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Investment efficiency: A conceptual review of measurement models

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ABSTRACT
The purpose of this paper is to review the measurement models of investment efficiency that have been employed in previous relevant empirical research works. Also, it aimed to review the benefits, limitations, and suitability of the models, including the relevant theories that explain corporate investment efficiency in an imperfect setting. The paper adopted a conceptual review approach and used relevant empirical research articles published in various Accounting and Finance journals from 2006 to 2025 as the main data for the study. There is no generally accepted measurement model of investment efficiency, and the majority of the measurement models used in previous relevant studies are suitable for listed firms; their applicability to non-listed firms depends on data availability. Also, the models offer different specific benefits, and none of them is without shortcomings. Practically, the findings imply that the choice and application of measurement models by corporate managers, investors, financial analysts and researchers will be highly influenced by the nature of firms and data availability.

Keywords: *Agency problem, cost of capital, investment efficiency, overinvestment, underinvestment*

1. Introduction

Corporate investment decisions are one of the financial decision areas handled by corporate financial managers. In the ideal situation, the assumption was that managers would work toward greater efficiency in their investment decisions. Investment efficiency (IE) is achieved when managers allocate resources to projects with positive net value; thus, both underinvestment and overinvestment are inefficiencies resulting from failure to allocate resources to profitable investments or from the decision to allocate resources to unprofitable investments (Zhi, 2023; Badpa & Tamshidi, 2025). Issue-invest decision theory attributed underinvestment problems to a rise in financing constraints (Xie, 2013; Rahman et al., 2013; Rymar, 2016; Ayagi, 2023), while Agency theory linked overinvestment to agency problems (Ibrahim & Ibrahim, 2021; Thien & Hung, 2023).

Owners, shareholders, and other potential investors are interested in corporate IE because of its influence on corporate financial performance (Geamănu, 2011; Salehi et al., 2022; Bao & Motlagh, 2024). The managers are also interested because of the key role that IE plays in helping them meet long-term financial performance targets. Moreover, the government would like to see corporate investments remain efficient for the general benefit of the economy (Wang & Zhu, 2025). Thus, financial analysts, investors, managers, and researchers/academics have been attempting to develop and use various measurement models of IE. For instance, financial analysts and investors use financial metrics such as return on investment (ROI) and efficiency ratios to compare profitability across investments and to evaluate how effectively companies use resources to generate profit.

Researchers and academics use residual models to measure the magnitude or extent of deviations from expected investments (Bidel et al., 2009; Chen et al., 2011; Zhu et al., 2014; Gaio et al., 2023). They also use models based on Neoclassical theory, Agency theory and Real options theory (Gao & Yu, 2020; Assad et al., 2023; Thien & Hung, 2023; Jafeel et al., 2023; Khan et al., 2024; Ibrahim & Ibrahim, 2021; Badpa & Tamshidi, 2025) to determine the efficiency of corporate investments. Elberry and Hussainey (2020) revealed that, despite the many measurement models of IE, the two most commonly used proxies among researchers are those developed by Biddle et al. (2009)

and Chen et al. (2011). Liu et al. (2025), on the other hand, argued that the commonly used measurement models for IE are the Data Envelopment Analysis (DEA) method, the Sensitivity model, and the Richarlison (2006) model.

Previous research on IE have mostly paid attention to examining its effects on items like profitability, value and shareholders' wealth (Huang & Yan, 2012; Kazakis et al.,2023; Bao & Motlagh,2024) or effects of other items such as information asymmetry, cost of capital, financial reporting quality, and auditor type (Nasir et al., 2018; Ayagi, 2023; Khan et al., 2024; Bleibtreu et al., 2025; Khan et al., 2025). To the best of this paper's knowledge, there has been a paucity of research studies that specifically reviewed the measurement models of IE. This paper attempts to fill this gap and, thus, aims to review the measurement models employed in published empirical studies on IE over nineteen years (2006-2025).

The paper contributes to the conceptual and theoretical literature on IE by identifying and reviewing various IE measurement models, their benefits, limitations, and suitability for different industries. Also, the paper made a theoretical contribution by underpinning its arguments with agency and Issue-invest decision theories that explain the root cause of IE, its likely risks, and thus the need for its measurement. Moreover, the paper's practical contribution lies in how it will influence the choice and application of measurement models by investors, financial analysts, managers, and academics/researchers, as it clearly highlights the suitability of each model across various industries. Other sections of the paper cover the literature review, methodology, conclusion, and recommendations.

2. Review of literature and hypothesis development

2.1 Conceptual review

Investment efficiency

The term investment can be defined as money committed or property acquired for future income. Thus, based on that definition, investment includes money committed in bonds, fixed deposits, preference shares, equities, and real tangible assets. In line with current trends, Richardson (2006) and Bidel et al. (2009) broadened the definition of the term to include investment in human capital, i.e., expenditures on research and development. The broadest definition was given by Daniel, Naveen, and Yu (2016), which, in addition to research and development expenditures for human capital development, also covered items such as selling and general administrative expenditures, investments in joint ventures, subsidiaries, and business acquisitions.

On the other hand, IE is defined by Thien and Hung (2023) as undertaking or embarking on all and only investment projects with positive net present value (NPV). Thus, by implication, a firm is said to be overinvesting when it accepts and executes projects with negative NPV. It is also said to be underinvesting when it rejects investment projects with positive NPV. Both overinvestment and underinvestment are regarded as inefficiencies in corporate investment. Biddle et al. (2009) argued that in an ideal capital market, free of market frictions, corporate firms invest efficiently. However, when the capital market is imperfect, the same corporate firms' investment projects may deviate from the optimal level due to asymmetric information, which gives rise to market frictions such as adverse selection and agency costs that jointly distort the existing cost of financing investment projects.

Biddle et al. (2009) argue that corporate IE is determined by COC, which is also determined by perceived adverse selection and moral problems/risks, since financiers who are ignorant of the true financial state of the company and viability of the project to be financed may raise the financing cost in order to cover the expected risks. Also, according to their argument, agency or moral hazard costs can affect IE in two ways. First, by directly affecting project selection. For, as Biddle et al. (2009) explained, managers might easily be tempted to suboptimally invest to serve their selfish interests rather than those of the principals (investors or finance providers). Second, when investors suspect that managers are unlikely to act in their best interests, as in the first scenario, investors would rationally raise the cost of finance to compensate for the risk of this hidden action, thereby leading to underinvestment.

Therefore, the above shows that Biddle et al. (2009) 's view on the determinants of IE was supported by previous studies on FRQ and IE. This indicates that variation in financing costs resulting from asymmetric information risks between managers and investors, either before or after raising capital for an investment project, can be considered a direct determinant of corporate IE. FRQ enhances IE by first reducing the IA between corporate firms (which

borrow to finance capital projects) and investors, who provide capital. A reduction in asymmetric information causes suppliers of capital to demand lower financing costs, thereby enabling firms to invest optimally.

Measurement of investment efficiency
The IE measurement models that this paper found to have been employed in previous studies are:

Investment-cash flow sensitivity model
This was initially developed by Fazzari et al. (1988) as reported by Daniel et al. (2016). It measures the sensitivity of the firm's investment to its internal funds, i.e., the degree of reliance on internal funds in the presence of market imperfections. Fazzari et al. (1988) and Kaplan and Zingales (1997), as cited in Rahman et al. (2013), argued that higher sensitivity leads to higher inefficiency in corporate investment activities because it implies a liquidity constraint. Biddle and Hilary (2006), Ascioglu et al. (2008), Baik et al. (2010), and Peláez (2010) employed this model in their research. Hence, as used in Biddle (2011), the model is as follows:

$$Invest_{j,t} = \beta 0_{,t} + \beta 1_{,t} * OCF_{j,t-1} + \beta 2_{,t} * MTB_{j,t-1} + \varepsilon_{j,t} \quad (1)$$

Where:

Invest = capital expenditures, scaled by net property, plant and equipment at the beginning of the year.
OCF = operating cash flows, scaled by net property, plant and equipment at the beginning of the year.
MTB = market-to-book ratio, measured as the ratio of the market value of equity plus the book value of total assets minus the book value of equity, which is divided by the book value of total assets.

However, Daniel et al. (2016) modified the model by broadening the definition of investment to include research and development expenditure, selling and general administrative expenditure, cash investment in joint ventures/subsidiaries and cash component of acquisitions; rather than the narrow definition of capital expenditure given to the term 'investment' by the proponents of the model. Internal funds were also redefined by Daniel et al. (2016) to encompass cash holdings at the beginning of the year. Therefore, the Investment-cash flow sensitivity model as modified and used in Daniel et al. (2016) is as follows:

$$Investment_{i,t} = \alpha_t + \alpha_t + \beta_1 \text{internal funds}_{i,t} + \beta_2 q_{i,t-1} + \varepsilon_{it}$$

Where:

$Investment_{i,t}$ = Total investment
Internal $Fundsi_{,t}$ = Investable Cash
α_i and α_t= Firm and year fixed effects
qi,t-1 = proxy for investment opportunities measured as the beginning period market-to-book value ratio

Investment-cash flow sensitivity model Measures access to capital, identifies investment inefficiencies, and focuses on internal fund generation. Also, it is very useful for small and medium-sized enterprises (SMEs) or private firms where market-based data is not available (D'Espallier et al., 2008; Wan & Zhu, 2011; Mulier et al., 2016). However, the limitations of the model include measurement errors, poor discriminatory power, confounding factors and declining significance (George et al., 2011; Chen & Chen, 2012; Chowdhury et al., 2016)

Richardson (2006) investment expectation model
This model first treated total investment as the sum of capital expenditure, acquisitions, and research and development, minus receipts from the sale of property, plant, and equipment. i.e.

$$ITOTAL_t = CAPEX_t + Acquisitions_t + RDt - SalePPE_t$$

Where:

$ITOTAL_t$ =Total investment at time t
$CAPEX_{t=}$ capital expenditure at time t
$Acquisitions_{t=}$ acquisitions at time t
RDt= Research and development at time t

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$SalePPE_{t=}$ sale of property, plant and equipment at time t

Total investment expenditure was then broken down into two components, i.e. Required investment expenditure to maintain assets in place, i.e. $I_{Maintainance}$ represented by amortization and depreciation and then investment expenditure on new projects, i.e. $I_{New,t}$

Thus, $I_{New,t} = I_{Total,t} - I_{Maintenance,t}$

Richardson (2006) further split $I_{New,t}$ into expected investment expenditure in new positive NPV projects (I^*_{New}) and abnormal/unexpected investment ($I_{\varepsilon New}$). The unexpected component can be either positive or negative, signifying over- or under-investment, respectively.

Therefore, the investment expectation model is given as:

$$I_{New},t = \alpha + 1V/P_{t-1} + \beta_2 Leverage_{t-1} + \beta_3 Cash_{t-1} + \beta_4 Age_{t-1} + \beta_5 Size_{t-1} + \beta_6 \text{ Stock Returns } _{t-1} + \beta 7\ I_{New,t-1} + \Sigma \text{Year Indicator} + \Sigma \text{Industry Indicator}$$

Were:

V/P= measure of growth opportunities, calculated as the ratio of the value of the firm andmarket value of equity
Age = the log of the number of years the firm has been listed on CRSP as of the start of the year.
Leverage = the sum of the book value of short-term and long-term debt deflated by the sum ofthe book value of total debt and the book value of equity
Cash =balance of cash and short term investments deflated by total assets measured at the start of the year.
Stock Returns= the stock returns for the year prior to the investment year. It is measured as the change in market value of the firm over that prior year
Year Indicators =vector of indicator variables to capture annual fixed effects.
Industry Indicators =vector of indicator variables to capture industry fixed effects
and I^*_{New}= the fitted value or predicted value from the expectation model i.e.an estimate of the expected level of investment
$I\varepsilon_{New}$ = unexplained portion or residual from the expectation model i.e. over- or under-Investment

Elberry and Hussainey (2021), Bai et al. (2023), Liu et al. (2025) were among the studies that used the model. And part of the advantages of this model was that it identifies investment inefficiencies, is a comprehensive measure of investment efficiency, focuses on managerial agency costs, and is applicable in diverse contexts (Richardson, 2006; Hu et al., 2011; Cai, 2014; Liu et al., 2025). On the other hand, estimation issues and sensitivity to free cash flow are among the model's shortcomings (Bergstresser, 2006; Lu et al., 2017).

McNichols and Stubben (2008) model of investment efficiency

Le et al. (2024) reported that McNichols and Stubben's (2008) model of IE is as follows:

$$Investment_{i,t} = a_0 + a_i Rev_{i,t} + e_{i,t}$$

Where:

$Investment_{i,t}$ = net increase in assets/lag of the total assets of firm *I* in year *t*
$Rev_{i,t}$ = Revenue growth of firm *i* from year t-1 to t
a_0 = Constant value
a_i = Variable coefficient
$e_{i,t}$ = Residual error of the model

Therefore, IE is the absolute value of the reminder in the model multiplied by -1

Although McNichols and Stubben's (2008) model of investment efficiency is designed for and applied to listed companies, it is not theoretically limited to them. Its practical application to unlisted firms is restricted by data availability rather than the model's structure (McNichols & Stubben, 2008). Furthermore, the model provides evidence of overinvestment due to misreporting, helps identify normal and abnormal investment, and corrects

investment behaviour post-manipulation (McNichols & Stubben, 2008; Liu et al., 2021). However, its major shortcomings emanate from potential measurement errors and omission of other drivers of efficiency (McNichols & Stubben, 2008).

Biddle et al. (2009) model of investment efficiency

The model started by developing a firm-specific investment model that is dependent on growth opportunities represented by sales growth. The residuals from this model, termed deviations from expected investment, are then used as proxies for inefficiencies in firms' investment. Thus, positive and negative deviations stand for overinvestment and underinvestment, respectively. The firm-specific model of investment is as follows:

$$\text{Investment}i_{,t+1} = \beta_0 + \beta_1 * \text{Sales Growth}i_{,t} + \varepsilon i_{,t+1} \quad (2)$$

Where:

Investment_{t+1}= total investment, i.e. the sum of research and development expenditure, capital expenditure, and acquisition expenditure less cash receipts from sale of property, plant, and equipment
Sales Growth_t =the percentage change in sales from year t-1 to t.

The model was designed for listed Firms with the original study focusing on US-listed companies. It offers a robust, quantitative method for identifying how information quality reduces investment frictions, controls for market frictions and aligns capital allocation with positive NPV projects (Bidel et al., 2009). Elberry and Hussainey (2020) pointed out that Biddle et al.'s (2009) model of investment efficiency is among the most widely used methods of measuring IE. It was employed in studies conducted by Moradzadehfard et al., (2013), XIE (2013), Zhu et al. (2014), Du (2014), Poorzamani and Keivanfar (2014), Mohammadi (2014), Lenger et al. (2015), Kim and Kwon (2015), Jafari et al. (2015), and Alizadeh et al. (2015), Ardianto et al. (2020), Elberry and Hussainey (2020), Elberry and Hussainey (2021), Elaoud and Jarboui (2021), Ibrahim and Ibrahim (2021), Salehi et al. (2022), Akbar and Salad (2022), Kumar et al. (2023), Omara and Rashed (2023), Assad et al. (2023), Thien and Hung (2023), Jafeel et al. (2023), Khan et al. (2024), and Badpa and Tamshidi (2025). Its major limitations include measurement and estimation limitations, contextual and environmental constraints, and conceptual limitations (Omara & Rashed, 2023; Jafeel et al., 2023).

Chen et al. (2011) parsimonious model of expected investment

This model assumed that expected investment was dependent on revenue growth. However, since the association between investment and revenue growth differs between revenue decreases and increases, this permits differential predictability for revenue increases and decreases using a piecewise linear regression model. The model is as follows:

$$\text{Invest}_{it} = \alpha 0 + \alpha 1 \text{NEG}_{it-1} + \alpha 2 \%\text{RevGrowth}_{it-1} + \alpha 3 \text{ NEG} * \%\text{RevGrowth}_{it-1} + \varepsilon_{it}$$

Where:

Invest_{it} = the sum of new investment in machinery, equipment, vehicles, land, buildings, and research and development expenditures, less the sale of fixed assets, scaled by lagged total assets for firm *i* in year *t*. This is in line with the Biddle et al. (2009) model

NEG_{it-1}= indicator variable which takes the value of one for negative revenue growth, and zero otherwise.

$\%\text{RevGrowth}_{it-1}$= revenue growth rate for firm *i* in year *t*-1

Chen et al. (2011) also considered residuals from this model as deviations from expected investment, which would serve as proxies for inefficiencies in firms' investment. Thus, positive and negative deviations represent overinvestment and underinvestment, respectively. Ardianto et al. (2020), Anh et al. (2024), and Elberry and Hussainey (2020) employed this model in their research. One of the key advantages of this model is that it is simple and parsimonious**;** that is, it uses a minimal number of predictors to explain investment, reducing the potential for overfitting and making it easier to implement compared to more complex structural models (Chen et al., 2011). However, despite the benefits to be derived, the model has some shortcomings, such as reliance on sales growth as a single proxy, limited generalizability, and the omission of intangible assets (Chen et al., 2011; Baik et al., 2024).

Zhu et al. (2014) model of investment efficiency

Apart from growth opportunities, Zhu et al.'s (2014) Model took into consideration other factors, such as leverage, cash level, size, return, and lagged investment, that determine firms' expected investment in a given period. The model is as follows:

$$Investment_{i,t} = \alpha_0+\alpha_1 Growth_{i,t-1}+\alpha_2 Leverage_{i,t-1}+\alpha_3 Cash_{i,t-1}+\alpha_4 Size_{i,t-1}+\alpha_5 Return_{i,t-1}+\alpha_6 Age_{i,t-1}+\alpha_7 Investment_{i,t-1}+\varepsilon_{i,t}$$

Where:

$Investment_{i,t}$ = sum of capital expenditures, R&D expenditures, and acquisitions minus sales of property, plant, and equipment, scaled by lagged total assets for firm i at the end of year t-1
$Growth_{i,t-1}$ =annual revenue growth rate for firm i at the end of year t-1
$Leverage_{i,t-1}$ = asset-liability ratio of firm i at the end of year t-1
$Cash_{i,t-1}$ = ratio of cash to total assets of firm i at the end of year t-1
$Size_{i,t-1}$= log of total assets of firm i at the end of year t-1
$Return_{i,t-1}$= stock returns of firm i at the end of year t-1
$Age_{i,t-1}$ = difference between the first year when firm i appears in CSEC at the end of year t-1
$Investment_{i.t-1}$ = lag of investment.

Consistent with Richardson (2006), Biddle et al. (2009), and Zhu et al. (2014) regard the model residuals as deviations from the firm's expected investment. They are used to represent inefficiencies in the firm's investment. Thus, positive and negative deviations represent overinvestment and underinvestment, respectively.

Nurcholisah (2016) model of investment efficiency

Nurcholisah (2016) developed and used this method in the study of twenty-two (22) Indonesian pension fund companies in 2022. The method measured IE as the increase in net assets of the sampled firms over the analysis period. Nurcholisah (2016) then noted that net present value was an important indicator of IE and recommended its inclusion in measuring corporate IE. The model shows how to mitigate agency issues, limit over-investment, and help prevent under-investment by reducing the cost of capital, ultimately optimizing resource allocation. However, one limitation of the model is that it overlooks dynamic macroeconomic variables (e.g., debt maturity, CEO career concerns) that affect a manager's investment behaviour (Nurcholisah, 2016).

Valiyan et al. (2022) investment efficiency models

Valiyan et al. (2022) used two methods, namely the ratio of net fixed assets to total assets and the investment level, to measure investment efficiency in a study of 142 companies listed on the Tehran Stock Exchange. The models showed how a corporate firm could optimize resource allocation to maximize firm value. Moreover, Valiyan et al. (2022) noted that the models are suitable for both listed and non-listed firms, provided appropriate data adjustments. However, the main shortcoming of the models is equating investment efficiency to basic asset allocations and stated investment levels, which may fail to capture the true net present value (NPV) of individual projects or long-term operational returns.

Gaio et al. (2023) model of investment efficiency

Consistent with previous studies (Biddle et al., 2009; Zhu et al., 2014), Gaio et al. (2023) developed a model of expected investment that accounted for the effects of lagged firm attributes on investment. The model is as follows:

$$Investment_{i,t} = \beta_0 + \beta_1 Investment_{i,t-1}+ \beta_2 Growth_{i,t-1}+ \beta_3 NG_{i,t-1}+ \beta_4 NG*Growth_{i,t-1}+ \beta_5 Size_{i,t-1} + \beta_6 Age_{i,t-1}+ \beta_7 Lev_{i,t-1}+ \beta_8 Cash_{i,t-1}+ \beta_9 ROA_{i,t-1}+\varepsilon_{i,t}$$

Where:

Investment = net investment in property, plant, machinery, equipment and research and development, measured as the annual change in total fixed assets plus depreciation and amortization expenses scaled by net investment of prior period.
Growth = Revenue growth rate
NG= Negative growth and a dummy variable that takes the value of 1 if revenue growth is negative and 0 otherwise.
Size = Natural logarithm of total assets

Age = Natural logarithm of firm's age since its foundation
Lev = financial leverage computed as the ratio of total liabilities to the sum of total liabilities and total shareholders' funds
Cash = Ratio of cash and cash equivalents to total assets
ROA = Return on assets calculated as a ratio of net income to total assets

Then, Gaio et al. (2023) revealed that the magnitude of deviations from the expected level of investment would measure the extent of IE. In other words, the IE measure is the absolute value of the residuals ($\varepsilon_{i,t}$) from the expected investment model. Negative residuals indicate underinvestment, and positive residuals indicate overinvestment. Gaio et al. (2023) model highlighted how to improve the identification of positive NPV projects across diverse market environments. Moreover, the model is suitable for both Listed and non-listed firms. However, its limitations stemmed from reliance on subjective proxies for earnings quality, sample and geographic bias, endogeneity and reverse causality and neglect of external disruptions (Gaio et al., 2023).

Askarzadeh and Yung (2025) model of investment efficiency
As in previous works (Biddle et al., 2009; Zhu et al., 2014; Gaio et al., 2023), Askarzadeh and Yung (2025) used the following model to estimate firm's optimal investment level.

$$Investment_{t+1} = \alpha_0+\alpha_1*TobinsQ_t+\alpha_2*Revenuegrowth_t+\alpha_3*CFO_t+IndutryFE+YearFE, \quad (1)$$

Where:

Investment = total investment of a firm computed as the sum of capital expenditure, cash flow from sale of plant, property and equipment, merger and acquisition expenditure scaled by lagged total assets
ToinsQ = market value of equity plus the book value of assets minus common equity divided by total assets
Revenue growth = the percentage growth in a firm's revenue from year t-1 to t
CFO = net cash flow from operations divided by total assets
IndustryFE, YearFE = controls for industry and year fixed effects

Askarzadeh and Yung (2025) noted that deviations from the firm's optimal investment level are captured in the residuals from estimating equation (1), which are then used to represent IE. Thus, a firm would be classified as over-investing if the residuals are positive. It would be classified as under-investing if the residuals are negative. Askarzadeh and Yung's (2025) model is suitable for all listed firms, excluding financial institutions and utility firms. It minimizes deviation from optimal investment and guides decision-making (Askarzadeh & Yung, 2025).

Table 1: Summary of the Review

Model	Papers	Benefits	Challenges and limitations	Suitability/Applicability
Investment-cash flow sensitivity model	Baik et al. (2010), Peláez (2010), Biddle (2011), Daniel et al. (2016)	Measures access to capital, identifies underinvestment, identifies overinvestment, applicable to non-listed firms, focuses on internal generation and discriminates between firm types (D'Espallier et al.,2008; Wan & Zhu, 2011; Mulier et al., 2016)	Measurement errors, declining empirical relevance, poor discriminatory power, confounding factors and declining significance (George et al., 2011; Chen & Chen, 2012; Chowdhury et al., 2016)	Listed and non-listed firms (private and SMEs). It is particularly useful for small and medium-sized enterprises (SMEs) or private firms where market-based data (such as Tobin's q) is unavailable.

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Table 1 continued

Model	Papers	Benefits	Challenges and limitations	Suitability/Applicability
Richardson (2006) Investment Expectation Model	Elberry and Hussainey (2021), Bai et al. (2023), Liu et al. (2025)	Identifies investment inefficiencies, provides a comprehensive measure of investment efficiency, focuses on managerial agency costs and is applicable in diverse contexts (Richardson, 2006; Hu et al., 2011; Cai, 2014)	Estimation issues, sensitivity to free cash flow and zero-mean residual limitation (Bergstresser, 2006; Lu et al., 2017)	Listed firms. Its application to non-listed firms is conditional upon data availability (Richardson, 2006; Elberry & Hussainey, 2021; Bai et al., 2023; Liu et al.,2025)
McNichols and Stubben (2008) Model of Investment Efficiency	Le et al. (2024)	Provide evidence of overinvestment due to misreporting, helps identify "normal" vs "abnormal" investment and correction of investment behaviour post-manipulation (McNichols & Stubben, 2008)	Focusing primarily on listed U.S. firms, potential measurement errors, omission of other drivers of efficiency (McNichols & Stubben, 2008)	Listed firms. Its application to non-listed firms is conditional upon data availability (McNichols & Stubben, 2008; Liu et al., 2021; Le et al., 2024)
Bidel et al., 2009 Model of Investment Efficiency	Salehi et al. (2022), Kumar et al. (2023), Omara and Rashed (2023), Assad et al. (2023), Thien and Hung (2023), Jafeel et al. (2023), Khan et al. (2024), and Badpa and Tamshidi (2025).	It offers a robust, quantitative method for identifying how information quality reduces investment frictions, **controls for market frictions** and aligns capital allocation with positive NPV projects (Bidel et al., 2009; Kumar et al., 2023)	Measurement and estimation limitations, contextual and environmental constraints and conceptual limitations (Omara & Rashed,2023; Jafeel et al., 2023)	Listed firms. (Bidel et al., 2009; Omara & Rashed,2023; Assad et al., 2023; Thien & Hung, 2023; Jafeel et al., 2023; Khan et al., 2024; Badpa & Tamshidi, 2025)
Chen et al. (2011) Parsimonious Model of Expected Investment	Ardianto et al. (2020), Elberry and Hussainey (2020), Anh et al. (2024),	Enhances investment efficiency study in private/emerging markets, identifies impact of information quality, simplicity and parsimony, robustness across	**Reliance on sales growth as a single proxy, limited generalizability**	Both listed and non-listed firms. But the original 2011 study specifically focused on **private firms** in

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Table 1 continued

Model	Papers	Benefits	Challenges and limitations	Suitability/Applicability
		proxies and supports agency theory application (Chen et al., 2011)	**and omission of intangible assets** (Chen et al., 2011; Baik et al., 2024)	emerging markets (Chen et al., 2011; Ardianto et al., 2020; Elberry & Hussainey, 2020; Anh et al., 2024)
Zhu et al. (2014) Model of Investment Efficiency	Zhu et al. (2014), Ayagi (2023)	provide comprehensive, non-parametric assessments that identify performance benchmarks while accommodating diverse data scales for improved corporate resource allocation (Zhu et al., 2014)	Measurement of growth opportunities, limited applicability to non-public or specialized firms, failure to capture non-financial drivers and information asymmetry misalignment (Zhu et al., 2014; Pereira, 2024)	Both public and private companies, although applying it to private firms requires methodological adjustments (Zhu et al., 2014; Gaio et al, 2023)
Nurcholisah (2016) Model of Investment Efficiency	Nurcholisah (2016),	The model shows how to mitigate agency issues, limit over-investment, and help prevent under-investment by reducing the cost of capital, ultimately optimizing resource allocation (Nurcholisah, 2016)	Overlooks dynamic macroeconomic variables (e.g., debt maturity, CEO career concerns) that alter a manager's investment behavior (Nurcholisah, 2016)	Both listed and non-listed firms (Nurcholisah, 2016; AL-Shatnawi, 2017)
Valiyan et al. (2022) Investment Efficiency	Valiyan et al. (2022)	Show how corporate firms could optimize resource allocation to maximize firm value Valiyan et al. (2022)	Equate investment efficiency to basic asset allocations and stated investment levels, which may fail to capture the true Net Present Value (NPV) of individual projects or long-term operational returns Valiyan et al. (2022)	Both listed and non-listed firms with specific data adjustments Valiyan et al. (2022)
Gaio et al. (2023) Model of Investment Efficiency	Gaio et al. (2023)	Highlight how to improve identification of positive NPV projects within diverse market	Reliance on subjective proxies for earnings quality, sample and geographic bias, endogeneity and	Both listed and non-listed firms (Gaio et al., 2023)

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Table 1 continued

Model	Papers	Benefits	Challenges and limitations	Suitability/Applicability
		environments (Gaio et al., 2023)	reverse causality and neglect of external disruptions (Gaio et al., 2023)	
Askarzadeh and Yung (2025) model of Investment Efficiency		Minimizes deviation from optimal investment, enhances decision-making (Askarzadeh & Yung, 2025)	Measurement ambiguities, generalizability across firm types and external macro shocks (Askarzadeh & Yung, 2025)	Listed firms excluding financial institutions and utility firms (Askarzadeh & Yung, 2025)

2.2 Theoretical review

Agency theory

Agency theory was developed in the mid-20th century by Stephen Ross and Barry Mitnick. It was later popularised and formalized in corporate governance by Michael C. Jensen **and** William H. Meckling (Eisenhardt, 1989; Mitnick, 2019). It is a supposition that explains the principal-agent relationship, or simply an agency relationship, that is, a relationship between principal and agent in a given transaction, whereby the principal hires the agent to make decisions or act on his behalf (Ingram, 2017*). The theory presupposes that* both the principal and the agent are motivated by divergent interests, so that the agent's interests may not align with those of the principal. And as long as their respective interests conflict, the agent is likely to pursue his self-serving objective, which diverges from the principal's goals. This conflict of interest is referred to as the agency problem, principal–agent problem, or agency dilemma, which further begets other problems such as asymmetric information (hence, moral hazard), distrust, and controversies between the principal and the agent.

Hanks (2017) gave a prime example of the moral hazard problem in the financial market, in which stockholders (the principal) charge managers (agents who hold less than 100% ownership of the company's stock) with efficiently steering the company, but the managers decide to put their own needs first. Also, on project selection, that is, a typical scenario where moral hazards problems arise, Lara et al. (2010) and Kim and Kwon (2015) pointed out that managerial myopic biases and expropriation of the firm's resources might tempt the managers to either select and implement capital project that are not profitable or decide not even invest at all; hence, causing inefficiency in corporate investment.

In line with Lara et al. (2010), Verdi (2006), and Biddle et al. (2009), who also argue that the moral hazard problem resulting from information asymmetry affects project selection. Since managers may not act in investors' best interests, they may instead choose to maximize their own welfare by inefficiently investing in poor projects. Also, scholars such as Ibrahim and Ibrahim (2021) and Thien and Hung (2023) agree that inefficiency in corporate investment results from agency conflicts, which prompt management to deviate from optimal investment levels.

Issue-invest decision theory

Issue-Invest Decision Model was developed by Myers and Majluf (1984). It is considered a modification of the Pecking Order Theory. The model predicts an inverse relationship between COE and IE based on the argument that where a firm lacks financial slack (that is, large holdings of operating cash flows, marketable securities or the ability to issue default-risk-free debt), it would rationally prefer to forego profitable investments rather than issuing shares at a price less than their actual market value in order to finance the investments. This view has been supported by scholars such as Xie (2013), who found that higher COE stemming from information asymmetry leads to either underinvestment or greater dependence on internally generated funds.

Consistent with the Issue-Invest Decision proposition, Adelegan and Ariyo (2008), Rahman et al. (2013) and Rymar (2016) also extensively explained that the exorbitant COE (i.e. liquidity constraint) could force the borrower (listed firm) to either recourse to internal finance (i.e. internal cash flow) or pass up the profitable investment projects, thereby underinvesting. Furthermore, Xie (2013) explained that, where the capital market is imperfect and the level of asymmetric information is high, both shareholders and debt holders react in the same way by rationally raising their respective financing costs. Thus, the only resort is internal cash flow, and since internal and

external finance are imperfect substitutes in the presence of information asymmetry, a firm might end up underinvesting even if it relies heavily on internally generated funds.

3. Methodology

As the main aim of this paper is to review the measurement models of IE, it adopted a conceptual review approach to gain a deeper understanding of the existing models and the rationale for using them as measures of IE. Relevant empirical research articles published in various Accounting and Finance journals from 2006 to 2025 served as the main data source for the study. The articles were obtained from databases such as Google Scholar, ResearchGate, SSRN (Social Science Research Network), ScienceDirect, EBSCO Business Source Complete, and ProQuest Accounting, Tax & Banking Collection. The main inclusion criterion is that articles must include IE in or as part of their title and must clearly use measurement model(s) of IE.

5. Conclusion

Based on the conceptual review, the paper concluded that there has not been a generally accepted measurement model of IE and that the majority of the measurement models used in previous relevant studies are suitable for listed firms; their applicability to non-listed firms depends on data availability. Also, the models offer distinct benefits, but none is without shortcomings. Therefore, the paper suggested that investors, corporate firms, financial analysts, and future researchers should consider the type, nature, and peculiarity of their industry, as well as the benefits and limitations of each model, before deciding which to employ when measuring IE.

References

Adelegan, O. J., & Ariyo, A. (2008). Capital market imperfections and corporate investment behavior: A switching regression approach using panel data for Nigerian manufacturing firms. *Journal of Money, Investment and Banking*, 2, 16-38.

Alizadeh, F., Hemmati, H., & Sarraf, H. (2015). *Financial reporting quality and debt maturity along with investment efficiency*. [Link]

AL-Shatnawi, H. M. (2017). Measuring the quality of the interim financial reports using the qualitative characteristics of the accounting information and its effect on the investment decisions according to the "IAS 34." *International Journal of Economics and Finance*, 9(5), 159-170. [Crossref]

Anh, D. L. T., Quang, N. T. T., & Anh, N. T. (2024). Investment decision and efficiency: Global insights on manufacturing firms amidst energy uncertainties. *Energy Economics*, 137, 107793. [Crossref]

Ardianto, A., Anridho, N., Ngelo, A. A., Ekasari, W. F., & Haider, I. (2023). Internal audit function and investment efficiency: Evidence from public companies in Indonesia. *Cogent Business & Management*, 10(2), 2242174. [Crossref]

Ascioglu, A., Hegde, S. P., & McDermott, J. B. (2008). Information asymmetry and investment cash flow sensitivity. *Journal of Banking & Finance*, 32(6), 1036-1048. [Crossref]

Askarzadeh, A., & Yung, K. (2025). *Internationalization and investment efficiency*. [Link]

Assad, N., Jaafar, A., & Zervopoulos, P. D. (2023). The interplay of real earnings management and investment efficiency: Evidence from the US. *Cogent Business & Management*, 10(2), 2237174. [Crossref]

Ayagi, S. R. (2023). Disclosure quality and investment efficiency of listed Deposit Money Banks in Nigeria: Direct and mediated effects via information asymmetry and cost of capital. *Bayero Journal of African Entrepreneurship Studies*, 5(2), 5-24.

Badpa, B., & Jamshidi, M. A. (2025). The effects of cost efficiency and investment efficiency on value chain performance and cash flow growth. *Iranian Journal of Accounting, Auditing & Finance (IJAAF)*, 9(4).

Bai, Y., He, L., & Zhang, T. (2023). Common institutional ownership and investment efficiency: Empirical evidence from China. *Borsa Istanbul Review*, 23(5), 1067-1077. [Crossref]

Baik, D., Chen, C. X., & Godsell, D. (2024). Board gender diversity and investment efficiency: Global evidence from 83 country-level interventions. *The Accounting Review*, 99(3), 136. [Crossref]

Bao, Z., & Motlagh, B. P. (2024). How investment efficiency affects firms performance? *Accounting and Auditing with Applications*, 1(1), 17-26.

Bergstresser, D. (2006). Discussion of "Overinvestment of free cash flow." *Review of Accounting Studies*, 11(2), 191-202. [Crossref]

Biddle, G. C. (2011). *Does mandatory adoption of international financial reporting standards increase investment efficiency?* [Link]

Biddle, G. C., & Hilary, G. (2006). Accounting quality and firm-level capital investment. *The Accounting Review*, 81(5), 963-982. [Crossref]

Biddle, G. C., Hilary, G., & Verdi, R. S. (2009). How does financial reporting quality relate to investment efficiency? *Journal of Accounting and Economics*, 48(2-3), 112-131. [Crossref]

Bleibtreu, C., Erinc, M., Orozco, L., & Shi, Z. (2025). Auditors and client investment efficiency: A quasi-replication and further insights from a regulatory change. *Journal of Business Economics*, 95(2), 257-294. [Crossref]

Cai, J. F. (2014). Investor protections, financial development and corporate investment efficiency. *Journal of Applied Finance and Banking*, 4(6), 59.

Chen, F., Hope, O. K., Li, Q., & Wang, X. (2011). Financial reporting quality and investment efficiency of private firms in emerging markets. *The Accounting Review*, 86(4), 1255-1288. [Crossref]

Chen, H. J., & Chen, S. J. (2012). Investment-cash flow sensitivity cannot be a good measure of financial constraints: Evidence from the time series. *Journal of Financial Economics*, 103(2), 393-410. [Crossref]

Chowdhury, J., Kumar, R., & Shome, D. (2016). Investment-cash flow sensitivity under changing information asymmetry. *Journal of Banking & Finance*, 62, 28-40. [Crossref]

Daniel, N. D., Naveen, L., & Yu, J. (2016). *Revisiting investment-cash flow sensitivity*. [Link]

D'Espallier, B., Vandemaele, S., & Peeters, L. (2008). Investment-cash flow sensitivities or cash-cash flow sensitivities? An evaluative framework for measures of financial constraints. *Journal of Business Finance & Accounting*, 35(7-8), 943-968. [Crossref]

Du, J. (2014). Research about the influence of transparency of accounting information on corporate investment efficiency. *Journal of Chemical and Pharmaceutical Research*, 6(7).

Eisenhardt, K. M. (1989). Agency theory: An assessment and review. *Academy of Management Review*, 14(1), 57-74. [Crossref]

Elaoud, A., & Jarboui, A. (2021). Auditor's criteria and investment efficiency: The moderating effect analysis. *Academy of Accounting and Financial Studies Journal*, 25(4), 1-10.

Elberry, N., & Hussainey, K. (2020). Does corporate investment efficiency affect corporate disclosure practices? *Journal of Applied Accounting Research*, 21(2), 309-327. [Crossref]

Elberry, N., & Hussainey, K. (2021). Governance vis-à-vis investment efficiency: Substitutes or complementary in their effects on disclosure practice. *Journal of Risk and Financial Management*, 14(1), 33. [Crossref]

Fan, M., & Phromphitakkul, W. (2021). Impact of female executive on investment efficiency of listed companies in Shanghai stock market: A case of over-investment. *Modern Economy*, 12(6), 1119-1136. [Crossref]

Fan, M., & Phromphitakkul, W. (2021). Impact of female executive on investment efficiency of listed companies in Shanghai stock market: A case of over-investment. *Modern Economy*, 12(6), 1119-1136. [Crossref]

Fazzari, S. R., Hubbard, G., & Petersen, B. (1988). Financing constraints and corporate investment. *Brookings Papers on Economic Activity*, 1, 141-195. [Crossref]

Gaio, C., Gonçalves, T. C., & Cardoso, J. (2023). Investment efficiency and earnings quality: European evidence. *Journal of Risk and Financial Management*, 16(4), 224. [Crossref]

Gao, R., & Yu, X. (2020). How to measure capital investment efficiency: A literature synthesis. *Accounting & Finance*, 60(1), 299-334. [Crossref]

Geamănu, M. (2011). Economic efficiency and profitability. *Studia Universitatis Vasile Goldiş, Arad-Seria Ştiinţe Economice*, 21(2), 116-119.

George, R., Kabir, R., & Qian, J. (2011). Investment-cash flow sensitivity and financing constraints: New evidence from Indian business group firms. *Journal of Multinational Financial Management*, 21(2), 69-88. [Crossref]

Hanks, G. (2017). *Examples of agency problems in financial markets*. [Link]

Hu, R., Tian, J., & Wu, X. (2011). The empirical measurement of enterprise inefficient investment - Richardson-based investment expectation model. In *International Conference on Information and Business Intelligence* (pp. 461-467). Springer Berlin Heidelberg. [Crossref]

Huang, X. J., & Yan, H. (2012). Shareholding structure, investment efficiency and firm value: Evidence from the Chinese securities market. In *Technology for Education and Learning* (pp. 549-555). Springer Berlin Heidelberg. [Crossref]

Ibrahim, A., & Ibrahim, A. (2021). The impact of risk disclosure on investment efficiency: Evidence from Egypt. *Alexandria Journal of Accounting Research*, 1(5), 1-39.

Ingram, D. (2017). *The agency theory in financial management*. [Link]

Jafari, A., Masoumi, S. R., & Bargbid, A. (2015). Examining the relation between financial reporting quality, short-term debt and investment inefficiency of the listed companies in Tehran stock exchange. *Science Journal (CSJ)*, 36(4).

Kaplan, S. N., & Zingales, L. (1997). Do financing constraints explain why investment is correlated with cash flow? *Quarterly Journal of Economics*, 112(1), 169-215. [Crossref]

Kazakis, P., Leung, W. S., & Ongena, S. (2023). *Investment efficiency of private and public firms* (No. 23-89). International Center for Financial Asset Management and Engineering. [Crossref]

Khan, M. A., Safdar, N., & Manzoor, W. (2024). Financial reporting quality and investment efficiency: A transnational evidence. *Pakistan Journal of Commerce and Social Sciences*, 18(2), 285-305. [Crossref]

Khan, M. A., Yau, J. T. H., Sarang, A. A. A., Gull, A. A., & Javed, M. (2025). Information asymmetry and investment efficiency: The role of blockholders. *Journal of Applied Accounting Research*, 26(1), 194-221. [Crossref]

Kim, K., & Kwon, O. (2015). The investment efficiency of private and public firms: Evidence from Korea. *The Journal of Applied Business Research*, 31(4). [Crossref]

Kumar, A. M., Chandrarin, G., & Harmono, H. (2023). Quality of financial statements, investment efficiency and firm value. *Journal of Economics, Finance and Management Studies*, 6(1), 407-418. [Crossref]

Lara, J. M. G., Osma, B. G., & Penalva, F. (2010). *Conditional conservatism and firm investment efficiency*. [Link]

Le, H. T. M., Cheng-Po, L., Phan, V. H., & Pham, V. T. (2024). Financial reporting quality and investment efficiency in manufacturing firms: The role of firm characteristics in an emerging market. *Journal of Competitiveness*, 16(1), 62.

Lenger, S., Ernstberger, J., & Stiebale, J. (2015). *The impact of IFRS on firms' investment efficiency - European evidence on private and public firms*. [Link]

Liu, K., Zhu, Y., Su, X., Lu, L., & Fu, R. (2025). Research on the impact of cross-border mergers and acquisitions on investment efficiency: Evidence from Chinese listed companies. *Humanities and Social Sciences Communications*, 12(1), 1-18. [Crossref]

Liu, S., Lin, S., Sun, Z., & Yuan, L. (2021). Earnings management and firms' investment behavior: The threshold effect of ROE. *Emerging Markets Review*, 47, 100797. [Crossref]

Lu, S., Young, W., & Hsieh, M. S. (2017). The impacts of overinvestment and financial constraints on seasoned equity offering long-run performance. *International Journal of Economics and Financial Issues*, 7(5), 216.

Maulana Akbar, A., & Salad, Z. (2022). *Sustainability and investment efficiency: A study of the effect of ESG score on investment efficiency in the biotechnological industry*. [Link]

McNichols, M. F., & Stubben, S. R. (2008). Does earnings management affect firms' investment decisions? *The Accounting Review*, 83(6), 1571-1603. [Crossref]

Mitnick, B. M. (2019). *Origin of the theory of agency: An account by one of the theory's originators*. Available at SSRN 1020378.

Mohammadi, S. M. (2014). The relationship Tehran stock exchange. *International Journal of Academic Research in Business and Social Sciences*, 4(6). [Crossref]

Moradzadehfard, M., Pooryeganeh, N., Samadiyan, B., & Ebrahimi, H. (2013). Study the relation between financial reporting quality and corporate investment (Case study of firms accepted in listed firms of Tehran-Iran Stock Exchange). *Life Science Journal*, 10(1s).

Mulier, K., Schoors, K., & Merlevede, B. (2016). Investment-cash flow sensitivity and financial constraints: Evidence from unquoted European SMEs. *Journal of Banking & Finance*, 73, 182-197. [Crossref]

Myers, S. C., & Majluf, N. S. (1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics*, 13(2), 187-221. [Crossref]

Nasir, A., Haris, A., Qaisar, A. M., & Abdul, W. (2018). Impact of investment efficiency on cost of equity: An empirical study on Shariah and non Shariah compliance firms listed on Pakistan Stock Exchange. *Pakistan Administrative Review*, 2(3), 307-322.

Nurcholisah, K. (2016). The effects of financial reporting quality on information asymmetry and its impacts on investment efficiency. *International Journal of Economics, Commerce and Management*, *IV*(5).

Omara, M. R., & Rashed, A. (2023). Financial flexibility and investment efficiency: The moderating role of board financial expertise. *Investment Management & Financial Innovations*, 20(4), 283. [Crossref]

Peláez, B. B. (2010). *Segment disclosure, cost of capital and investment efficiency*. [Link]

Pereira, C., Castro, B., Gomes, L., & Canha, H. (2024). Firms' investment level and (in)efficiency: The role of accounting information system quality. *International Journal of Financial Studies*, 12(1), 9. [Crossref]

Poorzamani, Z., & Keivanfar, M. (2015). Impact of financial reporting quality on investment inefficiency. *European Online Journal of Natural and Social Sciences*, 4(1).

Rahman, A. F., Hassan, M. S., Saleh, N. M., & Zaleha, A. S. (2013). The effect of underinvestment on the relationship between earnings management and information asymmetry. *Asian Academy of Management Journal of Accounting and Finance*, 9(2), 1-28.

Richardson, S. (2006). Over-investment of free cash flow. *Review of Accounting Studies*, 11(2), 159-189. [Crossref]

Rymar, I. E. (2016). *Information asymmetry and its impact on cost of equity capital: Volkswagen case*. [Link]

Salehi, M., Zimon, G., Arianpoor, A., & Gholezoo, F. E. (2022). The impact of investment efficiency on firm value and moderating role of institutional ownership and board independence. *Journal of Risk and Financial Management*, 15(4), 170. [Crossref]

Thien, T. H., & Hung, N. X. (2023). Intellectual capital and investment efficiency: The mediating role of strategic management accounting practices. *Cogent Business & Management*, 10(2), 2207879. [Crossref]

Valiyan, H., Abdoli, M., & Saghari, M. A. (2022). Stakeholder relationship capability and investment efficiency: A mosaic theory test. *Measuring Business Excellence*, 26(3), 346-365. [Crossref]

Verdi, R. S. (2006). *Financial reporting quality and investment efficiency*. [Link]

Wan, H., & Zhu, K. (2011). Is investment-cashflow sensitivity a good measure of financial constraints? *China Journal of Accounting Research*, 4(4), 253-270. [Crossref]

Wang, J., & Zhu, S. (2025). Impact of economic policy uncertainty on corporate investment efficiency: Moderating roles of financing constraints and financialization. *International Review of Economics & Finance*, 98, 103897. [Crossref]

Xie, L. (2013). *How does asymmetric information relate to investment efficiency? Evidence from analysts' earnings forecasts and daily stock trading*. [Link]

Yahya-Jafeel, A., Abdelbagi Abdalla, Y., Amin Abdalla, A., & Hersi Warsame, M. (2023). How corporate governance quality affects investment efficiency? An empirical analysis of nonfinancial companies in the Gulf Cooperation Council 2015-2020. *Cogent Business & Management*, 10(1), 2198061. [Crossref]

Zhi, Q. (2023). Calculating investment efficiency of Chinese energy enterprises by DEA method. In *E3S Web of Conferences* (Vol. 403, p. 08006). EDP Sciences. [Crossref]

Zhu, Z., Wang, F., Zhang, M., & Hoffmire, J. (2014). Financial reporting quality, collateral value, and investment efficiency: Evidence from China. *Advanced Management Science*, 3(2).