain market environments?

We assess this question empirically using IT assets and firm performance data of Fortune 1000 firms between 1996 and 2007. The IT and firm performance data are obtained from Harte-Hanks and Compustat respectively. Our analyses show that, stock analysts’ recommendation has a significant mediating effect on the stock market value of IT investments. The mediating effect varies by IT investment type. Analyst recommendations have a stronger mediating effect for firms investing in enterprise IT systems (ERP and CRM) than those investing in functional IT systems (DSS, HR and AIS). In addition, we find that the mediating role of analyst recommendations for IT investments is more salient when the firm’s market environments are more uncertain. Our analyses suggest that stock analysts provide a critical intermediary function in helping financial markets discover the business value of IT investments, especially for investments in sophisticated enterprise IT systems and for firms operating in uncertain market environments.

2. LITERATURE REVIEWS

The study is related to several streams of literatures. The first stream is on the business value of IT. This stream of literature has extensively analyzed the internal processes that relate a firm’s IT investments to its market performance (Barua et al. 1995). For example, Devaraj and Kohli (2003) posit and prove that the actual usage of the technology is a key variable to explain the impact of IT investment on
organizational performance. Zhu and Kraemer (Zhu and Kraemer 2005) further point out that IT usage breadth and depth are critical internal mechanisms that link IT investments to firm performance. Similarly, IT-related business processes and dynamic capabilities are documented as important intermediary outcomes between IT investments and organizational performance (Melville et al. 2004). Complementing this internal process-oriented view of IT investment, our study takes an external process-oriented view of IT valuation. We propose that stock analysts play a critical role in facilitating external investors to understand and assess the value of IT investments.

Prior literatures of business value of IT have also considered specific IT applications, including enterprise resource planning (Hitt et al. 2002), customer relationship management (Hendricks et al. 2007), knowledge management systems (Sabherwal and Sabherwal 2005), e-commerce (Dewan and Ren 2007), supply chain management systems (Dehning et al. 2007), and other IT infrastructure applications (Chatterjee et al. 2002). These studies reveal significant variations in the market value of these IT applications. We contribute to this stream of literatures by offering a new explanation of the phenomenon. We propose that the mediating effect of stock analysts varies with the complexity of IT applications. As a result, the market valuation of enterprise IT applications relies on not only IT applications themselves but also financial analysts’ recommendations. This dependency on external financial analyst amplifies variations in the market valuation of enterprise IT systems.

Our study is also related to prior IS studies that use stock price-based measures to assess the business value of IT investments (Dewan and Ren 2007). The underlying assumption of these measures is that the stock market has complete information and is able to accurately assess the value of IT investments. Our study extends the literature by pointing out that stock analysts play an important role in facilitating stock market investors to understand the complexity and inherent risks and benefits of IT investments in the valuation processes of IT investments. If a firm is not or barely covered by stock analysts, market-based measures may not accurately reflect the business value of IT for these firms.

Finally, our study also adds to emerging studies that examine stock analysts’ information-giving behaviors on market information environment and market valuation (Xu and Zhang 2012) and use their recommendation as risk measures (Dewan and Ren 2007; Dewan and Ren 2011). We extend these studies by incorporating stock analyst recommendation as a mediator between IT investment and firm stock market value, i.e., highlighting the role of stock analysts in discovering the value of IT investments.

3. RESEARCH FRAMEWORK AND HYPOTHESIS DEVELOPMENT

In this section, we present our research framework. Our framework hypothesizes that analyst stock recommendations mediate the relationship between IT investments and firm stock market value, as the mediating effect of financial analysts are driven by the degree of information asymmetry between firms and investors with regard to firms’ IT investments. Two key factors influence the degree of information asymmetry of IT investments made by a firm – the nature of the IT investments and the nature of a firm’s business environments. So we consider the nature of IT investments and the nature of a firm’s business environments as moderators of the meditational relationship.

3.1. Mediating Role of Analyst Recommendations for the Value of IT Investments

The information intermediary functions of stock analysts are particularly important for IT investments for several reasons. First, as IT spending, like R&D and advertising expenditures, directly influences firms’ asset, debt and cash flow (Bharadwaj et al. 1999), it motivates stock analyst’s to watch IT-related expenditures carefully and advise investors on the firm’s accounting profitability accordingly. Although on average IT spending has proven to increase firms’ productivity, the effect may not necessarily lead to corresponding profitability increase to offset the cost of IT investments (Hitt and Brynjolfsson 1996). Stock analyst can analyze whether benefits of IT investment outweigh the costs and whether it helps firms improving financial performance with new information collecting, processing and
analytical capabilities. It is therefore the analysts’ additional value to deliver their understanding about the IT costs and benefits trade-offs to the stock market and investors, whose buy and sell decisions subsequently influence the stock market’s valuation on the firm.

Second, despite the importance of IT investments, firms are not required to disclose to the public the nature or the scale of their IT investments (Brynjolfsson et al. 2002). The lack of timely and public disclosure creates information asymmetry and market inefficiency. Analysts can help mitigate the information asymmetry through compiling information from multiple sources and presenting the information in an integrated manner to investors (Kimbrough 2007). In this sense, analyst recommendations may serve as an information mechanism for the stock market valuations of IT investments. Echoing this perspective, IT investment can improve firms’ internal information environment and results in better management forecasts (Dorantes et al. 2013). Therefore, IT investment not only motivates stock analysts to pay more attention to it, but also affords firms to provide better information to the analysts, thus allowing them to offer more accurate recommendations.

Finally, due to the “general purpose” nature of IT investments, investors need to know not only the nature and scale of IT investments, but also firms’ investments in complementary resources and strategic process changes related to the IT investments. A large amount of such information cannot be easily accessed by investors. Analysts are able to mitigate this information asymmetry issue by obtaining firm-specific information through their connections within the firm and the industry to help investors gauge future cash flows and financial value of the IT investments (Srinivasan and Hanssens 2009). Thus, the forecasts and recommendations by stock analyst are more likely to reflect the true value of the IT investments and be accepted by investors (Ivkovic and Jegadeesh 2004), allowing the stock market to overcome the challenge of evaluating IT investments. In other words, there is a chained mediating effect, i.e., the firm information is channeled through analyst recommendations, which influence investors’ evaluation of firms and determine firm stock market valuation. Thus, we posit that:

\[ H_1: \text{Holding everything else constant, the effects of IT investments on firm stock market value are mediated by analyst recommendations.} \]

### 3.2. Moderating Effect on the Mediation Role of Analyst Recommendations

As the mediating effect of financial analysts is driven by information asymmetry between firms and investors with regard to firms’ IT investments, we expect the mediating effect to vary with the level of information asymmetry across firms. Two key factors influencing the level of information asymmetry of IT investments are studied here: nature of the IT investments and market environment uncertainty.

Depending on the scope of the organizational functions involved, IT investments can be classified into two important categories: functional IT and enterprise IT (also called cross-functional IT) (Brynjolfsson and McAfee 2012; McAfee 2006). The former refers to IT systems that require the involvement of one specific business function such as DSS, HR, and AIS, while the latter refers to IT systems that require enterprise-wide, cross-functional collaboration such as enterprise resource planning (ERP) and customer relationship management (CRM) systems (Nevo and Wade 2010).

We expect analyst recommendations to have a stronger mediating effect in firms with substantial investments in enterprise IT than those with substantial investments in functional IT. First, firm’s benefits from of enterprise IT are long-term and strategic. Enterprise IT often change the way complementary organizational resources operate, and the ultimate outcomes are difficult for external investors to forecast (Dos Santos et al. 2012; Mithas et al. 2012; Tambe and Hitt 2012). Furthermore, while enterprise IT provides long-term value for future strategic initiatives, it usually requires significant learning and incurs high short-term costs (Melville et al. 2004). For example, consider a firm that is planning to implement a CRM system in order to better understand consumer preferences. Although such a system can favorably affect a firm’s strategic position in the market, it is difficult for investors to value its impact as its success requires substantial changes to the existing business processes and demands
collaborations among marketing, sales, operations and finance functions (Hitt and Brynjolfsson 1996). Thus, the evaluation of enterprise IT systems requires substantial inside knowledge on firms’ operations. In such cases, stock analysts could contribute significantly to the value discovery of enterprise IT investments through their industry connections and their experience in evaluating similar investments, thus reducing information asymmetry between firms and investors.

On the other hand, functional IT investments (DSS, HR, and AIS) are different from enterprise IT investments. It is intended to solve firms’ specific challenges and needs in a given business function. Its implementations take less time than enterprise IT and the benefits can be realized in a short period of time. Given the specific objective and the relatively short implementation schedule, its value and costs are easier for investors to estimate than enterprise IT without analyst recommendations. Further, with a narrow scope, firms’ other business units are rarely affected by functional IT. Consequently, information needed to value functional IT is more straightforward to collect and process. The above discussion suggests that the expertise and experience of stock analysts are less important for the value discovery process of functional IT investments but more important for the value discovery process of enterprise IT investments. Therefore, we posit that:

\[ H_2: \text{Analyst recommendations have a stronger (weaker) mediating role in the effects enterprise IT investments in ERP and CRM (functional IT investments in DSS, HR and AIS) on firm stock market value.} \]

The level of information asymmetry of a firm’s IT investments is not only affected by the nature of the IT investments but also the nature of the firm’s business environment. IT investments made by firms in uncertain environments are more likely to create information asymmetry. This is because payoffs to IT investments depend on a firm’s overall performance (Anderson et al. 2006). When a firm is facing uncertain market demand for its product and services, the payoff becomes more uncertain (Balasubramanian et al. 2000). This problem is further exacerbated by the high fixed cost nature of IT investments. As market uncertainty for product or service (Dai et al. 2007) is often beyond the control of a single firm (Beckman et al. 2004), greater uncertainties in demand increase the investors’ challenge of assessing the return and risk of the IT investments (Bailey et al. 2003). Stock analysts provide investors with valuable industry insights and their knowledge across multiple firms in the same industry enables them to provide better forecast in uncertain environments (Beckman et al. 2004; Koopmans 1957; Milliken 1987). Investors are thus more reliant upon stock analysts to assess the return to IT investments when the firm is in more uncertain environments (Chang and Gurbaxani 2012).

\[ H_3: \text{Analyst recommendations have a stronger (weaker) mediating effect for firms in a higher (lower) market environmental uncertainty.} \]

4. DATA AND MEASURES

To test the hypotheses, we collect data on IT investments, analyst recommendations, firm stock market value, and a set of control variables. We collected data from multiple sources, including the Harte-Hanks CI database, Institutional Brokers’ Estimate System (I/B/E/S), the Center for Research of Securities Prices (CRSP), and COMPUSTAT. After merging data from multiple sources and eliminating missing values, we had a total of 3,236 firm-year observations between 1995 and 2006.

**IT investment data.** We obtained IT investment data from Harte-Hanks CI database. Harte-Hanks conducts annual surveys of IT systems and IT assets of Fortune 1000 firms. The survey is conducted at the establishment level with over 500,000 establishments contacted. It covers ten key IT areas, including personal computing, systems and servers, networking, software, storage, managed services and others. The survey also contains detailed information about the vendor and type of every IT system used by the firm. Various versions of this database have been used in prior research in the IS literature (e.g. Chen and Forman (2006); Forman (2005); Xue et al. (2008); Zhu and Kraemer (2002)).
We use the Harte-Hanks data to obtain measures of IT investments for each firm. We estimate the total amount of IT investments for each firm based on the total number of PC, servers, and IT employees reported by each firm. We follow the approach used by Hitt and Brynjolfsson (1996) that estimates a firm’s IT investments as the sum of PC and server capital plus three times the IT labor costs. We obtain yearly PC prices from Gartner Dataquest Global PC Annual Forecast, and yearly server prices from IDC Worldwide Server Quarterly Tracker. We adjust the nominal prices to real prices using the Bureau of Economic Analysis (BEA) price index for Computers and Peripheral Equipment (Lee and Barua 1999). Industry-average labor compensation is obtained from occupational compensation data reported by the Bureau of Labor Statistics (BLS), deflated by the Index of Total Compensation Cost. In addition, we categorize IT systems into five types\(^1\): Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), Decision Support Systems (DSS), Human Resource Systems (HR) and Accounting Information Systems (AIS). For each type of IT systems, we count the number of business establishments of each firm that report using such systems and normalize the measure by the total number of business establishments surveyed by Harte Hanks within the firm. These ratios measure the percentages of business establishments that use a particular type of IT systems for a given firm and provide an indicator of the prevalence of the particular type of IT systems in the firm.

**Analyst stock recommendations.** Data for analyst stock recommendations are obtained from I/B/E/S. I/B/E/S provides comprehensive data on stock analysts’ recommendations on publicly traded firms, earnings forecasts, and other financial indicator of the firm (Womack 1996). Though relatively new to the IS discipline, I/B/E/S has been widely used in finance, marketing, and accounting fields (Bradshaw 2004; Firth et al. 2013; He et al. 2013; Luo et al. 2010). I/B/E/S has data for over 45,000 companies from 70 stock markets worldwide. Because a company is often covered by multiple stock analysts, and each analyst provides multiple recommendations for each company over time, we collected a total of 339,068 observations of analyst stock recommendations. I/B/E/S measures analyst recommendations as the median consensus of buy-hold-sell recommendations provided by analysts (Howe et al. 2009). As the raw data is in a reversed Likert scale (with 1 = strong buy, 2 = buy, 3 = hold, 4 = under-perform, and 5 = sell), we transformed this reverse coding for ease of exposition (so 5 = strong buy). Because multiple stock analysts cover the same company, we used the average of analyst stock recommendations for each firm-year observation.

**Firm stock market value.** We measure a firm’s stock market value using the abnormal returns of the firm over and beyond what is expected after adjusting for market wide risk factors (Brown and Kapadia 2007). We obtained stock price data from CRSP to derive firm abnormal returns. To measure expected return from the broad financial markets, we use the Fama-French-Carhart model (Carhart 1997; Fama and French 1993) at the firm level as follows:

\[
R_{it} - R_f = \beta_{0i} \hat{\beta}_1(R_{m} - R_f) + \beta_2 \text{SMB}_i + \beta_3 \text{HML}_i + \beta_4 \text{MOM}_i + \epsilon_{it},
\]

where \(R_{it}\) are returns for firm \(i\) on time \(t\), \(R_m\) are average market returns, \(R_f\) is the risk-free rate, \text{SMB} are size effects, \text{HML} are value effects, \text{MOM} are Carhart’s momentum effects, \(\beta_{0i}\) is the intercept, and \(\epsilon_{it}\) is the model residual. We then calculate abnormal returns (\(\text{ASR}_{it}\)) as the difference between the observed returns and the expected returns (with an estimation window of 360 days, Luo et al. 2013):

\[
\text{ASR}_{it} = (R_{it} - R_f) - \left[\hat{\beta}_{0i} \hat{\beta}_1(R_{m} - R_f) + \hat{\beta}_2 \text{SMB}_i + \hat{\beta}_3 \text{HML}_i + \hat{\beta}_4 \text{MOM}_i\right].
\]

Data for Fama–French–Carhart factors and momentum (\(R_{m}, R_f, \text{MKT}, \text{SMB}, \text{HML}, \text{and MOM}\) are obtained from [http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html](http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html).

**Other variables.** To rule out alternative explanations and robustly identify the hypothesized effects, we include a comprehensive set of firm-, analyst- and industry-level control variables. We follow the

\(^1\) Our discussion with Harte-Hanks indicates that, during our study period, Harte-Hanks did not distinguish SCM systems from ERP systems.
widely used models of financial analyst metrics (He et al. 2013; Jegadeesh et al. 2004) and firm stock value in the extant finance and accounting literature (Firth et al. 2013; Lui et al. 2007) in our selection of control variables. This allows us to calibrate the extent to which IT investments contribute new information in explaining analyst stock recommendations and the mediating role of analyst stock recommendations in channeling the effects of IT investments on firm stock market value. They are: Firm profitability (ROA), measured as the ratio of a firm’s operating income (from Compustat) to its book value of total assets; ROA variability, measured as the standard deviation of the prior five years of ROA; R&D intensity, measured as research and development expenses divided by sales; New product announcements, measured as the number of new products introduced by a firm and collected from the Lexis/Nexis news search; Firm size, measured as the total assets of a firm; Advertising intensity, measured as the firm’s advertising expenses divided by sales; Firm financial leverage, measured as the ratio of long-term debt to total assets; Firm dividend, the ratio of cash dividends to firm market capitalization; Firm liquidity, the current ratio of a firm. Compared to fixed assets; Analysts’ earnings forecast errors, gauged as the differences (in absolute values) between the latest analysts’ median consensus forecasts (MEDEST) before the earnings announcements and the firms’ actual earnings per share scaled by stock prices; Analyst coverage, measured as the number (in natural log) of stock analysts following or covering a firm; Analyst expertise, measured as the averaged firm-specific experience of the financial analysts; Institutional ownership, obtained from the Thompson Financial CDA Spectrum database of SEC 13F filings; Industry competition, measured as the inverse of the Herfindahl concentration index; and Environmental uncertainty, measured as the variation of industry sales in the product market.

5. ANALYSES AND RESULTS

We use panel data models to control for a number of biases. Specially, to account for observable heterogeneity, we have controlled for multi-level (firm-, analyst-, and industry-level) covariates. In addition, to accommodate firm-specific unobservable heterogeneity, endogeneity, heteroskedasticity, and serial correlation in panel data, we employ the generalized method of moments (GMM) for estimations.

Endogeneity may exist in that firms with more favorable analyst recommendations and higher stock market value can afford more IT investments. To account for this endogeneity bias, we use instrumental variables approach. Specifically, we use the lagged industry average IT investment after excluding the firm (following the BLP approach to dealing with endogeneity). In addition, we use firm age, which is exogenous to our modeling system in hypothesis testing, as another instrumental variable. Firm age can be a desirable instrumental variable because firm age can be correlated with IT investments (because younger firms tend to have more up-to-date IT infrastructures and IT applications) but not correlated with error terms or firm stock market value (because old or young firms both can over-or under-perform relative to the general stock market). To test the validity of these instruments, we conducted the Hansen (1982) test. GMM also employs the White heteroskedasticity and autocorrelation robust covariance matrix \( \Phi_{HAC} \):

\[
(4) \quad \Phi_{HAC} = \hat{\Gamma}(0) + \left( \sum_{j=1}^{T-1} k_{j} q_{j}(\hat{\Gamma}(j) + \hat{\Gamma}')(j) \right), \quad \hat{\Gamma}(j) = \frac{1}{T-k} \sum_{t=j+1}^{T} Z_{t-j} \epsilon_{t} \epsilon_{t-j}' Z_{t},
\]

where \( \epsilon \) = the vector of White residuals, \( k \) = the kernel, \( q \) = the bandwidth, and \( Z \) = a \( k \times p \) matrix in GMM (see (Hamilton 1994): 409-22).

In addition, to test the reverse causality direction from analyst recommendations to IT investments, we conducted the Granger causality test (Granger 1969). The results confirmed the direction of influence
from IT investment to analyst recommendations across both total IT investment and all specific IT investment dimensions (smallest $F_{Granger}$ test = 12.371, $p < 0.01$), except AIS. Furthermore, we tested various model assumptions of normal distribution, auto-correlation, and heteroskedasticity of error terms with the Jarque-Bera test, the RESET test, the Durbin-Watson and White’s test, the Davidson-MacKinnon test, and the Breusch-Pagan test. None of the assumptions are violated in the results. Finally, the multicollinearity problem is not a serious threat because all variance inflation factor results are less than five and the condition indices are less than ten in our results.

5.1. Models Testing Moderated Mediation

Statistical testing a moderated mediation relationship requires a system of equations. Specifically, we follow the widely accepted approach suggested by Muller et al. (2005), using the following regression equations to test the moderated mediation effect. In the equations below, $IT_{it}$ refers to IT investment (total or specific IT dimension) for firm $i$ at time $t$, $Recom_{it}$ refers to the mediator variable of analyst stock recommendations for firm $i$ at time $t$, $Value_{it+1}$ refers to the abnormal return of firm $i$ in the next time period $t$, and $Uncertainty_{it}$ refers to the moderating variable of market uncertainty.

(5) $Value_{it+1} = \beta_{10} + \beta_{11}IT_{it} + \beta_{12}Uncertainty_{it} + \beta_{13}IT_{it} * Uncertainty_{it} + \beta_{14}Control_{it} + \epsilon_{1it+1}$

Equation (5) models how environmental uncertainty moderates the effects of IT on firm stock market value.

(6) $Recom_{it+1} = \beta_{20} + \beta_{21}IT_{it} + \beta_{22}Uncertainty_{it} + \beta_{23}IT_{it} * Uncertainty_{it} + \beta_{24}Control_{it} + \epsilon_{2it+1}$

Equation (6) assesses how environmental uncertainty moderates the effect of IT on the mediator of analyst recommendations.

(7) $Value_{it+1} = \beta_{30} + \beta_{31}IT_{it} + \beta_{32}Uncertainty_{it} + \beta_{33}IT_{it} * Uncertainty_{it} + \beta_{34}Recom_{it+1} + \beta_{35}Recom_{it+1} * Uncertainty_{it+1} + \beta_{36}Control_{it} + \epsilon_{3it+1}$

Equation (7) assesses the degree to which environmental uncertainty moderates both the effect of analyst recommendations on firm stock market value and the residual effects of IT on firm stock market value after controlling for the direct effect of analyst recommendations. Muller et al. (2005) suggest that in order to establish moderated mediation, three conditions must be satisfied. First, there should be a significant effect of IT on firm stock market value ($\beta_{31} \neq 0$). Second, the effects of IT on the stock analyst recommendations should vary significantly with environmental uncertainty ($\beta_{32} \neq 0$), and/or the effects of the stock analyst recommendation on the firm stock market value shall vary significantly environmental uncertainty ($\beta_{33} \neq 0$). Finally, the residual effect of IT on firm stock market value shall be significant ($\beta_{31} \neq 0$), and controlling for the mediator, is moderated ($\beta_{33} \neq 0$). That is, the mediational role of analyst recommendation is moderated significantly (Rucker et al. 2011; Zhao et al. 2010).

5.2. Results for Analyst Recommendations as a Mediator between IT and Firm Stock Market Value

In $H_1$, we expect that analyst recommendations mediate the associations between IT and firm stock market value, i.e., IT→analyst stock recommendations→firm value chain. Following Baron and Kenny (1986) and Zhao et al. (2010), in order to establish mediation, 1) IT must affect analyst recommendations, 2) recommendations must affect firm value and 3) the inclusion of the mediation variable (i.e. analyst recommendation) reduces the strength of the effect of IT on market value. We first presented the baseline model (Model 1) without IT capital in Table 1. In Model 2, IT is included, and the coefficient is positive and highly significant ($p < 0.01$). Models 4 and 5 are used to test whether analyst recommendations mediate the effects of IT in a firm's market value. Model 5 results indicate that analyst recommendations significantly affect firm stock market value ($p < 0.05$). Further, including stock recommendations as a mediator in model reduces the strength of the effects of IT on stock market value (from $p < 0.05$ to $p < 0.10$). Collectively, the results suggest a significant mediating relationship.
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<td>.031**</td>
<td>.025**</td>
<td>.172****</td>
<td>.178***</td>
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<td>New product</td>
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<td>.003</td>
<td>.002</td>
<td>.625**</td>
<td>.633*</td>
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<td>announcements</td>
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<td>Advertising</td>
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<td>.029**</td>
<td>.027**</td>
<td>.191***</td>
<td>.195***</td>
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<tr>
<td>intensity</td>
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<tr>
<td>Firm size</td>
<td>.136**</td>
<td>.135**</td>
<td>.186**</td>
<td>.335**</td>
<td>.316**</td>
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<tr>
<td>ROA</td>
<td>2.055****</td>
<td>2.067****</td>
<td>2.219****</td>
<td>2.036****</td>
<td>2.161****</td>
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<td>ROA variability</td>
<td>-.0121</td>
<td>-.0126</td>
<td>-.0175</td>
<td>-.1808**</td>
<td>-.163**</td>
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<td>Financial leverage</td>
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<td>-.0004</td>
<td>-.0005</td>
<td>.006</td>
<td>.003</td>
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<tr>
<td>Dividend</td>
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<td>.519</td>
<td>.536</td>
<td>.152</td>
<td>.155</td>
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<tr>
<td>Liquidity</td>
<td>.024</td>
<td>.022</td>
<td>.025</td>
<td>.355*</td>
<td>.387*</td>
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<tr>
<td>Analyst coverage</td>
<td>1.932**</td>
<td>1.917**</td>
<td>1.883**</td>
<td>.468**</td>
<td>.472**</td>
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<td>Analyst forecast</td>
<td>-.0633**</td>
<td>-.0615**</td>
<td>-.713**</td>
<td>-.051</td>
<td>-.053</td>
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<td>errors</td>
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<tr>
<td>Analyst expertise</td>
<td>.512*</td>
<td>.509*</td>
<td>.615*</td>
<td>.237*</td>
<td>.245**</td>
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<tr>
<td>Institutional</td>
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<td>1.682**</td>
<td>1.557**</td>
<td>2.017**</td>
<td>2.152**</td>
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<td>ownership</td>
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<td>Industry competition</td>
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<td>-.072</td>
<td>-.073</td>
<td>-.352**</td>
<td>-.319**</td>
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<tr>
<td>R-squared</td>
<td>0.18</td>
<td>0.24</td>
<td>0.28</td>
<td>0.17</td>
<td>0.22</td>
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<tr>
<td>Change in R-squared</td>
<td>0.06***</td>
<td>0.04***</td>
<td>0.05</td>
<td>0.05**</td>
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<tr>
<td>F-statistic</td>
<td>38.089</td>
<td>56.797</td>
<td>69.783</td>
<td>18.845</td>
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<tr>
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Table 1: Results for CSP, Analyst Recommendations, and Firm Future Returns Note: * p < 0.10, p < 0.05, *** p < 0.01.

We conducted the Sobel test extended by the bootstrapping approach in order to assess whether the indirect mediation effects are statistically significant (Sobel 1982). The Sobel test model is:

\[ z_{value} = \frac{ab \sqrt{s_a^2 + s_b^2} + s_a^2 s_b^2}{s_{ab}} \]

where \( a \) and \( s_a \) are coefficients and standard errors (from the bootstrapping) for the impact of independent variables on mediators, while \( b \) and \( s_b \) are coefficients and standard errors for the impact of mediators on the dependent variable. We find that Sobel test results are significant (\( z_{value} = 6.029, p < 0.01 \)) for the mediation effects of analyst recommendations, supporting H1.

5.3. Results on the Moderating Effect on the Mediating Role of Analyst Recommendations

H2 predicts that analyst recommendations have a stronger mediating effect on the stock market value of firms with significant enterprise IT investments (ERP and CRM) than those with significant functional IT investment (DSS, HR and AIS). Table 2 Panel A reports the results. The results show that enterprise IT investments (ERP and CRM) significantly affect analyst recommendations (\( p < 0.01 \)) and analyst recommendations significantly influence stock market value. Further, including the mediator of recommendations in the model reduces the strength of the effects of ERP and CRM-based IT investments on stock market value. Sobel test again shows that the mediation effects are significant (\( z_{value} = 8.386 \) for
ERP and 9.108 for CRM, p < 0.01), suggesting that analyst recommendations play a significant mediation role in channeling the effects of enterprise IT investments (CRM and ERP) on firm stock market value.

<table>
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<tbody>
<tr>
<td>IT</td>
<td>.565***</td>
<td>.538***</td>
<td>1.806**</td>
<td>.956*</td>
<td>.525***</td>
<td>.542***</td>
<td>1.952**</td>
<td>.903*</td>
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<tr>
<td>IT x Market environmental uncertainty</td>
<td>--</td>
<td>.267**</td>
<td>.725**</td>
<td>.442*</td>
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<td>.277**</td>
<td>.715**</td>
<td>.451*</td>
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**Mediation Effects**

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<tbody>
<tr>
<td>IT</td>
<td>.408**</td>
<td>n.s.</td>
<td>n.s.</td>
<td>.318**</td>
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<td>IT x Market environmental uncertainty</td>
<td>.130*</td>
<td>n.s.</td>
<td>n.s.</td>
<td>.105*</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

**Mediation Effects**

In contrast, the effects of functional IT investment (DSS, HR and AIS) were not significant on firm stock market value (p > .10) for all three types of IT systems, failing to meet the conditions for the mediating effects. These findings support H2, suggesting that the analyst recommendations play a significant mediating role for enterprise IT investments (ERP and CRM) but not for functional IT investment (DSS, HR and AIS). We also tested the mediating models with all five IT investments simultaneously (ERP, CRM, DSS, HR, and AIS in the same models) and found consistent evidence for the meditational role of analyst recommendations for enterprise IT investments but not functional IT investments.

H3 suggests that the mediating role of analyst recommendations in linking IT investments to firm stock market value would be stronger in industries with higher environment uncertainty. To test this moderated mediation hypothesis, we use equations 5-7 (Muller et al. 2005). Specifically, Table 1 Column M3 shows that environmental uncertainty significantly moderates the effect of IT investments on analyst recommendations (p < 0.05 in M3). Column M5 indicates that environmental uncertainty significantly moderates the effect of analyst recommendations on firm stock market value (p < 0.05 in M5). After
controlling for the mediator of analyst recommendations, the residual effect of IT on firm value is positively and significantly moderated by environment uncertainty ($p < 0.05$). Because both moderating effects are positive, the mediating role of analyst recommendations between IT and stock market value is stronger for firms facing higher environment uncertainty, thus supporting $H_3$.

5.4. **Robustness of the Results**

We also conducted alternative measures of analyst stock recommendations by using upgrade recommendations; employed different empirical models including fixed effects model (to rule out alternative explanations due to firm-specific effects), random effects model (to rule out alternative explanations due to firm-related random shocks), and bootstrapping methods for estimations (to rule out alternative explanations due to unstable estimates); specified a hierarchical linear model (HLM) to captures the potential heterogeneous industry-specific effects of IT investments; used instrumental variables (IT investment of other firms in the industry except the focal firm) and control firm-level variables to reduced endogeneity concerns; employed different measures of IT investment; tested the lags in responses to IT timing; and conducted a falsification test to check the results. All results provide consistent support for our hypotheses. Due to space limited, we don’t present details here.

6. **CONCLUSIONS AND DISCUSSIONS**

This research explores the value discovery role of stock analysts in facilitating the financial market’s assessment of firms’ IT investments. Using twelve-year longitudinal data of IT investments, financial performance, and analyst recommendations of Fortune 1000 firms, we find that analyst recommendations play an important mediating role in linking a firm’s IT investments to its stock market value. Furthermore, our analysis suggests that the mediating role is more significant for investments in enterprise IT systems, and more salient for firms in uncertain environments.

The theoretical implications of this study are multifold. First, research to date on IT value has largely overlooked the value discovery role of stock analysts. This study bridges the research gap and demonstrates how analyst recommendations help financial markets evaluate firm IT investments. We provide a new perspective that enriches the literature on the value creation process of IT investments. Extant research on IT value takes an internal process-oriented view, focusing on identifying internal capability factors that generate value from IT investments. This study takes an external process-oriented view, focusing on how IT investments is understood and evaluated by the financial market. By examining the mediating effect of stock analysts between IT investment and firm stock market value, we showed that the value creation of IT investment is not an independent process inside the firm. Rather, it is intertwined with the active engagement of stock analysts who interpret and assess firms’ IT investments for the financial market. As such, our study broadens the scope of IT business value research by highlighting the importance of understanding the external value discovery process in the evaluation of IT investments. To the best of our knowledge, it is the first study that assesses the mediating role of stock analysts in market evaluation of IT investments.

Second, this study further highlights the “general purpose” nature of IT and its implications on the market evaluation of IT investments. Our finding suggests that, because IT is a “general purpose” technology, its evaluation requires an in-depth understanding of firms’ internal operation, business strategies, and complementary organizational resources. As such, different types of IT investments affect the market evaluation of IT investments differently, depending on the complexity of the IT investments and firms’ ability to make complementary investments. Our analysis suggests that investments in enterprise IT, which are more intangible and strategic, benefit more through the mediating role of analysts’ recommendation than functional IT. One plausible explanation is that due to the intangible and long-term nature of the business value of enterprise IT, the market relies more heavily on stock analysts who have the expertise and information to assess firms’ business strategy, internal operations and complementary resources in extracting the value from enterprise IT investments. Similarly, the market relies more
heavily on stock analysts when firms make IT investments in more complex and uncertain market environments.

Third, this study provides a new explanation on variations in the market valuation of IT investments. Our finding suggests that analyst recommendations could be a key factor that affects the market valuation of IT investments. The amount of coverage a firm receives from financial analysts and their capability in understanding and evaluating a firm’s IT investments affect the market evaluation of firms’ IT investments. This finding has important implications for research that use market valuation to assess the business value of IT. Our finding suggests that the financial market may not fully recognize the value of a firm’s IT investments especially for investments in enterprise IT systems and for firms in uncertain environments (situations in which the mediational role of analyst recommendations is much more needed so as to assess and interpret the uncertain business value of IT investments).

References


