Information Technology Investment and Firm Performance: A Meta-Analysis

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Abstract

In the recent past, researchers have shown conflicting results regarding the returns to IT investment. Some researchers posit that the equivocal results of IT investment are due to inconsistent measurement of firm performance following IT investment. We propose to use meta-analysis to summarize and synthesize the patterns of relatively consistent relations from empirical studies of IT investment returns during the last decade.

1. Introduction

The payoff from information technology (IT) investment has been studied by academic researchers, economists, and business practitioners in recent years. However, research findings about the impact of IT on firm performance have shown conflicting results across studies. Early empirical studies found that there was either no relationship, or a slightly negative relationship, between firm performance and IT investments [29], [21], [14], [36], [32]. However, in the late 1990s, several studies indicated a positive relation between IT investments and firm performance, such as productivity or profitability [2], [8], [16], [17], [18], [30], [42], [43].

In this paper, we address these seemingly conflicting results by the use of meta-analysis to assess the impact of information technology investment on firm performance. The putatively conflicting results in empirical studies may be an artifact of the data due to statistical variation rather than actual conflicting results [25]. Meta-analysis statistically examines the results of existing studies to extract patterns of relatively consistent relations and causalities that conduct general principles and synthesize the results of the past years of research [24]. Using these systematic quantitative techniques for integrating findings, meta-analysis (refer to “analysis of analyses,” [24] obtains statistical power by pooling across many small-sample studies without requiring data from the original studies. The primary purpose of this paper is to investigate the value from information technology, and to determine whether it is possible to detect payoffs from investment in IT. It is important to understand under what conditions individuals can expect to find a measurable return from IT investment. With these thoughts in mind, the following research steps are undertaken.

2. Productivity Paradox of IT Investment

The productivity paradox phrase was coined when large investments in information technology (IT) apparently failed to produce significant increases in productivity on two levels. The first is at the industry or economy-wide level. This was summed up in 1987 by Noble Prize winning economist Robert Solow, who wrote, “We see the computer age everywhere except in the productivity statistics, (as quoted in [18]).” The second Productivity Paradox was observed at the company level, where “there was no correlation whatsoever between expenditures for information technologies and any known measure of profitability” [45]. In this paper, we address the apparent productivity paradox at the individual company level. Some believe that this productivity paradox came about simply due to measurement issues and research methods. For example, Brynjolfsson [15] questions the appropriateness of research methodologies used, the reliability and validity of datasets, and the measurement of IT investment research benefits. The equivocal results of IT investment, in many cases, could be caused by the inconsistency in IT firm performance measurement issues [48]. For example, many early studies examined correlation between IT spending ratios and various performance measurements, such as profits or stock returns [7], [35]. Since the correlation was either zero or very low, some concluded that computer investment has been unproductive. However, spending more on computers should not, on average, be expected to generate higher profitability or stock market returns. Zero correlation should be interpreted as indicating “normal” ratios to investments in IT [18].
There are other possible explanations for the inconsistent effects of IT investment on firm performance. First, the nature of the IT expenditures studied by researchers has changed over time. Rai et al. [4] noted that there has been no uniform conceptualization of IT investment or identification of appropriate performance measures. Second, the nature of the economic environment and regulations has changed over time. For example, any increase in product variety and quality should properly be measured as part of the value of IT outputs, but almost never is. In addition, the price deflators that the government currently uses to remove the effects of inflation likely mask the benefits of IT [18]. Since real output is estimated by multiplying a nominal output by the price deflator, inflation could be overestimated, and real output underestimated by an equivalent amount. Third, when new IT has been introduced, early payoffs may not be representative of the long-term value of IT due to a period of learning or adjustment, and restructuring of the organization environment. IT studies have been characterized by mis-measurement of a variety of dependent variables and lags. All of these issues leave the question of the productivity of IT investments open to continuing debate.

Initially, this study briefly reviews the meta-analysis studies in the IT payoff literature and provides a theory-driven rationale to investigate variables that might moderate the relationship between IT investment and firm performance. Specifically, the paper draws upon recent studies in the following sections. This study proposes a framework (Figure 1), which addresses the general question, “Can differences in firm performance be explained by IT investment?”

2.1 A Framework for the IT Payoff Analysis

This study focuses on IT payoff studies, which employ the explanatory variables based on IT spending, including total IT investment and IT staff expenditures. The most commonly used financial performance measures of the returns to IT investment are either based on the stock market valuation or on accounting performance [5]. Therefore, we particularly focus on two common financial approaches, (1) market measures and (2) accounting measures, and look at how the potential value of an IT investment turns into a realized payoff for the firm.

This study also examines the contextual factors that likely influence the relation between IT investment and firm performance, such as industry type, and firm size. Additionally, this study investigates two sub-periods over which prior studies tended to find differing results in the period of 1990- to 2002. Findings are compared with the concept of the productivity paradox, which was popularly discussed in the early 1990s and seemed to disappear in the late 1990s.

![Figure 1. Framework for Evaluating IT investment on Firm Performance](image)

2.2 Hypotheses

Over the last number of years, the accrued benefits to IT investment has been the subject of continuous debate by information system researchers and practitioners. Some studies in the 1990s [29], [21], [14], [36] indicate a negative or no relation between IT and productivity. These findings support the productivity paradox since there is a failure of IT to produce significant increases in productivity despite large IT costs incurred by organizations when they adopt IT. However, more recent studies show that there are positive payoffs from IT and have changed their position from “is there any payoff?” to “when and why is there a payoff?” Results of these later IT investment studies show a positive relation between IT investment and firm performance [2], [16], [17], [18], [40], [30]. Given the evidence that the relationship has changed over time, we propose hypotheses about the relationship between IT investment and firm performance. We believe that the productivity paradox primarily due to measurement and methodology issues but that firms continue to invest in information technology because there is a positive relationship between IT and firm performance. Otherwise, firms would cease to make these investments. This leads to our first hypothesis about the relationship between IT investment and firm performance and if that has changed over time:

**Hypothesis 1:** There is a positive relation between IT investment and firm performance.

The first information technology investments were made to automate business processes. This resulted in a costly investment in information technology that may not have been any more productive than the human labor that it replaced. As time has gone on, firms have increasingly used IT investments to provide critical decision-making information to managers and empowered the line workers with the information they needed to more efficiently complete their work.
addition, many firms have found that IT can transform their businesses as time goes on. Dehning et al. [6] provide evidence that 1) firms increasingly move in a path dependent fashion from IT investments that automate their business processes to investments that transform their businesses in the more recent time periods and 2) that there are greater returns to firms that make transformational investments than firms that do not. Given this evidence, we propose the following hypothesis:

**Hypothesis 2:** The relation between IT investment and firm performance differs between an early period (1990 – 1995) and a more recent period (1996-2001).

Previous studies have examined firm performance based on various types of IT measurements, focusing on where potential value lies and how best to contextually measure the firm’s realized value from IT. The most commonly used IT investment measurements are measures of financial performance [1]. Thus, this study particularly focuses on two common financial approaches, (1) market measures and (2) accounting measures to investigate how the potential value of an IT investment turns into realized payoffs for the firm. Market measurement studies assess firm performance using event studies (short-window abnormal stock returns) [7], [26], [30], [28], [8], [13] market valuation of common equity [2], [20], [42] and Tobin’s q [2]. Accounting measurements studies assess firm performance using ratios such as ROA [46], [30], [28], [44], [47], ROE [34], [30], [28], [4], and ROS [28], [3]. Given the wide variety of performance measures, this study creates a clarification scheme to capture whether each study used market measures or accounting measures, or both, as dependent variables. Thus, the purpose of the following hypothesis is to evaluate whether IT payoff varies based on the type of dependent measure used.

**Hypothesis 3:** Studies employing different measurements of IT performance yield different results regarding the effect of IT investment.

**Hypothesis 3.1:** Studies employing market measurements of IT performance yield different results regarding the effect of IT investment.

**Hypothesis 3.2:** Studies employing accounting measurements of IT performance yield different results regarding the effect of IT investment.

A variety of contextual factors may help explain the relationship between IT investment and firm performance, such as industry type and firm size. Although some studies [44] have not controlled for industry, other studies have shown that the results of IT investment differ across industries [8]. In the early 1980s, industry appeared to have a profound effect on results. More information-intensive industries, such as finance or service companies, exhibited a greater effect of IT on firm performance than less information-intensive industries, such as manufacturing [41], [23], [8]. Thus, we hypothesize the following:

**Hypothesis 4:** Information-intensive industries have positive returns to IT investment than non-information-intensive industries.

Extant research shows that the size of firms influences the market reactions to IT investment [37], [19], [12]. Since stock market participants tend to know more about large versus small firms, the incremental value of their IT investment announcements is expected to be lower than for small firms. Thus, the information content (market reaction) to small firm announcements seems to be greater than large firm announcements. Small firms are likely to be more risky and to experience losses more frequently compared to large firms. Small firms have greater variability in liquidity and solvency measures [9]. Some studies still indicate an uncertainty whether the market reacts positively or negatively to small firm IT investment announcement [37], [19], [12]. Securities for the smaller size of firms are traded at lower prices and the volatility of stock price for smaller firms is commonly much greater than that for the larger size of firms [39], [33]. Some studies present that this size effect presents difficulties in combining smaller and larger firms in event studies, rather serves as a surrogate for the amount of predisclosure information [8], [31], [11]. In fact, compared to larger firms, smaller firms are less easily exposed to the market, or larger firms’ IT investments may be buried by other noisy accounting factors. Thus, this study hypothesizes a relationship based on size.

**Hypothesis 5:** Smaller firms will have positive returns to IT investment than larger firms.

3. Methods

3.1 Selection of Studies

To form our sample of studies examining the returns to IT investment, a computer search was conducted on 7 databases. In addition, manual and electronic searches from 1990 to 2002 were made through major IS journals, including Journal of Management Information System (JMIS), Information System Research (ISR), Management Information System Quarterly (MISQ), Communication of ACM

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1 7 databases were used in this study: ABI/Inform, Academic Universe, ArticleFirst, Business & Company Resource Center, Expanded Academic ASAP, Lexis_Nexis Academic, Net Library.
This study also captures a wider review of publications, such as psychology, management journals, conference proceedings and previous literature reviews as references. We note that this paper focuses only on published IS refereed papers, including journal articles and conference papers, but excludes dissertations and working papers. Articles were classified as “related empirical” articles if their titles, abstracts and key words emphasized IT investment, payoffs, firm performance, productivity, computers/Information systems, returns, revenue growth, market valuation, IT stock, IT announcement, IT expenditure or spending IT measures or evaluation.

3.2 Meta-Analysis Procedure

Procedures used in meta-analysis allow quantitative review and syntheses of studies examining similar research questions. One advantage of meta-analytic procedures is to integrate results from existing studies to reveal patterns of relatively invariant underlying relations and causalities; the constitution of which assimilates general principles and cumulative knowledge [49]. For example, the analysis of a large body of IT investment literature using meta-analytic statistical methods can allow researchers to reach stronger conclusions, particularly when there are inconsistent results across prior studies. In addition, the meta-analytic procedure allows one to use a test of a generalizability hypothesis and a situational specificity hypothesis [27], and provides guidelines for future research [25]. Consistent with the process recommended by Hunter et al. [25], this meta-analysis consists of the following steps:

1. Development of a framework and factors that contribute to explaining IT payoff
2. Selection of studies to be included in the analysis
3. Documentation and statistical meta-analysis
4. Findings from the statistical procedures, and directions for future research.

Meta-analysis represents the quantitative summary of individual study findings across the entire body of research. The first analytical step of this study was to compute the index of correlation magnitude between IT investment and firm performance. Following the common practice in meta-analytical procedure [25], [25], this study measures an estimate of population correlation p by using Pearson’s correlation coefficient r. However, if particular studies did not provide an estimation of r, computational adjustments [38] were used to convert different statistics to correlation estimate r.

According to Hunter et al [24], if significance testing for homogeneity assumption is not performed, the best explicit way is either to average the correlation estimates or to include all correlation estimates as if they were obtained from different studies. Thus, for the estimation of the various source of variance, this study followed the argument, provided by Hunter et al. [24], to measure an average in which each correlation is weighted by the size of the sample from which the correlation was obtained. Based on Hunter et al [24], the estimate of the population correlation is given by

\[ R = \frac{\sum [N_i r_i]}{\sum N_i} \]

where:
\[ R = \text{weighted average estimate of the population correlation.} \]
\[ r_i = \text{observed correlation from sample } i, \text{ where } i \text{ may refer to a study or a subgroup from within a study.} \]
\[ N_i = \text{the number of individuals in sample } i \]
\[ \sum N_i = \text{sum of all individuals in all samples for the set of results included in the analysis.} \]

This study, therefore, examines the primary hypothesis whether this weighted average correlation between IT investment and firm performance is significantly positive.

Next, this study estimates whether the contextual factors such as the different level of information intensity vary systematically across studies as a function of specific moderators. In such cases, this study aims to account for sources of artifactual variance, such as sampling error, differences in range restriction of variables, differences in the reliabilities of measures for study variables, clerical errors, contaminations of criteria variables, and mistakes in analysis [27]. According to Hunter et al [24], an estimate of error due to sampling is given by

\[ \sigma_e = \frac{(1-R^2)^2 K}{\sum N_i} \]

where:
\[ \sigma_e = \text{estimate of sampling error.} \]
\[ R^2 = \text{weighted average estimate of population correlation.} \]
\[ \sum N_i = \text{sum of individuals in all samples for the set of results included in the analysis.} \]
\[ K = \text{the number of results included in the analysis.} \]

Sampling error across studies behave exactly the same as measurement error across individuals [24]. This study estimated sampling errors by increasing sample size.

According to Hunter et al [24], the observed variance of the individual correlations around the whole population correlation is computed using a weighted sum of squares formula to obtain an estimate of the true variance. The formula for the weighted sum of squares is:
\[ S^2_r = \frac{\sum N_i (r_i - R)^2}{\sum N_i} \]

where:

- \( S^2_r \) = frequency weighted average squared error.
- \( N_i \) = the number of individuals in sample \( i \).
- \( r_i \) = observed correlation for sample \( i \).
- \( R \) = weighted average estimate of the population correlation.

4. Results

The studies used in the meta-analysis are represented in Table 1. This study includes 15 published studies and sample sizes range from 76 to 624. A total of 3,883 subjects were used in all the studies combined at an average of 258.87 per study without double counting for repeated measures. Most studies had samples greater than (or close to) 100. Table 1 summarizes results of different studies and the code for a range of possible moderator variables. Each study that met the selection criteria was coded for two primary moderators such as financial measures (eg. market and accounting measurements) on the basis of the conceptual criteria outlined in the hypotheses. Table 1 includes results concerning whether there is a positive relationship between IT investment and firm performance. Figure 2 represents IT payoff between an early (1990-1994) and a more recent period (1995-2002) along with the concept of “productivity paradox.”

Table 2 shows that IT payoff varied depending upon the type of dependent financial measures employed. In addition, this study examines contextual moderators and their specific categories that were: type of industry (IT-intensive industry, such as finance or service; non-IT-intensive industry, such as manufacturing), and the size of the firm (large vs. small size of the firms). Thus, table 2 presents results on returns of IT investment with financial measure across two different types of industries. As a consequence, results of the section are divided into two subsections, each examining the type of industry in order to provide more homogeneous subgroups in tests for possible moderator effects. Table 2 presents results on returns of IT investment with financial measure based on the size of each firm. The following results of the section are divided into two subsections, each examining the size of firm in order to provide more homogeneous subgroups in tests for possible moderator effects.

4.1 Results of Hypothesis Testing

Several potential sources of artifactual variance have been identified, such as sampling error, differences in range restriction of variables, differences in the reliabilities of measures for study variables, clerical errors, contaminations of criteria variables, and mistakes in analysis as noted previously. Hence, the easiest to estimate from published studies are sampling error, error due to unreliability of predictor measures and range restriction. Since sampling error is a function of sample size, it can be estimated as long as studies report sample sizes. Estimation of the error due to unreliability and range restriction requires that either the reliability coefficients and ranges be reported for measures used in individual studies or that they be imputed from some assumed distribution for the set of results to be cumulated. For this present set of studies there were no reported reliability or range restriction statistics; therefore, we estimated only sampling error, which typically has been the major source of error in meta-analysis. Thus, this study followed the 75% error variance rule [25], which means if more than 75% of the observed variance can be attributed to methodological artifacts, then the assumption that all results come from the same population is warranted.

**Hypothesis 1: Supported**
In Table 1, the first two columns include the analyses of the 15 results for returns of IT investment with market measure. Based on the sample weighted mean correlation, \( r \), across these studies is 0.275, which is significant at the 0.05 level. By following the 75% error variance rule [25], approximately, seventy five percent of the observed variance in returns of IT investment with financial measures could be explained by sampling error. Therefore, H1 is barely supported for a positive relation between IT investment and firm performance over the time period represented by this sample.

**Hypothesis 2: Partially Supported**
The increased interest in the productivity paradox since 1970 has engendered a significant amount of research, but so far, this has not been fully explained. The frequencies of studies included in this meta-analysis indicated that over 40% (six out of fifteen) of studies reported in this paper were published in major IS journals between 1993 and 1997. After peaking in 1997, our meta-analysis shows that firm-level studies and the number of observations dropped in the late 1990’s, whereas, IT payoff studies appear to be on the rise in the year 2000 (Figure 2). The result of hypothesis 2 indicates that positive and negative payoff outcomes reported by studies in our meta-analysis dropped between 1993 and 1997, after which they are on the rise. This graph is superimposed and can be interpreted in the context of the period during which the productivity paradox was popularly discussed in early to mid-90s and eventually disappeared in late 90’s to current.
Hypothesis 3: Supported

The results of each study show that the strategic and economic measures, as a group, are significantly related to IT investment measures. In particular, Table 2 summarizes for returns of IT investment with financial measures. The reason for this significant relationship is explained by the fact that correlation considers consistent function of moderator effects. As such the results provide the effect of IT investment market measures on firm performance and this effect is usually stronger and more significant than the individual effects in the meta-analysis. Table 2 includes the analysis of the 7 results for returns of IT investment with market measure. Based on the sample weighted mean correlation, r, across these studies is 0.075, which is significant at the 0.05 level. Approximately, seventy five percent of the observed variance in returns of IT investment with market measure could be explained by sampling error. However, the analysis of the 8 results for returns of IT investment with account measure. Based on the sample weighted mean correlation, r, across these studies is 0.454, which is significant at the 0.05 level. Approximately, twenty three percent of the observed variance in returns of IT investment with accounting measure could be explained by sampling error. Therefore, H3 is partially supported for a positive relation between IT investment with market measurements and firm performance.

Hypothesis 4: Partially Supported

Table 2 contains the analysis of the 13 results for returns of IT investment across two different types of industries (information-intensive vs. non-information-intensive industry). The sample weighted mean r across studies, which were examined for returns of IT investment across two industries is 0.218, with a 0.05 level of significance; thus, barely 75.7 percent of the observed variance in returns of IT investment across two types of industry together could be explained by sampling error.

By providing more homogeneous subgroups in test for possible moderator effects, this study divided into two subsections (eg., information-intensive industry and non-information-intensive industry) examining type of industry as noted in Table 2. The sample weighted mean r across non information-intensive industry is 0.222 significant at the 0.05 level, whereas the sample weighted mean r across information-intensive industry is 0.213 significant at the 0.05 level. In fact, 89.4 percent of the observed variance in returns of IT investment across information intensive industry could be explained by sampling error in spite of only 62.1 percent of the observed variance for returns of IT investment across non information-intensive industry. Even if H4 is not supported, and information-intensive industry has statistically more positive IT payoffs than non information-intensive industry.

Hypothesis 5: Partially Supported

Table 2 contains the analysis of the 13 results for returns of IT investment based on the size of the firms (large vs. small firms). The sample weighted mean r across studies, which were examined for returns of IT investment across the size of the firms is 0.324, with a 0.05 level of significance; thus, barely 75.7 percent of the observed variance in returns of IT investment across two industries (information-intensive vs. non information-intensive industry) examining the size of the firms together could be explained by sampling error.

By providing more homogeneous subgroups (eg. the smaller firms and the larger firms) in test for possible moderator effects, this study divided into two subsections, examining the size of firm as noted in Table 2. The sample weighted mean r across larger firms is 0.247 significant at the 0.05 level, whereas the sample weighted mean r across smaller firms is 0.4 significant at the 0.05 level. In fact, 82.5 percent of the observed variance in returns of IT investment based on the size of the firms could be explained by sampling error in spite of only 48.2 percent of the observed variance
for returns of IT investment based on the larger firms. Although H5 is not supported, we find evidence that small firms have statistically more positive IT payoffs than the large firms.

5. Conclusions

5.1 Summary of Findings and Significance

The finding of a significant relationship between IT investments and firm performance is a very difficult task since many other factors may affect firm performance it may be difficult to extract the effects of IT investments. Many studies argue that IT offers the promise of anticipating “the biggest technological revolution men have known” (p. 650) [10]; however, other studies show a disillusionment with IT as its productivity seems to have stagnated [15]. The closer one examines the data behind the studies of IT performance, the more it looks like mis-measurement is at the core of the productivity paradox [50]. To address the critical question of how IT payoffs can be evaluated, this paper conducts a meta-analysis to summarize and synthesis the evaluations of IT management from the 1990s of IS research.

This study has shown that part of the problem may be due to measurement of mis-measurement issues at the national and industry sector levels of analysis. Results from this analysis provide supporting evidence for the hypotheses that financial market measurements moderate the relationship between IT investment and firm performance. The findings indicate that financial market measurements are strong moderators of the IT payoff assessment studies when meta-analyzed across the body of relevant literature (eg. N=3,883).

The results from the second level moderator analysis suggest a relationship between the type and the size of firm and IT payoff is further moderated by the economic measurements of IT payoff. The findings showed statistically more positive returns of IT investment in information-intensive industries than non-information-intensive industries. Interestingly, the meta-analysis showed the small size of the firm tends to have statistically more positive returns of IT investment than the large size of the firm. A major implication of the adjusted second-level moderator analysis is not only that it confirms the second hypothesis, but also it reveals the presence of significant positive payoffs within the results of different economic measurements.

5.2 Strengths of the Study

This meta-analysis is the first attempt to empirically validate returns of IT investment in the US on the firm level by examining the major IS journals since the early 1990s. These validated results of meta-analysis provide useful assessment for returns of IT investment studies at a time of increasing investment in IT. In fact, whereas most current IT investment research appears to address the question “What payoffs do IT investments provide?” this study attempts to investigate the related set of questions, “where, when, and how do IT investments provide payoff?” Regarding these issues, this study enhances the previous IT payoff literature and provides suggestions for meaningful and rich documentation of the payoff of IT investment in future research.

5.3 Research Limitations

A number of limitations of this study must be acknowledged. One limitation is that this meta-analysis draws upon studies only published in major North American Information Systems (IS) journals since 1990. The process followed in selecting, classifying, and analyzing articles was designed to be as rigorous as time and resources would allow. Possible additional extensions of this research, however, could include analyses covering extended scope from the US firm level to international firm level and/or examining additional journals, such as research published in Management Science, European journals, or other relevant journals on the subject of IT investment.

Another limitation is that this study focused on only published research. It did not examine all IT investment research presented at conferences or submitted to journals for their review (e.g., dissertations or other unpublished papers). Thus, it may only convey editors’ and reviewers’ views of valid IT investment measurements rather than those of IT payoff researchers. This study also has not examined returns of IT investment that are recently under way. It may be limited to research undertaken several years ago as opposed to current research on IT payoff due to the significant publishing time lags.

6. References


Tables

Table 1: Description of Studies Used in Meta-analysis of Returns of IT investment

<table>
<thead>
<tr>
<th>Source</th>
<th>Authors</th>
<th>Study #</th>
<th>Moderators</th>
<th>N</th>
<th>p-value</th>
<th>t-Stat.</th>
<th>r:mean-correlation</th>
<th>Ni*r</th>
<th>Ni*(r-weighted r mean)²</th>
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<tr>
<td>JMIS, 1990</td>
<td>Alpar, et al</td>
<td>1</td>
<td>ROE</td>
<td>175</td>
<td>0.361</td>
<td>2.081</td>
<td>0.156</td>
<td>27.341</td>
<td>2.219</td>
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<tr>
<td>JMIS, 1990</td>
<td>Floyd, et al</td>
<td>2</td>
<td>ROA</td>
<td>130</td>
<td>0.026*</td>
<td>4.489</td>
<td>0.369</td>
<td>47.942</td>
<td>1.299</td>
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<tr>
<td>ISR, 1993</td>
<td>Dos Santos, et al</td>
<td>3</td>
<td>returns</td>
<td>97</td>
<td>p&gt;0.05</td>
<td>0.211</td>
<td>0.022</td>
<td>2.095</td>
<td>5.929</td>
</tr>
<tr>
<td>Journal, Year</td>
<td>Authors, et al</td>
<td>Hypothesis</td>
<td>Number of Studies: K</td>
<td>Number of Subjects: N</td>
<td>Weighted mean r*</td>
<td>% of explained variance R² by sampling error b</td>
<td></td>
<td></td>
<td></td>
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<td>Hypothesis 1</td>
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<td>3883</td>
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<td>590</td>
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<td>Hypothesis 2.2 (post-period)</td>
<td>Supported</td>
<td>10</td>
<td>3293</td>
<td>0.275</td>
<td>76.23%</td>
<td></td>
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<tr>
<td>Hypothesis 3.1 (Market Measures)</td>
<td>Supported</td>
<td>7</td>
<td>1897</td>
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<td>74.60%</td>
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<td>Hypothesis 3.2 (Accounting Measures)</td>
<td>partially supported</td>
<td>8</td>
<td>1986</td>
<td>0.454</td>
<td>72.23%</td>
<td></td>
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<td>Hypothesis 4: Type of industries</td>
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<td>10</td>
<td>654</td>
<td>0.218</td>
<td>75.70%</td>
<td></td>
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<td>4.1: Information-intensive industry</td>
<td>Supported</td>
<td>5</td>
<td>325</td>
<td>0.222</td>
<td>89.40%</td>
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<td>4.2: Non-information-intensive industry</td>
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<td>329</td>
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<td>62.10%</td>
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<td>5.1: Larger firms</td>
<td>not supported</td>
<td>3</td>
<td>211</td>
<td>0.247</td>
<td>48.20%</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>5.2: Smaller firms</td>
<td>Supported</td>
<td>3</td>
<td>213</td>
<td>0.4</td>
<td>82.50%</td>
<td></td>
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</tr>
</tbody>
</table>

a weighted mean r = ∑ Ni*ri / ∑ Ni
b % of explained variance R² by sampling error = estimate sampling error / observed variance