

# The Interaction Effect of Auditor Industry Specialization and board independence on Investment Efficiency

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## ABSTRACT

The aim of this study is to investigate the interaction impact of auditor industry specialization and board independence on investment efficiency. This study investigates whether board independence is more or less effective in constraining over and under investment for firms audited by industry specialists than for firms audited by non-specialists. This study applied a correlational research design. A sample was selected of 100 Iranian manufacturing firms listed Tehran Stock Exchange (TSE) for a period of 2005-2011. Regression analysis was used to test the research proposition. The paper finds that over and under investment is more negatively associated with board independence for firms audited by industry specialists than for firms audited by non-specialists, consistent with the notion that there is a complementary relationship between auditor industry specialization and board independence. The findings suggest a positive interaction effect of auditor industry specialization and board independence on investment efficiency. This study contributes to the literature by documenting explicit evidence that high quality boards can be more effective through hiring industry specialist auditors. This study also suggests that it may be worth investigating the interaction effect among different corporate governance mechanisms and auditor industry specialization on investment efficiency.

## KEYWORD

Auditor industry specialization; board independence; over investment; under investment.

## INTRODUCTION

Prior audit research has shown that firms audited by industry specialist auditors are associated with higher earnings quality (e.g., Bedard et al, [2]; Balsam et al., [2]; Krishnan, [20]; Dunn and Mayhew, [13]). It is argued that specialist auditors are generally concerned with their reputation costs, and this motivates them to conduct more extensive audits to ensure higher earnings quality (e.g., Simunic and Stein, [26]). Johnson et al. [18] pointed out that auditors that have a wealth of industry knowledge have the

enhanced ability to detect fraud, thereby enhancing the audit quality and earnings quality. Francis and Yu [14] and Reichelt and Wang [25] suggested that auditors from major accounting firms have more exchange opportunities in terms of audit experience and consulting subjects, which can improve their ability to detect fraud or and require the company to make corrections based upon the auditor's opinions, resulting in higher audit quality. Thus, industry specialist auditors serve an important role in monitoring financial reporting process.

Industry specialist auditors may constrain over and under investment problems not only through the audit of financial statements but also through their interaction with the client's internal corporate governance mechanisms including board of directors. Auditors may interact with the board of directors, as directors are involved in resolving the conflicts between management and auditors [2]. Beasley and Petroni [3] and Carcello et al. [10] suggest that high quality boards of directors demand high quality auditors. If the interaction between the board of directors and auditors is effective, high quality boards will benefit from hiring industry specialist auditors. In other words, there may be a complement relationship between board independence and auditor industry specialization.

Balsam et al, [2] studied the relationship between industry expertise and earning quality. In order to make the findings more robust, the authors used in previous studies of six industry expertise appear metrics. Customer main income-based industry market share of continuous variables, the leader and dominant persons; based on the number of customer-industry market share of the continuous variable, the number of clients and industry leaders. Alternative indicators of earnings quality control of the absolute value of accruals and earnings response coefficients. The results showed that six indicators of industry expertise in the five manipulation of accruals and the absolute value of a significant negative correlation; six indicators of industry expertise and earnings response coefficients of a significant positive correlation. These results suggest that industry expertise limit the extent of earnings management and the user can observe the market reaction to earnings is expected

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to show the extent that the auditor's industry expertise have improved earnings quality.

We study the role of auditor industry specialization on effect between board independence and investment efficiency on sample of 700 firm-year observations during the sample period of 2005-2011 in Tehran Stock Exchange. The analysis shows that the negative association between investment efficiency and board independence is stronger for firms with high auditor industry specialization than for firms with low auditor industry specialization, consistent with the notion that there is a complement relationship between auditor industry specialization and corporate governance. Overall, our results suggest that auditor industry specialization can improve the effectiveness of corporate governance mechanism in constraining investment inefficiency. Although our results suggest that firms with higher auditor industry specialization are associated with more efficient investment, one cannot conclude from this paper that increasing auditor industry specialization would necessarily translate into higher investor welfare. Use of Industry specialist auditors may improve investment efficiency by improving corporate governance quality.

Our study contributes to several streams of literature. First, we contribute to the emerging literature on the relation between board independence and audit quality. Unlike prior research (Beasley and Petroni, [3]; Carcello et al., [10]), our study employs a more explicit approach to testing whether auditor industry specialization can complement or substitute to board independence. Although previous studies find that high quality corporate governance demand high quality auditors, there is no empirical evidence that high quality auditors can help high quality of corporate governance to increase the monitoring effectiveness, which can be regarded as the benefits of hiring industry specialist auditors. Our study fills this gap in the literature by documenting explicit evidence that high quality of corporate governance can be more effective through hiring industry specialist auditors.

Second, this study adds to the extant literature on the effect of board independence on investment efficiency [6, 23]. Prior research focuses on the main effect of corporate governance on investment. Our study suggests that it may be worth investigating the interaction effect among different corporate governance mechanisms on investment efficiency. Third, this study also has a practical implication for boards of directors. Our findings suggest that industry specialist auditors can help outside directors to more effectively oversee financial reporting process. Therefore, it is valuable for boards of directors to hire industry specialist auditors.

The remainder of this paper is organized as follows. Section 2, presents the literature review. Section 3, provides a description of the data and methodology. Sections 4 and 5 look into the empirical results and conclusions, respectively.

## LITERATURE REVIEW

Several behavioral studies show that industry specialist auditors have more expertise (Solomon et al. [27]; Taylor [30]; Owosho et al. [24]). Building on them, a large body of

studies has examined the association between industry specialist auditors and audit quality. For instance, Mayhew and Wilkins [22] posit that industry expertise is related to the market shares of audit firms because high market-share firms are able to develop more industry-specific knowledge, enabling auditors to provide higher quality services than do low market share firms.

Analogous to prior work that employs auditor brand name to the proxy for audit quality and also analyzes the association between brand name and earnings quality [1,7], various studies attempt to identify the relation between auditor industry specialization and earnings quality. For instance, Balsam et al. [2], using absolute discretionary accruals and earnings response coefficients (ERCs), find that industry specialists have lower absolute discretionary accruals and higher ERCs. Also, industry specialist auditors constrain managerial discretion more than do non-specialist auditors, thereby improving earnings quality [20]. Dunn and Mayhew [13] posit that the association between industry specialization and disclosure quality is strongest in unregulated industries because enhanced disclosure is likely to add more value in unregulated industries relative to regulated industries. A positive association between industry specialist auditors and analysts' rankings of disclosure quality, which is documented in Dunn and Mayhew's study, is consistent with their prediction. Tsui et al. [31] and Kwon et al. [21] suggest that auditor industry specialization may substitute to corporate governance. Hermalin and Weisbach [16] contend that board composition is endogenously determined, suggesting that the monitoring effectiveness of outside directors is affected by economic factors. The demand for board effectiveness may decrease when the quality of alternative corporate governance mechanisms is high. Thus, whether there is a complement or substitute relationship between auditor industry specialization and board independence, could be an empirical question.

Industry audit specialists reduce opportunistic behavior of management and improve investment efficiency in several ways. First, industry specialists presumably have a greater knowledge of industry accounting practices and therefore are better able to identify and reign in more aggressive practices. Second, because industry audit specialists have developed a reputation for industry expertise, they have an incentive to protect their reputation in order to earn audit fee premia for that expertise [11]. In general, auditors protect their reputation by resisting client pressure for greater discretion and by imposing stricter standards on clients in order to minimize the risk of misleading reporting [25]. Thus if industry specialists are stricter and are better able to constrain their clients' opportunistic behavior of management, then their clients earnings reports should have smaller over and under investment relative to the clients of other auditors, and are less likely to meet or beat analysts' earnings forecasts by one cent per share, *ceteris paribus*.

The agency theory of the firm also suggests that managers over-invest to reap private benefits such as empire building and entrenchment. This problem is usually exacerbated when managers do not have to raise capital in

external markets because of the availability of internal funds. Thus, firms are likely to deviate from an efficient level of investment due to moral hazard problems arising from managerial attempts to expropriate firm cash flows or adverse selection problems that give rise to financing constraints. In sum, agency costs may act as a deterrent for optimal levels of investment and thus lead to inefficient investment by firms.

Existing empirical research mostly ignores agency problems by assuming no conflicts of interest between managers and current owners. Instead, it assumes managers are aligned with current owners and focuses on how asymmetric information between the firm and new financiers produces financial constraints that influence the investment decision [16]. In a general theoretical framework, management can be thought of as making real investment decisions that deviate more from the first best solution of the *q* theory the more asymmetric the information, and the more serious the agency conflict [28].

The existing governance research that comes closest to ours is by Sun and Liu [29], who use a sample of Real Estate Investment Trusts (REITs) to investigate the relationship between governance mechanisms and investments. Their results are mixed. For example, they find that REITs are more sensitive to investment opportunities the more financial institutions own in the trust. Other governance mechanisms, such as ownership by directors, officers, and external block holders, which would all supposedly reduce the agency problem, are associated with weaker rather than stronger investment sensitivity.

Bedard et al [4] argue that board size is one of the important determinants of effective corporate governance. As argued by Lipton and Lorsch (1992) and Jensen and Meckling [17], smaller boards are more effective, since larger boards tend to lead to coordination and decision-making problems. When board size becomes too large, the board will be more symbolic and is less likely to be part of decision-making process [32]. However, it is also argued that larger boards bring advantages for the firm, especially complex firms. Such firms have greater advising requirements, leading to the need of larger boards, which potentially have more experiences and expertise [9]. Additionally, large boards can also provide more effective monitoring, thereby discouraging management from extracting private benefits [9].

Bae and Choi [1] examine whether the investment efficiency of client firms with industry specialist auditors is higher relative to that with non-specialist auditors. Using a large sample from the period 1976 to 2005, they find that investment efficiency of client firms with industry specialist auditors is significantly higher than that with non-specialist auditors. Furthermore, industry specialist auditors discourage both over-investment and under-investment, although they do so more in the over-investment side relative to the under-investment side. The results are generally unaffected by the different definitions of specialist auditors, clients' firm size, yearly regressions, differences in the market share of specialist auditors, and the potential self-selection bias.

Sun and Liu [29] examine whether board independence is more or less effective in constraining earnings management for firms audited by industry specialists than for firms audited by non-specialists. They found that earnings management is more negatively associated with board independence for firms audited by industry specialists than for firms audited by non-specialists, consistent with the notion that there is a complementary relationship between auditor industry specialization and board independence. The findings suggest a positive interaction effect of auditor industry specialization and board independence on accounting quality.

A complementary relationship between auditor industry specialization and board independence may arise from the interaction between outside directors and external auditors. Outside directors, especially those sitting on the audit committee, have opportunities to regularly meet with external auditors to review the company's financial statements, audit process and internal control systems. During these meetings, auditors can provide advice to outside directors on the effective oversight of the financial reporting process.

It is also possible for a substitute relationship between auditor industry specialization and board independence, although we conjecture a complementary relationship between them. We are concerned with this competing conjecture because Tsui et al. [31] and Kwon et al. [21] suggest that auditor industry specialization may substitute to corporate governance. Hermalin and Weisbach [16] contend that board composition is endogenously determined, suggesting that the monitoring effectiveness of outside directors is affected by economic factors. The demand for board effectiveness may decrease when the quality of alternative corporate governance mechanisms is high. Thus, whether there is a complement or substitute relationship between auditor industry specialization and board independence, could be an empirical question [6].

Based on prior research into the relationship between investment efficiency and corporate governance [6, 23, 30], we investigate the effect of auditor industry specialization on the effectiveness of board independence in constraining over and under investment. Specifically, we conjecture a more (less) negative association between investment efficiency and board independence quality for firms audited by industry specialists if auditor industry specialization complements (substitutes) to board independence quality. Since this is an empirical question, we develop the research hypotheses as follows:

**H<sub>1</sub>:** The association between investment efficiency and board independence quality is different for firms audited by industry specialist auditors and firms audited by non specialist auditors.

#### SAMPLE AND MEASUREMENT OF MAIN VARIABLES

##### DATA SOURCE

We obtain our sample of publicly listed Iranian firms available in Tehran Stock Exchange. However, due to high volume of population and heterogeneity among firms listed in TSE, following conditions are considered:

1. Firms must have listed since 2005 in TSE.
2. Firm's fiscal year must be ended at the end of year and they have not changed their fiscal year during studied period.
3. Firms must not be brokerage or investment firm. As a result of these conditions, through systematic elimination sampling 100 firms are selected to be studied during 2005 to 2011.

Finally, to mitigate the influence of outliers, we winsorize all variables at the 1 and 99 percent levels.

#### PROXY FOR INVESTMENT EFFICIENCY

The three key constructs in the analysis are investment efficiency, board independence and auditor industry specialization, and we investigate how auditor industry specialization and board independence in the current year affects next year's investment efficiency.

Conceptually, investment efficiency refers to firms undertaking all and only projects with positive net present value. Consistent with prior research (e.g., Biddle et al. [8]), we measure investment efficiency as deviations from expected investment using a model that predicts investment as a function of growth opportunities. Thus, both under-investment (negative deviations from expected investment) and over-investment (positive deviations from expected investment) are considered inefficient investments.

We proceed by first estimating a firm-specific model of investment as a function of growth opportunities (as measured by sales growth) and use the residuals as a firm-specific proxy for deviations from expected investment. The model is described below:

$$\text{Invest}_{i,t+1} = \beta_0 + \beta_1 * \text{Sales Growth}_{i,t} + \varepsilon_{i,t+1} \quad (1)$$

Following Biddle et al. [8], We define  $\text{Invest}_{i,t}$  as the sum of new investment in machinery, equipment, vehicles, land, buildings, and research and development expenditures, less the sale of fixed assets, and scaled by lagged total assets for firm  $i$  in year  $t$ .  $\text{Growth}_{i,t-1}$  is the annual revenue growth rate for firm  $i$  in year  $t-1$ .

We estimate the investment model cross-sectionally with at least 15 observations in each industry by year. The sample consists of 840 firm-year observations with available data to estimate equation (1) from 2005 to 2011. To mitigate the influence of outliers, we winsorize all variables at the 1 and 99 percent levels. We then classify firms into two groups based on the residuals of equation (1) (i.e. the deviations from the predicted investment levels). To ease exposition, to ease exposition, we multiply the underinvestment variable by -1 so that a higher value suggests a more severe underinvestment.

#### PROXY FOR INDUSTRY SPECIALIST

Industry specialist is generally identified based on the market share of an auditing firm in an industry, and different measures of market share are used in the literature. The most commonly used measures are the relative sales of a client firm and relative assets of the client firm within a given industry (e.g., Balsam et al., [2]; Krishnan, [20]; Mayhew

and Wilkins, [23]; Dunn and Mayhew, [13]). Other measures used in the literature are the relative audit fees earned by a Big 4 international auditing firm as a proportion of the total audit fees earned by all auditors in that particular industry (e.g., Bae and Choi [1] Francis et al., [14]) and the relative assets of a client firm of Big 4 international auditing firm within a given industry (e.g., Mayhew and Wilkins, [23]). Because audit fee data are not available for all sample countries, it is not feasible to use the audit fee measure in this study. In this study, we use the measure of relative assets of the client in a sensitivity test.

The following model is used to calculate an auditing firm's market share based on the relative assets measure in a given country, industry, and year:

$$MS_{ikl} = \sum ASSET_{ijkl} / \sum \sum ASSET_{ijkl} \quad (2)$$

We suppress the subscripts denoting a specific year for exposition purposes. Where  $MS_{jkl}$  is the market share of auditor  $i$  in industry  $k$ ,  $ASSET_{kij}$  represents the total assets of client firm  $j$  in industry  $k$  audited by auditor  $i$ ,  $j$  represents the number of clients that are served by audit firm  $i$  in industry  $k$ , and  $I$  is the number of audit firms in industry  $k$ . An auditor with largest industry market share is defined as an industry specialist in our study.

#### PROXY FOR BOARD INDEPENDENCE

Boards of directors can play a significant role in controlling agency problems. From an agency perspective, the ability of the board to act as an effective monitoring mechanism depends on its independence of management [3, 12]. According to Fama and Jensen (1983), independent directors on boards make boards more effective in monitoring managers and exercising control on behalf of shareholders. Prior research (Beasley, [3]; Klein, [19]; Xie et al., [32]) on boards of directors usually uses board independence (the proportion of independent directors on the board to measure board independence quality as independent directors is regarded as effective monitors of the management. These studies document a positive association between board independence and financial reporting quality, suggesting that board independence positively affects the effectiveness of financial reporting process. Thus, we use board independence (BDIND) as a major measure of board independence quality in our study.

We also use several control variables in the analyses because they may affect investment efficiency or board independence quality. We are guided in our choice of control variables by prior studies such as Richardson (2006), Biddle et al. [8] and Firm size (SIZE) is measured as the natural logarithm of asset. We include SIZE as large firms have high political costs and thus are more likely to manage earnings [25]. On the other hand, Boone et al. [9] find that board independence is positively associated with firm size. Financial leverage (LEV) is measured by the ratio of long-term debt to total assets. LEV is added in regression models because Biddle et al [8] and Chen et al [11] find that this variable is negatively associated with investment efficiency. Nevertheless, Jensen and Meckling [17] propose that



financial leverage can reduce agency costs, suggesting that LEV may affect the demand for board independence quality. Market-to-book ratio (MB) is measured by the ratio of the market value of common equity to the book value of common equity.

We include MB in regression models because Biddle et al. [8] suggest that firms with high growth opportunities, identified by high market-to-book ratio, are more likely to engage in over and under investment. Other studies, such as Bathala and Rao (1995) and Linck et al. (2008), also find that board independence quality is negatively associated with growth opportunities. Asset tangibility (ratio of PP&E to total assets), level of cash flows from operations (deflated by lagged sales), operating cycle, the firm's financial health (measured as Altman's (1968) z-score), [29].

### RESEARCH DESIGN

Before testing the interaction effects of board independence and auditor industry specialization, we examine their main effects on investment efficiency based on the following regression model:

$$\text{Overinv}_{i,t} \text{ or } \text{Underinv}_{i,t} = \beta_0 + \beta_1 \text{SPEC}_{jt} + \beta_2 \text{Bgover}_{jt} + \sum \beta_i \text{Controls}_{jt} + \varepsilon_{jt} \quad (3)$$

For all tests, we estimate regression models with standard errors that cluster by year, which can mitigate the effect of autocorrelation of time series data.

To examine our research proposition, we expand equation (3) by including the interaction term of board independence and auditor industry specialization as follows:

$$\text{Overinv}_{i,t} \text{ or } \text{Underinv}_{i,t} = \beta_0 + \beta_1 \text{SPEC}_{it} + \beta_2 \text{SPEC}_{it} * \text{Bgover}_{it} + \beta_3 \text{Bgover}_{it} + \sum \beta_i \text{Controls}_{it} + \varepsilon_{it}$$

In equation (4), we expect the coefficient on BDIND\* AISPE to be negative (positive) if board independence and auditor industry specialization have a complement (substitute) relationship on enhancing investment efficiency. Based on the literature, we also expect that the coefficients on MB, OC, TANG and INST are positive, and that the coefficients on SIZE, ALT\_Z, are negative.

### EMPIRICAL RESULTS

Table I provides descriptive statistics for our measures of investment efficiency, AUD\_SPE, board independence, as well as for our main control variables. Panel A shows that only 36 percent of firms belong to overinvestment group, while an overriding majority of sample firms belong to the underinvestment group. This intuitive result confirms that manufacturing firms in Iran, due to their difficulty in securing external financing, are more likely subject to the problem of underinvestment rather than overinvestment. The mean and median of auditor industry specialization are 0.195 and 0.074, respectively, which are close to those reported in Behn et al. [5] (i.e. mean= 0.042, median= 0.037). The mean and median of board independence are 0.55 and 0.56, respectively, which indicate that approximate

55-57 percent of directors on the board are independent directors during our sample period.

Panel B presents the correlation coefficients between the variables. We find that board independence and auditor industry specialization are negatively associated with Investment efficiency respectively ( $r = -0.111$ ;  $p < 0.01$ ). These correlations provide univariate evidence that board independence and auditor industry specialization negatively affect over and under investment. We also find that auditor industry specialization is positively correlated with board independence ( $r = 115$ ;  $p < 0.01$ ), consistent with the notion that high quality boards have a high demand for high quality audits (Beasley and Petroni, [3], Sun and Liu, [29]).

Table II reports the main results on the effects of board independence and auditor industry specialization on investment efficiency. The results in columns 3 and 4 show that the coefficient on board independence is negative and significant ( $t = -3.198$ ;  $p < 0.01$ ), consistent with Klein [19], Sun & Liu [29] while the coefficient on auditor industry specialization is insignificant, inconsistent with Balsam et al [2]. The results in columns 5 and 6 indicate a negative and significant coefficient ( $t = -2.730$ ;  $p < 0.01$ ) on the interaction of board independence and auditor industry specialization. The results suggest that auditor industry specialization could be a complement rather than substitute to board independence in improving accounting quality. Thus, high quality boards are more effective in constraining investment inefficiency when they hire industry specialist auditors.

To test the robustness of our results, we divided our firms to over and under investment in table III and VI. We expect that the coefficient on BDIND\* AISPE is significantly negative for over and under investment, if the interaction of board independence and auditor industry specialization can enhance investment efficiency. These results in are consistent with the complement argument, suggesting that auditor industry specialization enhances the effectiveness of board independence in reducing both over and under investment discretionary accruals. Thus, our results still hold when we use over investment and under investment to measure investment efficiency.

Panel A: Descriptive Statistics of the Main Sample

	N	Mean	STD	25%	Median	75%
InvEffi	700	0.421	0.249	0.207	0.410	0.636
OverInv	252	0.336	0.235	0.129	0.303	0.517
UnderInv	448	0.466	0.246	0.259	0.463	0.670
AUD_SPE	700	0.195	0.264	0.021	0.074	0.221
BINDE	700	0.555	0.146	0.405	0.570	0.660
SIZE	700	11.96	0.632	11.50	11.87	12.31
LEV	700	0.558	0.576	0.177	0.576	0.684
MBV	700	1.731	1.360	1.291	0.687	2.456
TANG	700	0.256	0.197	0.097	0.202	0.392
CFO_SAL	700	0.174	0.198	0.068	0.155	0.256
FRQ	700	-0.049	0.042	-0.068	-0.043	-0.021
OC	700	2.128	0.376	1.974	2.160	2.311

Panel B. Investment Efficiency sample (n = 700)

	InvEffi	AUD_SPE	BINDE	SIZE	LEV	MBV	TANG	CFO_SAL	FRQ
InvEffi	1.000								
AUD_SPE	-0.111**	1.000							
BINDE	-0.159**	0.115**	1.000						
SIZE	-0.135**	0.096*	0.053	1.000					
LEV	-0.150**	0.059	-0.054	0.052	1.000				
MBV	0.136**	0.028	-0.037	0.056	-0.431**	1.000			
TANG	0.159**	-0.106**	-0.050	0.091*	-0.050	0.014	1.000		
CFO_SAL	-0.001	-0.100*	0.041	0.023	-0.023	0.028	0.041	1.000	
FRQ	-0.174**	-0.173**	0.048	-0.033	0.111**	-0.032	-0.016	0.074	1.000
OC	-0.130**	-0.086*	0.164**	-0.043	0.047	0.017	-0.075	0.070	0.092*
ALT_Z	-0.124**	-0.006	0.047	-0.088*	-0.274**	0.266**	-0.145**	-0.007	0.036

Notes: \*, \*\* Represent significance at the 5 percent, and 1 percent levels, respectively, using two-tailed tests.

Table II. Main results

	Model 1		Model 2	
	Coeff	t-statistic	Coeff	t-statistic
Constant	1.433	7.411**	1.348	6.915**
AUD_SPE	-0.037	-1.003	0.014	0.333
BINDE	-0.211	-3.198**	-0.144	-2.050*
AUD_SPE*BINDE	-	-	-0.104	-2.730**
SIZE	-0.065	-4.243**	-0.060	-3.932**
LEV	-0.144	-2.322*	-0.142	-2.308*
MBV	0.028	3.580**	0.027	3.452**
TANG	0.152	3.067**	0.143	2.902**
CFO_SAL	0.015	0.318	-0.002	-0.050
FRQ	-0.905	-3.925**	-0.953	-4.141**
OC	-0.063	-2.449*	-0.056	-2.166*
Z-Score	-0.091	-4.361**	-0.087	-4.229**
Industry FE	Yes	Yes	Yes	Yes
Firm/year cluster	Yes	Yes	Yes	Yes
Obs	700		700	
Adjusted R <sup>2</sup>	0.157		0.234	
F-value	10.327**		9.739**	

Table III. Results on underinvestment

	Model 1		Model 2	
	Underinvestment			
	Coeff	t-statistic	Coeff	t-statistic
Constant	1.541	6.374**	1.455	5.988**
AUD_SPE	-0.021	-0.405	0.041	0.697
BINDE	-0.302	-3.943**	-0.236	-2.923**
AUD_SPE*BINDE	-	-	-0.112	-2.412*
SIZE	-0.070	-3.578**	-0.065	-3.333**
LEV	-0.124	-1.602	-0.120	-0.549
MBV	0.027	2.820**	0.027	2.773**
TANG	0.168	2.802**	0.161	2.700**
CFO_SAL	0.015	1.123	0.045	0.677
FRQ	0.075	-3.455**	-0.915	-3.577**
OC	-0.058	-1.931	-0.051	-1.696
Z-Score	-0.077	-3.037**	-0.074	-2.957
Industry FE	Yes		Yes	
Firm/year cluster	Yes		Yes	
Obs	700		700	
Adjusted R <sup>2</sup>	0.175		0.186	
F-value	9.139**		8.944**	

Many other independent variables in Model 1 have statistically significant coefficients that are largely consistent with the findings in prior studies such as Biddle et al. [8] and Chen et al [11]. For example, SIZE, defined as the natural logarithm of lagged total assets, has a significantly negative coefficient (-0.060, t-statistic -3.932), implying larger firms make smaller investments relative to their size. LEV, which captures the capital structure of the firm, is negatively associated with investment efficiency (-0.142, t-statistic -2.308), which implies that a higher degree of financial leverage constrains the level of the firm's investment efficiency. Market-to-book ratio (MB) has a significantly positive coefficient (0.027, t-statistic 3.452), indicating that firms with more growth opportunities making relatively larger investments. Similarly, asset tangibility (TANG) has a positive coefficient (0.143, t-statistic 2.902), suggesting a positive relation between investment efficiency and tangible asset intensity.

Table VI. Results on Overinvestment

	Model 1		Model 2	
	Overinvestment			
	Coeff	t-statistic	Coeff	t-statistic
Constant	1.643	6.443**	1.470	5.672**
AUD_SPE	-0.021	-0.435	0.035	0.678
BINDE	-0.245	-2.835**	-0.184	-2.087*
AUD_SPE*BINDE	-	-	-0.134	-2.696**
SIZE	-0.088	-4.488**	-0.075	-3.787**
LEV	-0.199	-2.279*	-0.195	-2.271*
MBV	0.030	2.938**	0.027	2.679**
TANG	0.202	2.830	0.193	2.749**
CFO_SAL	-0.036	-0.608	-0.046	-0.791
FRQ	-0.897	-2.640**	-0.907	-2.710**
OC	-0.054	-1.360	-0.044	-1.125
Z-Score	-0.108	-3.735**	-0.100	-3.498
Industry FE	Yes		Yes	
Firm/year cluster	Yes		Yes	
Obs	700		700	
Adjusted R <sup>2</sup>	0.332		0.157	
F-value	11.433**		11.051**	

CFO\_SALE, the level of cash flows from operations relative to lagged sales, also has a negative relation but insignificant with InvEffi (coefficient estimate  $-0.002$ , t-statistic  $-0.050$ ), which is consistent with prior studies such as Biddle et al [8].

Financial reporting quality (FRQ) has a significantly negative coefficient ( $-0.953$ , t-statistic  $-4.141$ ), indicating firms with higher financial reporting quality are associated with more efficient investment, one cannot conclude from this paper that increasing financial reporting quality would necessarily translate into higher investor welfare. Enhanced financial reporting may improve investment efficiency by reducing information asymmetry. Operating Cycle (OC) is a measure of the operating cycle of the firm and is negatively associated with investment efficiency ( $-0.056$ , t-statistic  $-2.166$ ), which is consistent with prior studies such as Biddle et al. [8]. ALT\_Z captures the firm's financial health and is negatively associated with investment efficiency ( $-0.087$ , t-statistic  $-4.229$ ) which is consistent with prior studies such as Biddle et al. [8], Chen et al [11].

### CONCLUSION

This study examines whether auditor industry specialization enhances the effectiveness of board independence in constraining over and under investment. We argue that investment efficiency is more (less) negatively associated with board independence for firms with high auditor industry specialization than for firms with low auditor industry specialization if there is a complement (substitute) relationship between auditor industry specialization and board independence. Using a sample of 700 firm-year observations from 2005 to 2011, we document evidence on the positive effect of auditor industry specialization on the effectiveness of board independence. The results are consistent with the notion that auditor industry specialization complements board independence. Overall, our findings suggest that high quality boards are more effective in constraining over and under investment when they hire industry specialist auditors.

This study makes the following contributions to the literature and provides implications for academics and practitioners. First, we add to the extant research into the relationship between audit quality and board independence by examining whether auditor industry specialization complements or substitutes to board independence. Unlike prior research (Beasley and Petroni, [3]; Carcello et al., [10]), this study provides more explicit evidence that high quality boards can benefit from industry specialist auditors. Second, this study suggests that in addition to the main effects examined in prior research, it may be worth examining the interaction effects among different corporate governance mechanisms on investment efficiency. Third, this study also provides a practical implication that it is valuable for boards of directors to hire industry specialist auditors.

We note that our results should be cautiously interpreted because of the following limitations of this study. First, the endogeneity of board independence is still a concern of our analyses while we allow for this issue by running the two-stage regression. Like other corporate governance studies, it is difficult for our study to find the most appropriate instrumental variable. Future research may employ more refined approaches to dealing with this issue. Second, the large dataset in this study constrains the possibility of considering more aspects of board independence, which may reduce the generalizability of our findings. Future research may explore more alternative measures of board independence.

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