How price informativeness affects the sensitivity of investment-to-stock price in Vietnamese listed firms

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Abstract: This study investigates the relationship between the stock market and firm investment from a price informativeness perspective. Using an unbalanced panel dataset of Vietnamese listed firms from 2007 to 2017, the results show that stock market valuation is positively related to firm investment in both static and dynamic models. Moreover, the investment of firms with a higher level of price informativeness is likely less sensitive to their stock prices than that of firms with a lower level of price informativeness. In addition, the development of financial markets plays an important role in determining investment and investment-to-stock-price sensitivity. The regression results also show that the role of price informativeness in the investment-to-stock price relationship is not much different among groups of firms with high and low-quality auditors, as well as those with small and large firms.

Keywords: firm investment; stock market valuation; price informativeness; emerging markets.

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1 Introduction

The relationship between the stock market and investment behaviour has received much attention from the broad literature on corporate finance. The theory of investment argues that firm managers could make investment decisions based on the ratio of real capital assets to their replacement cost if the capital market is efficient (Summers et al., 1981; Tobin, 1969). However, it is widely accepted that the capital market is not always efficient (Sharma and Thaker, 2015) because of market manipulation (Comerton-Forde and Putniņš, 2014), poor information disclosure (Shamsuddin and Kim, 2010), and market friction (Shleifer and Vishny, 1997). Consequently, movements in stock prices do not fully reflect the fundamental value of a firm's investment. Not only corporate managers, but also policymakers, are interested in investigating the effect of stock price information on firm investment. Stock prices aggregate information during speculative trading activities to consolidate information from outsiders (Subrahmanyam and Titman, 1999), and corporate managers can use such information to make better investment decisions. For policymakers, findings on the correlation between the stock market and firm investment can provide guidance about the stock market and in policy proposals that are highly adaptive to the actual market.

While the strong relationship between the stock market and corporate investment and the key role of price informativeness in price-to-investment sensitivity have generally been established in the literature, recent studies have paid more attention to developed markets (Baker et al., 2003; Barro, 1990; Blanchard et al., 1993; Chen et al., 2007; Fung and Tsai, 2015) than emerging markets, in which the capital market is less efficient (Dickinson and Muragu, 1994; Gupta et al., 2018). Additionally, the demand for investment in long-term fixed assets and infrastructure is large in developing countries, as is necessary to boost the economy (Nazmi and Ramirez, 1997). Moreover, investment from the private sector has a greater direct effect on economic growth than public investment (Khan and Reinhart, 1990). However, many emerging markets have inadequate disclosure, information, accounting standards, and basic 'hard data'. Thus, in emerging markets such as Vietnam, information derived from stock prices may be different from that in developed markets. Consequently, this affects the investment-to-price relationship in different ways because of the potential different institutions (Ben-Nasr and Cosset, 2014; Fernandes and Ferreira, 2009). Therefore, the relationship between price informativeness and investment-to-price sensitivity should be viewed differently for different types of markets.

In Vietnam, most empirical studies consider the effect of various factors on investment such as the debt market (Phan, 2018; Vo, 2019), stock market liquidity (Ha and Vinh, 2017; Tho and Y, 2016), or other firm-specific characteristics (Okuda and Nhung, 2012; Tran and Le, 2017), rather than that of the stock market's functioning. The effect of price informativeness is also rarely found in recent literature. To the best of our knowledge, our study is the first to consider the role of the stock market's functioning on firm investment in Vietnam. In this study, several approaches are also applied to observe the role of price informativeness in investment-stock price sensitivity and that of the development of financial markets in the relationship between the stock market and investment from a price informativeness perspective. As a result, this study uncovers the patterns of firms as observed from stock prices, which differ from those documented in the context of developed countries (Bakke and Whited, 2010; Chen et al., 2007). This is

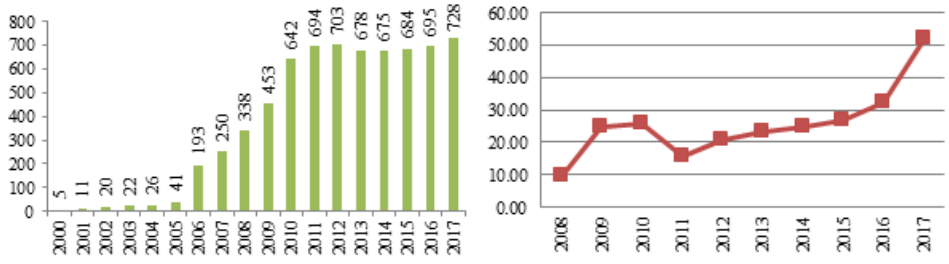
possibly due to the differences in country-level institutional infrastructure, stock price informativeness, and the value that strategic managers attach to such information.

The remainder of this paper is organised as follows. Section 2 presents an overview of the stock market and private investment in Vietnam. Section 3 provides a literature review of the stock market and firm investment at the aggregate and firm levels. Section 4 discusses the sample and model. Section 5 presents the empirical regression results and discussion. Finally, Section 6 provides the conclusions and suggestions.

2 The stock market and firm investment in Vietnam

The Vietnamese stock market started with the establishment of the Ho Chi Minh City Stock Trading Center in 2000. At that time, there were only five listed firms with a total market capitalisation of nearly 1 trillion dongs. By the end of 2017, Vietnam's stock market had 728 listed firms in two stock exchanges in Ho Chi Minh City (HOSE) and Ha Noi (HNX). The total market capitalisation was only 0.28% of gross domestic product (GDP) in 2000, which reached over 50% in 2017. An overview of the financial markets and the development of Vietnam's stock market are provided in more detail in Vo (2016). Figure 1(a) shows the increase in the number of listed firms in 2000–2017, while Figure 1(b) demonstrates the total-market-capitalisation-to-GDP ratio over the last ten years.

Figure 1 (a) Number of listed firms from 2000 to 2017* (b) The market capitalisation of listed firms (% of GDP) from 2008 to 2017** (see online version for colours)

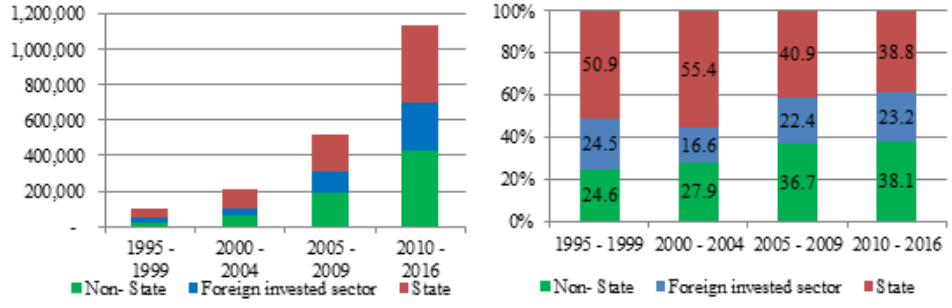


(a) (b)

Source: *State Securities Commission (SSC) of Vietnam, **World Bank, World Development Indicators

In over 20 years, the total average investment has dramatically increased tenfold from over 100 trillion dongs in 1995–1999 to about 1,100 trillion dongs in 2010–2016 [Figure 2(a)]. As shown in Figure 2(b), the investment structure has changed as well. The domestic private sector only accounts for approximately 24% to 28% of the total investment during 1995–2004. However, from 2005 onwards, this figure has noticeably increased to 38%. An overview of firm-level investments from the private and public sectors in Vietnam is available in more detail in Nguyen and van Dijk (2012). The private sector's role in the economy was promoted and continues to increase with the support of two laws: the Private Enterprise Law in 1990 and the Company Law in 1990. Meanwhile, domestic private investment was also promoted by issuing the Domestic Private Investment Promotion Law in 1994.

Figure 2 (a) Total investment from 1995 to 2016* (b) Share of investment by types of ownership from 1995 to 2016 (see online version for colours)

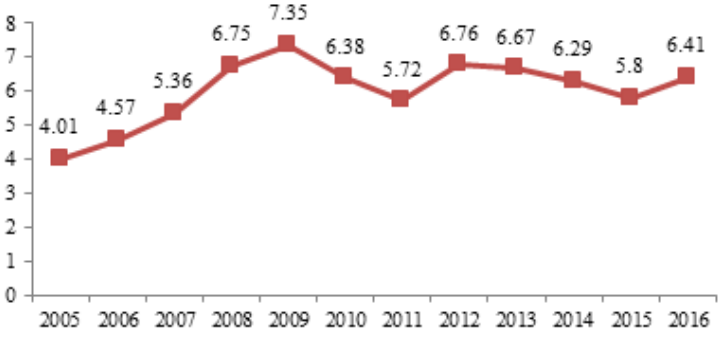


Note: *Investment is in billion dongs.

Source: General Statistics Organization (GSO) Vietnam

However, the incremental capital-output ratio (ICOR) still remained quite high compared with other ASEAN countries. On average, in 1995–2011, Vietnam required five units of capital investment to generate 1 unit of extra production, while these figures were 3 for Indonesia, 3.5 for Malaysia, and 4.3 for Thailand (OECD, 2013). Figure 3 shows that the ICOR did not improve over the ten years from 2005 to 2016.

Figure 3 ICOR in Vietnam (see online version for colours)



Source: General Statistics Organization of Vietnam

Clearly, the increase in total investment is associated with the development of the stock market in Vietnam. Moreover, the share of total investment from the private sector has sharply grown over the span of 20 years, whereas the number of listed firms has also increased.

3 Literature review

3.1 Stock market and firm investment in aggregated data

Several studies have investigated the interaction between firm investment and the stock market at the aggregated level. It is important to examine the relationship between the stock market and firm investment because the stock market allows firms to raise funds by

issuing new shares and corporate bonds, which in turn are used by firms for investment. One strand of literature confirms that the stock market plays a weak role in investment growth. For instance, von Furstenberg et al. (1977) were one of the first studies to explain the importance of the stock market to investment, in which the stock market is measured by the *q*-ratio. The *q*-ratio is the ratio of the market value of the liabilities to the replacement cost of the assets. Gross investment is measured as a percentage of the real capital stock of non-financial corporations. Using the ordinary least squares (OLS) estimator, their result demonstrates that market valuation has no additional explanatory power with regard to investment decisions when controlling for other variables in the US data.

Similarly, Barro (1990) evaluated the correlation between the stock market and investment in the USA and Canada from 1891 to 1987, where he considered the growth rate of investment to be the growth rate of real fixed, non-residential, private domestic investment. He measured the changes in the stock market as the growth rate of *q*, where *q* is the ratio of the total nominal market value of non-financial corporations to capital stock at nominal reproduction cost. He alternatively and iteratively regressed investment on current and one-year lagged growth rates of stock market prices, the growth rate of the *q*-ratio, the after-tax corporate profit variable, and the one-year lagged growth rate of investment. The robustness of the result was checked using the monthly stock price as a measure of the stock market variable. He found that the different measures of stock market variables produce contradictory results. In particular, past stock returns have a significant impact on investment, while the one-year lagged *q*-ratio has only limited predictive value for investment.

In addition, Blanchard et al. (1993) also used the OLS method applied on 90 years of data from 1900 to 1990 to see how stock market fluctuations affect investment in the USA. They argued that the optimal firm valuation by corporate managers and the firm's valuation by the stock market are different. This difference might be due to the difference in information or bubbles. They added the lagged values of both managers' valuation and stock market valuation into the investment equation and found that both measures significantly affect investment. However, when they controlled for fundamentals, they found that market valuation plays a limited role in investment decisions.

The second strand of literature documents the significant effect of the stock market on investment. Galeotti and Schiantarelli (1994) developed a model in which they argued that investment is related to the stock market in terms of dividend and the market value of equity and debt. They then proposed that the movements of market value are decomposed by the fundamental and non-fundamental component changes and tried to show the effect of changes in non-fundamentals on investment. They used quarterly US data for the non-financial sector from 1954 to 1987 to test the relationship between investment and the two components of stock price changes. Using a generalised method of moments (GMM) estimator to allow for serial dependence of the error terms, this study found a significant relation between investment and the two components of stock price changes. Laopodis and Sawhney (2007) also used the US data from 1970 to 2003 to test the cointegration relationship between the stock market and private investment. They followed Engle and Granger's (1987) methodology to find the long-run and short-run interaction between the stock market and investment in the USA. The study showed that the past changes in investment and stock prices are interactive in the long run, while the short-run correlation between two time series is insignificant.

Henry (2000) used a sample of 11 developing countries from 1977 to 1994 to examine the correlation between private investment and the stock market when the government allowed foreigners to trade more shares in the stock market. He considered both stock market valuation and stock return as measures of the stock market variable. Using the OLS method, he found that stock market valuation has a strong correlation with private investment and that the liberalisation of the stock market boosts private investment. Similarly, Benson Durham (2002) also used the OLS estimator on data of 64 countries from 1981 to 1998 to examine the long-run and short-run relationships between the liberalisation of the stock market and private investment. He found that the stock market only positively affects investment in higher-income countries.

In summary, at the aggregate level, the relationship between the stock market and investment is mostly investigated using the OLS method, and many pieces of evidence come from the US data. Moreover, the positive effect of the stock market on investment is not always documented, and this correlation is influenced by other macroeconomic conditions.

3.2 Stock market valuation, firm investment, and price informativeness

The effect of the stock market on investment at the firm level through its informational role is also explored in several previous studies because the stock market aggregates more information than what is revealed by macroeconomic variables (Cover and Lee, 2015). However, most studies have explored this relationship based on the US data (Baker et al., 2003; Bakke and Whited, 2010; Barro, 1990; Blanchard et al., 1993; Chen et al., 2007; Morck et al., 1990; Ouyang and Szewczyk, 2016; Polk and Sapienza, 2009). Furthermore, the impact of price informativeness on the sensitivity of firm investment and stock price is still under debate.

The first strand of literature confirms that the level of price informativeness affects the sensitivity between stock market valuation and firm investment. Morck et al. (1990) ran an OLS regression on each equation in a system of unstructured equations to see how the stock market predicts investment as viewed from an informational, financing, and market pressure perspective by obtaining the significance of coefficients and the incremental power of *R-squared*. They found that the stock market affects investment through its informational role, but not through market pressure and cost of financing. However, this study applies the OLS method on cross-sectional data that is limited to capturing the relationship between investment and stock market valuation over years. Using a different approach, Chen et al. (2007) employed the fixed-effects model to investigate the effect of price informativeness on the relationship between investment and stock prices using panel data of US firms from 1981 to 2001. They showed that price informativeness has a strong and positive effect on the correlation between firm investment and stock price.

Similarly, Bakke and Whited (2010) used data in 1991–2004 to examine this relationship. Using both OLS and GMM methods, they confirmed that price informativeness matters for firm investment. Additionally, Foucault and Gehrig (2008) developed a new theory of cross-listing in which they argued that the manager extracts information from stock prices to make investment decisions. Using a statistical summary of cross-listing premium and trading concentration in the USA, they proved that firms obtain more information from cross-listings and hence, make better investment decisions. Ouyang and Szewczyk (2016) strictly followed Chen et al. (2007) to test the role of price

informativeness in the sensitivity of merger investment-to-stock price. Applying the OLS method to US data, they found similar results to that of Chen et al. (2007) – that price informativeness increases merger investment-stock price sensitivities.

The second strand of literature documents that information in stock prices does not play any role in the correlation between stock market valuation and firm investment for several entities. In the USA, Fung and Tsai (2015) investigated the stock market and firm investment through three functions, as in Morck et al. (1990), but they used updated panel data from 1990 to 2006. Additionally, they argued on the endogeneity issue among corporate financing decisions and investment decisions to apply two-stage least squares with an instrumental variable. However, the results only showed that the stock market does not affect investment through an informational role. Similarly, Bolbol and Omran (2005) tested how stock markets affect firm investment from the perspectives of information, financing, and market pressure in 83 Arab firms from 1996 to 2001. Closely following Morck et al.' s (1990) methodology, they showed similar results – that the stock market does not matter to Arab firms' investment. In China, Wang et al. (2009) examined the effect of the stock market on firm investment from a price informativeness perspective. They also argued that the endogeneity problem is caused by the simultaneous determinants of investment decisions, financing decisions, company fundamentals, and market performance. However, they simply followed the broad literature to use OLS estimation and ignored the endogeneity issue. The results showed that the stock market does not affect firm investment because stock prices contain little information about firms' future operating performance.

The third view on the relationship among price informativeness, stock market valuation, and firm investment is different from the first two views. Kong et al. (2010) used a dataset of 313 Chinese firms from 2001 to 2006 to conduct a test of investment-stock price sensitivity to information. The findings showed that the degree of informativeness negatively affects the sensitivity of firm investment-to-stock price.

Investigation of the predictors of firm investment based on firm-level data has recently received much attention from researchers in Vietnam (Dinh Nguyen and Phan Thi Anh, 2013; Ha and Vinh, 2017; Hue Ton and Phuong Nguyen, 2014; Malesky et al., 2015; Okuda and Nhung, 2012; Phan, 2018; Tho and Y, 2016; Tran and Le, 2017; Trinh et al., 2017; Vo, 2019). Meanwhile, the effect of price informativeness on firm investment has not yet been examined, except by Vo (2017), who only studied how foreign investors improve price informativeness. Therefore, our work is the first to focus on the effect of the stock market on firm investment from the perspective of price informativeness. In this study, we do not test the effect of the stock market on investment from the three perspectives (information, equity financing, and catering) as in Fung and Tsai (2015), Morck et al. (1990), and Ouyang and Szewczyk (2016), since this approach only determines which function of the stock market may influence firm investment but could not evaluate how the stock market affects firm investment from its functioning. In this study, we do not use only OLS estimator as in Morck et al. (1990) and Wang et al. (2009) or a fixed-effects estimator as in Chen et al. (2007) because some potential issues may occur, such as endogeneity problems, that caused by casual interaction between investment decisions and financing decisions. To make a comparative analysis, we use both static and dynamic models and employ OLS, fixed-effects, random-effects, and GMM estimators to test how private information in stock prices affects investment-to-stock price sensitivity. Moreover, we verify the robustness of the results of our study.

Vietnam's stock market is only nearly 20 years old, compared to that of Thailand – about 60 years or that of Malaysia – nearly 90 years. Moreover, the Vietnamese stock market is less efficient than developed markets (Dong Loc et al., 2010); however, most of the studies focus on the US data. Our study focuses on an emerging market, Vietnam, and uses a panel dataset of Vietnamese listed firms to examine the interaction between stock market valuation and firm investment from the perspective of price informativeness.

4 Model, variables measurement, and data

4.1 The sample

Data for all variables are calculated based on the financial statements of Vietnamese listed firms obtained from the VNDIRECT databases (https://www.vndirect.com.vn). The daily stock prices are from the VNDIRECT database. The number of outstanding shares at the end of each year is from the cophieu68 databases (https://www.cophieu68.vn). Both the ratio of market capitalisation to GDP and the ratio of total credit provided by the banking system to GDP are from the World Bank database.

As of 2017, there were 728 listed firms in both Vietnamese stock exchanges (HOSE and HNX). First, financial firms (nearly 60; e.g., banks, insurance, life assurance companies, and securities corporations) are excluded because of their unique regulatory capital requirements. We also exclude firms with only two consecutive observations to calculate the investment as the difference in capex between two years. The final unbalanced panel data consists of 633 non-financial listed firms from 2007 to 2017. We winsorise all variables at 1 and 99th percentiles to mitigate the influences of outliers, as in the previous literature (Baker et al., 2003; Chen et al., 2007).

Table 1 presents the summary statistics for all variables used in the estimation. The average mean value of investment (*INV*) is 0.020 with a standard deviation of 0.106. The sample mean of Tobin's Q is 1.026, which reflects better expectations of growth opportunity. The sample mean of leverage (*LEV*) is 0.501, which indicates that half of the capital structure is funded by debt. The sample mean of the price informativeness measure (*INFO*) is sharply high at 0.893, but it does not significantly differ from that of developed markets (for instance, this figure is 0.83 in the USA, as in Chen et al. (2007).

Table 1 Descriptive statistics

Variable	*Number of observations*	*Mean*	*Standard deviation*	*Minimum*	*Maximum*
INV	4,758	0.020	0.106	–0.268	0.527
Q	4,758	1.026	0.525	0.307	3.524
LEV	4,758	0.501	0.220	0.046	0.903
CFL	4,758	0.081	0.100	–0.144	0.488
SALE	4,758	0.109	0.385	–1.086	1.683
INFO	4,758	0.893	0.144	0.425	1.000

Notes: All variables are winsorised at the 1st and 99th percentiles.

Table 2 reports the correlation between variables that are not high. The highest positive correlation between cash flow (*CFL*) and Tobin's Q is 0.433, while the negative correlation between leverage (*LEV*) and cash flow (*CFL*) is –0.355. Thus,

multicollinearity is not a serious problem in this study. Negative correlations are found between INV and both independent variables, *LEV* and INFO, implying the negative effect of debt-asset ratio on firm investment.

Table 2 The correlation matrix

	INV	*Q*	*LEV*	*CFL*	*SALE*	*INFO*
INV	1.000					
Q	0.267	1.000				
LEV	–0.002	–0.033	1.000			
CFL	0.139	0.433	–0.355	1.000		
SALE	0.151	0.244	0.012	0.284	1.000	
INFO	–0.157	0.051	–0.015	–0.086	–0.076	1.000

4.2 Model and variable measurements

As mentioned in the literature section, several studies used stock market valuation to explain investment (Baker et al., 2003; Campello and Graham, 2013; Fung and Tsai, 2015) since it reflects information on a firm's investment opportunity. The relationship between the stock market and investment is expected to be positive. The stock market valuation is measured by Tobin's *Q*, which is the market-value-to-book-value ratio of total assets at the beginning of the year. The market value of total assets equals the sum of the book value of total liabilities and the market value of equity. The market value of equity equals the number of the outstanding shares multiplied by the market price.

Cash flow is added as another independent variable to explain the investment (Aivazian et al., 2005; Chen et al., 2007; Lang et al., 1996) and expected to be positively related to the investment. Cash flow is measured by the ratio of earnings before interest, tax, and depreciation to total assets at the beginning of the year.

Leverage is entered into the investment equation as a control variable (Chen et al., 2007; Dang, 2011; Lang et al., 1996; Phan, 2018), where the effect of leverage on investment has two sides. On the one hand, firms with high leverage might reject a good investment project because of debt overhang concerns. On the other hand, corporate managers tend to issue more debt to expand firms' investment. Leverage is measured by the ratio of total debt to total assets at the beginning of the year.

The variable sales growth is added to capture multiplier effects (Chen et al., 2007; Lang et al., 1996; Wang et al., 2009) and is expected to have a positive relationship to investment. Sales growth is measured by the change in sales to total assets at the beginning of the year.

Price informativeness is also used to explain the investment (see for example, Chen et al., 2007; Morck et al., 1990; Wang et al., 2009). These studies attempted to measure how much firm-specific information (price non-synchoronicity) price has, apart from market information.

The price informativeness of a firm is measured by $1 - R^2$, where R^2 is obtained from the following regression of the stock's return on market return (Chen et al., 2007; Durnev et al., 2003; Morck et al., 2000).

$$r_{i,t} = \alpha_0 + \beta . r_{m,t} + \varepsilon_{i,t}$$

where $r_{i,t}$ is the daily return of firm i at time t, and $r_{m,t}$ is the daily market return (VN-INDEX) at time t.

The coefficient on the interaction between price informativeness and stock market valuation is expected to be positive when the investment is sensitive to the stock price because the stock price provides additional information that is new to corporate managers. However, if the coefficient on the interaction between price informativeness and stock market valuation is negative, this indicates that price informativeness decreases the sensitivity of investment-to-stock prices because the stock price provides information that corporate managers already know.

Hence, the model used in this study is expressed as follows:

$$\begin{aligned} INV_{i,t} = {} & \beta_0 + \beta_1 Q_{i,t-1} + \beta_2 \left(Q_{i,t-1} \times INFO_{i,t-1}\right) + \beta_3 LEV_{i,t-1} + \beta_4 CFL_{i,t} \\ & + \beta_5 SALE_{i,t-1} + \beta_6 INFO_{i,t-1} + \varepsilon_{i,t} \end{aligned} \tag{1}$$

where INV is firm investment measured by the ratio of capital expenditure to total assets at the beginning of the year. Q is stock market valuation; *INFO* is price informativeness. The other control variables *LEV*, *CFL*, and *SALE* are leverage, cash flow, and sales growth, respectively. The subscript i, t or i, $t-1$ represents firm i at time period t or $t-1$, respectively. The one-period lag of all variables is used because current investment decisions are based on all available information about the firm's situation (e.g., growth opportunity, leverage, and sales growth) at the beginning of a year.

This study also adds lagged investment as an independent variable, as shown in model (2), to capture the potential accelerator effect of investment (Dang, 2011; Phan, 2018). Thus, the dynamic model used in this study is expressed as follows:

$$\begin{aligned} INV_{i,t} = {} & \beta_0 + \beta_1 INV_{i,t-1} + \beta_2 Q_{i,t-1} + \beta_3 \left(Q_{i,t-1} \times INFO_{i,t-1}\right) + \beta_4 LEV_{i,t-1} \\ & + \beta_5 CFL_{i,t} + \beta_6 SALE_{i,t-1} + \beta_7 INFO_{i,t-1} + \varepsilon_{i,t} \end{aligned} \tag{2}$$

We also add two more variables–the ratio of market capitalisation to GDP (*STOCK*) and the ratio of total credit provided by the banking system to GDP (*BANK*). The idea is to test how the development of the financial market affects corporate financial decisions, as was done in several recent studies (Chung and Phan, 2020). These two variables are applied to static and dynamic models, as shown in equations (3) and (4). The parameters β_7 and β_8 are expected to be positive, as we expect that expansion of the stock market volume and size of the commercial banking system will provide more funds for firms' investments.

$$\begin{aligned} INV_{i,t} = {} & \beta_0 + \beta_1 Q_{i,t-1} + \beta_2 \left(Q_{i,t-1} \times INFO_{i,t-1}\right) + \beta_3 STOCK_t + \beta_4 BANK_t \\ & + \beta_5 LEV_{i,t-1} + \beta_6 CFL_{i,t} + \beta_7 SALE_{i,t-1} + \beta_8 INFO_{i,t-1} + \varepsilon_{i,t} \end{aligned} \tag{3}$$

$$\begin{aligned} INV_{i,t} = {} & \beta_0 + \beta_1 INV_{i,t-1} + \beta_2 Q_{i,t-1} + \beta_3 \left(Q_{i,t-1} \times INFO_{i,t-1}\right) + \beta_4 STOCK_t \\ & + \beta_5 BANK_t + \beta_6 LEV_{i,t-1} + \beta_7 CFL_{i,t} + \beta_8 SALE_{i,t-1} + \beta_9 INFO_{i,t-1} + \varepsilon_{i,t} \end{aligned} \tag{4}$$

The pooled OLS, fixed-effects, and random-effects models are applied to models (1) and (3), while the system GMM method is applied to models (3.2) and (3.4). The pooled OLS method is widely used in most studies of the relationship between the stock market and investment under the assumption of zero unobservable individual effects (Bakke and Whited, 2010; Morck et al., 1990; Ouyang and Szewczyk, 2016; Wang et al., 2009). However, this assumption is too strong, given that there is large heterogeneity across

firms. To control for individual firms' heterogeneity, we employ random-effects and fixed-effects models, which have been commonly used in recent studies (Baker et al., 2003; Campello and Graham, 2013; Chen et al., 2007). The random-effects models assume that individual-specific effects are uncorrelated with the independent variables, while the fixed-effects models assume that individual-specific effects are correlated with the independent variables. GMM is an appropriate method to control for some potential issues in the dynamic model, such as endogeneity problems that cause casual interaction between investment and financing decisions.

Arellano and Bond (1991) developed a difference GMM using lagged values in levels as instruments of the variables in differences and required that the error term does not have second-order autocorrelation. However, the difference GMM suffers from the 'weakness' of its instruments. Additionally, differencing may reduce the power of the tests by reducing the variation in the explanatory variables (Beck et al., 2000). This shortcoming can be mitigated by including the equation in levels in the estimation procedure (Arellano and Bover, 1995; Blundell and Bond, 1998).

5 Results

This section is divided into three parts. The first part shows the empirical results using the entire dataset (i.e., Vietnamese firm-level data). The second part discusses the results based on the firm-level dataset with high-quality auditors and low-quality auditors. High-quality auditors refer to the four largest accounting and auditing firms – Deloitte, KPMG, Ernst and Young, and PricewaterhouseCoopers (Big 4). The choice of auditor (i.e., high-quality vs. low-quality) is a reflection of the firm's characteristics (Lawrence et al., 2011). Moreover, Big 4 auditors usually perform higher-quality audits (Eshleman and Guo, 2014) and may provide better financial reporting quality (Palmer, 2008). The last part demonstrates the regression results for the sub-sample of small and large firms.

5.1 Results of the full sample data

5.1.1 Baseline results

The results of model (1) using pooled OLS, fixed effects, and random effects, and model (2) using system GMM are shown in Table 3. We found no econometrics problem, such as over-identification or second-order autocorrelation, in the GMM estimation.

We found that firm investment is significant and positively correlated with the market valuation of a firm (Q) in all estimations. Column 4 of the system GMM estimation shows that a one-unit increase in stock market valuation (Q) is associated with a 0.081 increase in the firm investment rate. The result supports that firms tend to invest more in fixed assets when their growth opportunities increase. This is consistent with the findings of several previous studies on the positive relationship between the stock market and firm investment for both aggregated and disaggregated data across countries (Campello and Graham, 2013; Galeotti and Schiantarelli, 1994; Henry, 2000; Phan, 2018; Polk and Sapienza, 2009; Vo, 2019).

Table 3 Regression results for the full sample

Variables	*Pooled OLS*	*Fixed effects*	*Random effects*	*System GMM*
	(1)	*(2)*	*(3)*	*(4)*
Q	0.191***	0.220***	0.194***	0.081***
	(0.034)	(0.041)	(0.043)	(0.018)
Q × INFO	–0.151***	–0.176***	–0.154***	–0.045*
	(0.036)	(0.043)	(0.045)	(0.017)
LEV	–0.005	–0.074***	–0.007	–0.007
	(0.007)	(0.021)	(0.008)	(0.007)
CFL	–0.014	0.000	–0.014	–0.001
	(0.022)	(0.034)	(0.023)	(0.024)
SALE	0.022***	0.011*	0.021***	0.019***
	(0.004)	(0.005)	(0.004)	(0.004)
INFO	0.029	0.023	0.029	–0.033***
	(0.032)	(0.038)	(0.039)	(0.006)
L. INV				0.155***
				(0.032)
Observations	4,758	4,758	4,758	4,120
Adj. R-squared	0.115	0.116	0.146	
AR(2) test (P-value)				0.106
Hansen test (P-value)				0.158

Notes: *, **, *** shows significance at 10%, 5% and 1%, respectively. Robust standard errors are given the parentheses.

When we consider how price informativeness affects the investment-to-stock-price sensitivity, we obtain negative significant coefficients on the interaction term between stock market valuation and price informativeness ($Q \times INFO$). This implies that the sensitivity of investment-to-stock price is lower for firms whose stock prices have greater firm-specific return variations. For instance, the system GMM estimates show that the sensitivity of investment-to-stock market valuation declined from 0.081 units to 0.036 [0.036 = 0.081 + (–0.045)] units when we considered the effect of private information in stock prices in the investment equation. Many empirical results have also found that price informativeness plays an important role in the relationship between stock market valuation and firm investment (Bakke and Whited, 2010; Chen et al., 2007; Foucault and Gehrig, 2008; Ouyang and Szewczyk, 2016). However, the regression results contradict evidence from well-developed markets–that price informativeness, measured by price non-synchronicity, increases the sensitivity of investment-to-stock prices in the USA (Chen et al., 2007). Our results show a negative impact of price informativeness on the investment-to-stock-price sensitivity, which is in line with evidence from China (Kong et al., 2010). The possible explanation for the differences between markets may be the differences in market characteristics, national culture, and firm-level transparency. For example, stock prices are less informative in high-inflation-rate countries, causing lower sensitivity of investment to the stock price in these countries (Farooq and Ahmed, 2018). Corporate managers may be less dependent on stock price information because the stock

prices in Vietnamese markets may be less informative due to the low level of corporate transparency.

The coefficient of the one-year lagged investment (*L.INV*) is positive and significant at 1% in system GMM. This indicates that firms adjusted their capital stock, which is in line with the findings of Eberly et al. (2012). As for the control variables, leverage (*LEV*) has a negative and significant effect on firm investment, but only in the fixed-effects model. This is in line with other evidence from the Vietnamese market on the correlation between firm investment and leverage (Phan, 2018; Vo, 2019). This potentially implies that firms in Vietnam would reduce investment if they have a high level of debt in their capital structure. Cash flow (*CFL*) does not influence firm investment in Vietnam in all estimations, while sales growth (*SALE*) has a significant and positive effect on firm investment behaviours in all estimations. This implies that Vietnamese-listed firms rely more on external financing than on internal funds.

5.1.2 Controlling for the development of the financial market

The estimation results of models (3) and (4) are shown in Table 4. We found no econometrics problem, such as overidentification or second-order autocorrelation, in the GMM estimation.

After the variables for the two factors of financial market are added, we found that the one-period lag of investment significantly affects the current investment in a dynamic model with a slightly smaller magnitude. In addition, the system GMM results in column 4 show that the effect of stock market valuation on investment is more than double if we control for the development of financial markets, compared with baseline results. The magnitude of the effect increases from 0.081 to 0.285, as shown in column 4 in Tables 3 and 4, respectively.

Furthermore, we found that investment is less sensitive to stock prices for firms with higher firm-specific return variations in stock prices. In particular, the system GMM estimates show that price informativeness reduces the sensitivity of investment-to-stock market valuation from 0.189 units to 0.044 [0.044 = 0.285 + (–0.241)] units. However, the sensitivity of investment-to-stock prices is slightly higher after controlling for the development of financial markets in the system GMM estimation. This confirms the important role of the financial market in allocating capital for listed firms. The important role of financial market development in corporate financing decisions is also found in another empirical investigation of Vietnamese listed firms (Chung and Phan, 2020).

The coefficients of sales growth (*SALE*) are positively significant in most models, which confirm that expansion of sales revenue causes an increase in firm investment. The coefficients of current cash flows (*CFL*) are insignificant in all estimations. This reflects the characteristics of Vietnamese publicly listed firms – they generally do not have much free cash because they are highly reliant on external finance. Similar to the baseline regression, the coefficient of leverage (*LEV*) is significantly negative in the fixed-effects model at the same magnitude.

The development of financial markets significantly affects investment choices, as well as investment-to-price sensitivity based on firm-level data. The influence of the stock market on firm investment is more powerful than that of the banking system. However, expansion of the banking system (*BANK*) and market capitalisation (*STOCK*) do not influence firms to increase their investment. This could be explained by the high non-performing loans (NPLs) in Vietnam during this period. The growth of NPLs was

nearly 9% in 2012 vs. about 3% in 2011 (Nguyen, 2015), as highly restricted banks provided more debt to their customers. Moreover, credit growth decreased by about one-third during 2009–2011, as the State Bank of Vietnam (SBV) wanted to curb the inflation rate. Thus, banks could not expand their credit line during this period.

Table 4 Regression results for the full sample with controlling the development of financial markets

Variables	*Pooled OLS*	*Fixed effects*	*Random effects*	*System GMM*
	(1)	(2)		
Q	0.202***	0.231***	0.206***	0.285***
	(0.034)	(0.040)	(0.043)	(0.074)
Q × INFO	–0.158***	–0.181***	–0.161***	–0.241**
	(0.035)	(0.042)	(0.045)	(0.074)
STOCK	–0.122***	–0.127***	–0.122***	–0.295*
	(0.018)	(0.018)	(0.018)	(0.118)
BANK	–0.053***	–0.054***	–0.053***	–0.157*
	(0.013)	(0.013)	(0.012)	(0.065)
LEV	–0.006	–0.073***	–0.008	–0.005
	(0.007)	(0.021)	(0.008)	(0.009)
CFL	–0.020	0.000915	–0.020	–0.022
	(0.022)	(0.034)	(0.024)	(0.026)
SALE	0.019***	0.008	0.0178***	0.017***
	(0.004)	(0.004)	(0.004)	(0.005)
INFO	0.053	0.051	0.053	0.203*
	(0.032)	(0.038)	(0.040)	(0.097)
L.INV				0.113***
				(0.031)
Observations	4,758	4,758	4,758	4,120
Adj. R-squared	0.125	0.129	0.146	
AR(2) test (P-value)				0.107
Hansen test (P-value)				0.278

Notes: *, **, *** shows significance at 10%, 5% and 1%, respectively. Robust standard errors are given the parentheses.

5.2 Regression results for firms with high-quality auditors vs. low-quality auditors

In this section, we investigate how the estimation results of the static and dynamic models change if we control for the quality of auditing services used by listed firms. This idea is driven by the quality of accounting information disclosed by a firm and is related to the quality of auditing companies that provide the service to that firm, thus helping to decrease the overinvestment problem (Elaoud and Jarboui, 2017). It is widely accepted that Big 4 auditing firms offer higher audit quality than non-Big 4 auditing firms (Eshleman and Gou, 2014). The same idea of examining the quality of auditing services

by Big 4 auditing firms and non-Big 4 auditing firms was also employed in several studies (Baatwah et al., 2018). We group firms into two. As the group of high-quality auditors consists of firms that used auditing services from the Big 4 (Deloitte, Ernst and Young, PricewaterhouseCoopers, and KPMG), and the other group consists of the rest. In the accounting literature, it is found that the quality of financial reports could affect investment decisions since better financial reports lessen the information asymmetry problem (Houcine, 2017). In the Vietnamese context, in the 2016 report by the World Bank, it stated that the quality of financial reports is inconsistent with international standards, while the capacity and resources of local auditing firms are limited, compared with those of international firms, for complying with quality assurance arrangements. It is noted that the number of firms that select good auditing services is half the number of firms that use the auditing services of non-Big 4 firms.

5.2.1 Regression results for the sub-samples

Table 5 demonstrates the regression results of the static and dynamic models for the sub-sample of firms with Big 4 auditors and non-Big 4 auditors, respectively. We are not concerned with econometric problems, such as over-identification or second-order autocorrelation, in the GMM estimation.

The positive coefficients on stock price (Q) in all estimations are consistent with the idea that stock market valuation stimulates corporate investment in Vietnamese listed firms. This confirms the strong relationship between stock prices and firm investment for listed firms in Vietnam. However, the effect of stock price (*Q*) on firm investment is even stronger for firms with high-quality auditors than for low-quality auditors. In the GMM estimation, the magnitude of the growth opportunity effect is only 0.089 for firms with non-Big 4 auditors, whereas it is more than double that (0.194) for firms with Big 4 auditors.

We found that private information reflected in stock prices helps firms reduce the sensitivity of investment-to-stock market valuation in both sub-samples, which is consistent with the baseline results. However, there is not much difference in the magnitude of the effect of price informativeness on the investment-stock market valuation relationship between the two groups of firms. This implies that private information is reflected in stock prices in similar ways, regardless of the quality of audit services that firms use. Moreover, the coefficient on lagged investment (*L.INV*) is positively significant at less than the 10% level. This confirms that there is dynamic adjustment in investment for firms in both groups. However, the magnitude of the effect seems larger for firms with Big 4 auditors.

As for the control variables, the results indicate that internal funds (*CFL*) do not affect investment behaviours. This implies the weak role of internal financing in determining investment in Vietnamese listed firms. On the contrary, the coefficients on growth of sales (*SALE*) are mostly positive and significant for both sub-samples of firms, suggesting that an increase in firm revenue increases investment. The coefficient on leverage (*LEV*) is negatively significant only for the fixed-effects model, which is consistent with what we expected.

Table 5 Regression results for the sub-samples of firms with high-quality auditors and low-quality auditors

Variables	*Firms with low-quality auditors*				*Firms with high-quality auditors*			
	Pooled OLS	*Fixed effects*	*Random effects*	*System GMM*	*Pooled OLS*	*Fixed effects*	*Random effects*	*System GMM*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Q	0.224***	0.221***	0.225***	0.089***	0.181***	0.223***	0.187**	0.194**
	(0.047)	(0.056)	(0.054)	(0.021)	(0.048)	(0.058)	(0.060)	(0.066)
Q × INFO	–0.184***	–0.178**	–0.185***	–0.052*	–0.141**	–0.178**	–0.146*	–0.158*
	(0.049)	(0.059)	(0.056)	(0.021)	(0.052)	(0.060)	(0.062)	(0.062)
LEV	–0.001	–0.057*	–0.002	–0.006	–0.020	–0.145**	–0.025	–0.059
	(0.008)	(0.024)	(0.009)	(0.008)	(0.016)	(0.050)	(0.017)	(0.031)
CFL	–0.001	0.019	–0.000	0.007	–0.060	–0.060	–0.064	–0.126
	(0.025)	(0.038)	(0.027)	(0.028)	(0.046)	(0.073)	(0.050)	(0.099)
SALE	0.019***	0.010*	0.018***	0.019***	0.030***	0.014	0.028*	0.027*
	(0.005)	(0.005)	(0.005)	(0.005)	(0.009)	(0.011)	(0.011)	(0.011)
INFO	0.050	0.024	0.048	–0.035***	0.022	0.032	0.022	–0.008
	(0.043)	(0.053)	(0.049)	(0.007)	(0.048)	(0.054)	(0.055)	(0.020)
L.INV				0.118***				0.150**
				(0.036)				(0.057)
Observations	3,490	3,490	3,490	3,016	1,268	1,268	1,268	1,104
Adj. R-squared	0.101	0.098	0.137		0.155	0.169	0.182	
AR(2) test (P-value)			0.327				0.231	
Hansen test (P-value)			0.257				0.225	

Notes: *, **, *** shows significance at 10%, 5% and 1%, respectively. Robust standard errors are given the parentheses.

Table 6 Regression results for the sub-samples of firms with high-quality auditors and low-quality auditors with the controlling of financial market development

Variables	*Firms with low-quality auditors*				*Firms with high-quality auditors*			
	Pooled OLS	*Fixed effects*	*Random effects*	*System GMM*	*Pooled OLS*	*Fixed effects*	*Random effects*	*System GMM*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Q	0.243***	0.241***	0.245***	0.132***	0.185***	0.226***	0.190**	0.185**
	(0.046)	(0.055)	(0.053)	(0.029)	(0.048)	(0.057)	(0.061)	(0.057)
Q × INFO	–0.200***	–0.191**	–0.201***	–0.095***	–0.141**	–0.175**	–0.144*	–0.154**
	(0.048)	(0.058)	(0.055)	(0.027)	(0.051)	(0.059)	(0.062)	(0.054)
STOCK	–0.138***	–0.142***	–0.138***	–0.112***	–0.079*	–0.0775*	–0.079**	–0.077
	(0.021)	(0.021)	(0.021)	(0.027)	(0.033)	(0.030)	(0.030)	(0.040)
BANK	–0.049***	–0.052***	–0.049***	–0.016	–0.064**	–0.0597*	–0.063**	–0.055
	(0.015)	(0.016)	(0.014)	(0.019)	(0.024)	(0.023)	(0.021)	(0.030)
LEV	–0.003	–0.058*	–0.004	0.000	–0.018	–0.139**	–0.022	–0.028
	(0.008)	(0.023)	(0.009)	(0.008)	(0.015)	(0.050)	(0.018)	(0.019)
CFL	–0.008	0.015	–0.008	0.012	–0.061	–0.0516	–0.064	–0.043
	(0.025)	(0.038)	(0.027)	(0.028)	(0.046)	(0.073)	(0.050)	(0.063)
SALE	0.017***	0.007	0.016**	0.018***	0.026**	0.0112	0.025*	0.023*
	(0.005)	(0.005)	(0.005)	(0.005)	(0.008)	(0.011)	–0.011	(0.010)
INFO	0.081	0.060	0.080	0.004	0.040	0.0528	0.041	0.060
	(0.042)	(0.052)	(0.049)	(0.024)	(0.048)	(0.056)	(0.057)	(0.047)
L.INV				0.106**				0.145*
				(0.033)				(0.061)
Observations	3,490	3,490	3,490	3,016	1,268	1,268	1,268	1,104
Adj. R-squared	0.113	0.113	0.135		0.161	0.176	0.189	
AR(2) test (P-value)			0.265				0.206	
Hansen test (P-value)			0.117				0.170	

Notes: *, **, *** shows significance at 10%, 5% and 1%, respectively. Robust standard errors are given the parentheses.

Table 7 Regression results for the sub-samples of small firms and large firms

Variables	*Small firms*				*Large firms*			
	Pooled OLS	*Fixed effects*	*Random effects*	*System GMM*	*Pooled OLS*	*Fixed effects*	*Random effects*	*System GMM*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Q	0.209***	0.237***	0.218***	0.084**	0.190***	0.227***	0.207***	0.079***
	(0.057)	(0.070)	(0.058)	(0.032)	(0.042)	(0.051)	(0.051)	(0.020)
Q×INFO	–0.179**	–0.199**	–0.186**	–0.061	–0.141**	–0.188***	–0.160**	–0.051*
	(0.059)	(0.072)	(0.059)	(0.031)	(0.046)	(0.054)	(0.053)	(0.021)
LEV	–0.013	–0.047	–0.018	–0.012	0.005	–0.110***	–0.015	–0.034*
	(0.010)	(0.027)	(0.011)	(0.014)	(0.012)	(0.032)	(0.014)	(0.015)
CFL	–0.010	–0.020	–0.012	0.000	–0.021	0.024	–0.015	–0.135*
	(0.027)	(0.042)	(0.030)	(0.058)	(0.037)	(0.056)	(0.043)	(0.065)
SALE	0.020***	0.013**	0.018***	0.037	0.022**	0.012	0.018*	0.179**
	(0.005)	(0.005)	(0.004)	(0.051)	(0.007)	(0.009)	(0.009)	(0.058)
INFO	0.020	0.025	0.023	–0.021*	0.036	0.047	0.039	–0.010
	(0.048)	(0.059)	(0.049)	(0.010)	(0.044)	(0.050)	(0.049)	(0.015)
L.INV				0.151*				0.157***
				(0.059)				(0.036)
Observations	2,379	2,379	2,379	2,017	2,379	2,379	2,379	2,103
Adj. R-squared	0.081	0.079	0.142		0.135	0.136	0.119	
AR(2) test (P-value)			0.094				0.832	
Hansen test (P-value)			0.135				0.196	

Notes: *, **, *** shows significance at 10%, 5% and 1%, respectively. Robust standard errors are given the parentheses.

Table 8 Regression results for the sub-samples of small firms and large firms with the controlling of financial market development

Variables	*Small firms*				*Large firms*			
	Pooled OLS	*Fixed effects*	*Random effects*	*System GMM*	*Pooled OLS*	*Fixed effects*	*Random effects*	*System GMM*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Q	0.223***	0.252***	0.232***	0.152***	0.198***	0.235***	0.216***	0.207**
	(0.055)	(0.067)	(0.055)	(0.043)	(0.042)	(0.051)	(0.051)	(0.076)
Q × INFO	–0.189***	–0.208**	–0.195***	–0.115**	–0.145**	–0.191***	–0.165**	–0.199*
	(0.056)	(0.068)	(0.056)	(0.040)	(0.046)	(0.053)	(0.053)	(0.080)
STOCK	–0.120***	–0.117***	–0.121***	–0.114**	–0.118***	–0.119***	–0.121***	–0.037
	(0.025)	(0.027)	(0.026)	(0.042)	(0.026)	(0.023)	(0.024)	(0.065)
BANK	–0.045**	–0.050**	–0.047**	–0.009	–0.061**	–0.061**	–0.059**	0.121**
	(0.017)	(0.018)	(0.016)	(0.029)	(0.019)	(0.020)	(0.019)	(0.043)
LEV	–0.016	–0.053*	–0.021	–0.007	0.005	–0.104**	–0.013	–0.034
	(0.010)	(0.026)	(0.011)	(0.010)	(0.012)	(0.032)	(0.014)	(0.064)
CFL	–0.019	–0.024	–0.021	–0.011	–0.020	0.035	–0.010	–0.034
	(0.027)	(0.043)	(0.031)	(0.034)	(0.037)	(0.056)	(0.043)	(0.205)
SALE	0.018***	0.011*	0.016***	0.021***	0.020**	0.008	0.015	0.035
	(0.005)	(0.005)	(0.004)	(0.005)	(0.007)	(0.009)	(0.009)	(0.055)
INFO	0.050	0.058	0.053	0.001	0.059	0.073	0.064	–0.143*
	(0.046)	(0.058)	(0.048)	(0.039)	(0.045)	(0.052)	(0.051)	(0.070)
L.INV				0.115**				0.108**
				(0.041)				(0.036)
Observations	2,379	2,379	2,379	2,017	2,379	2,379	2,379	2,103
Adj. R-squared	0.092	0.092	0.168		0.144	0.147	0.119	
AR(2) test (P-value)			0.064				0.250	
Hansen test (P-value)			0.738				0.142	

Notes: *, **, *** shows significance at 10%, 5% and 1%, respectively. Robust standard errors are given the parentheses.

The signs of the coefficients of the variables (*Q*, *Q* × *INFO*, *LEV*, *CFL*, *SALE*) remain unchanged. This further confirms the robustness of the results presented in Table 3.

5.2.2 Controlling for the development of financial markets in the two sub-samples

Table 6 shows the regression results for a group of firms with non-Big 4 auditors with firm-specific variables and the inclusion of financial market development variables. The regression result confirms the significant effect of stock market valuation on firm investment in all estimations. The result is strongly significant at 1% for all models in a group of firms with non-Big 4 auditors. Price informativeness has a negative effect on investment in both static and dynamic models.

The coefficients on *STOCK* and *BANK* are mostly significant at the 1% level for firms with non-Big 4 auditors. This confirms that the development of financial markets does affect investment in these firms. This could be because Vietnamese firms do not fund their investments from the stock market. Moreover, the size of the banking system rose under the pressure of the SBV's policy to make commercial banks comply with Basel II rather than to expand their credit during this period. Meanwhile, the coefficients of *STOCK* and *BANK* are significant at less than 1% in the group of firms with Big 4 auditors. This implies the stronger effect of the financial market on firms with lower quality of financial reporting. It is understandable that banks and investors are more intent on providing funds to firms with lower-quality financial reporting. Moreover, firms with better financial reporting quality pay attention to their firm market value (*Q*) rather than the expansion of sales, as compared with firms with lower financial reporting quality.

The magnitude of the effect of stock market valuation changed differently after controlling for the effect of the financial market in the investment equation. First, the effect of stock market valuation (Q) seems stronger for firms with non-Big 4 auditors than for firms with Big 4 auditors. In particular, the coefficients of *Q* in the system GMM increased from 0.089 to 0.132 for firms with lower financial reporting quality. For firms with higher financial reporting quality, the magnitude slightly decreased from 0.194 to 0.185. However, the role of stock price informativeness remained unchanged after controlling for the development of financial markets. In general, there is not much difference in the influence of the stock market on investment behaviours (from the perspective of price informativeness) in Vietnamese listed firms when looking at the level of auditors' quality.

5.3 Regression results for small firms and large firms

This sub-section discusses the regression results of two sub-samples of firms based on firm size. Firm size significantly affects not only firm investment but also the informativeness of stock prices. Larger firms may have greater bargaining power in negotiating with debt-holders and less asymmetric information, and thus, have a better chance of obtaining funds for their investment. Moreover, larger firms are likely to be more transparent than small firms, which could affect price informativeness. The effect of firm size on price informativeness was first investigated by Collins et al. (1987). Subsequent researchers confirmed variations in stock price information among firms of different sizes (Chan and Chan, 2014). Thus, we grouped firms into two based on firm

size, as measured by the logarithm of total assets. The sub-sample of small firms includes firm-years that have a lower natural logarithm of total assets than the sample median. The sub-sample of large firms consists of the rest.

5.3.1 Regression results for the sub-samples

Table 7 shows the regression results of the static and dynamic models for the sub-samples of small firms and large firms, respectively. The positive coefficients for Q in all estimations are consistent with the idea that a firm tends to invest more if i's market value is higher regardless of firm size. The coefficients on the interaction term continue to be significant and negative for all methods for large firms. By contrast, price informativeness does not affect firm investment in the system GMM regression for small firms.

In addition, both groups of firms make investment decisions based on the expansion of firm sales. The coefficients of sales growth (*SALE*) are the most significant and positive in most regressions except in the system GMM. Leverage (*LEV*) is highly significant at the 1% and 10% levels for the fixed-effects and system GMM models, respectively, but only for large firms. This suggests that debt constrains investment in larger firms, while small firms depend more on the scale of sales to make investment decisions.

5.3.2 Controlling for the development of the financial market in the sub-samples

The regression results for both groups of firms, including the financial market variables, are presented in Table 8. The coefficients of the market value of firms (*Q*) and the interaction term ($Q \times INFO$) remain negative and significant in all estimations. The magnitude of the effect is even larger in both sub-samples after inclusion of the financial market variables. This indicates that variation in the size of the banking system and the stock market is correlated with corporate investment.

Investment is less sensitive to stock prices if price informativeness is higher for both small and large firms. However, the magnitude of the effect of informativeness seems stronger after controlling for the development of the financial market. Column 8 of Tables 7 and 8 reveals that the magnitude of the effect of market valuation increases from 0.079 to 0.207 in the system GMM for large firms.

5.4 Robustness checks

In this sub-section, we check the robustness of our results by adding year dummies to capture the time trends in the main equation, shortening the sample over 2010–2017 to avoid the effect of 2007–2009 global financial crisis, and excluding the fundamental variables (*LEV*, *CFL*, and *SALE*) to see how the sensitivity of investment-to-stock prices varies with non-fundamental variables.

As the first robustness check, we re-estimate our models by adding year effects. It is not surprising that the coefficients estimated on stock market valuation (*Q*) and the interaction term ($Q \times INFO$) shown in Appendix (Tables A1, A2, and A3) mostly follow the same pattern as those for the same variables in Tables 3, 5, and 7. Then, the sub-sample covering 2010 to 2017 was applied using the same techniques to eliminate the influences of the 2007–2009 global financial crisis. The positive effect of growth

opportunities (Q) and the inverse effect of price informativeness on stock market valuation–firm investment correlation are found in most of the estimations. Next, we re-estimate the regression for investment with price informativeness measure (*INFO*) and without control variables (*LEV*, *CFL*, and *SALE*). The coefficients of stock market valuation (*Q*) and the effect of price informativeness shown in the Appendix are consistent with the results shown in the previous regression.

6 Conclusions

This study examines the role of the stock market on firm investment level, and how private information in stock prices would affect the sensitivity of investment to the stock price, using the dataset of Vietnamese listed firms during 2007–2017. This study also extends this relationship by considering the quality of auditing services used by firms and firm size, as well as by controlling for the development of financial markets in the investment equation.

In general, we find that stock market valuation significantly affects firm investment in all estimations, and corporate investment is less sensitive to stock market valuation when we take the effect of price informativeness. This finding is consistent with the results in other emerging markets such as China. However, the results found in Vietnamese listed firms are different from the evidence from developed countries (i.e., the USA), thereby supporting the view of potential differences in information efficiency between developed and less-developed markets. The results are robust in most sub-samples of firms. In addition, this study documents that the effect of price informativeness on investment-to-price sensitivity is not much different between groups of firms with high and low-quality auditors, as well as the groups of small and large firms. As for the fundamental variables, the regression results show that leverage and sales growth are the two important factors affecting investment decisions in Vietnamese listed firms, while cash flow does not affect investment decisions.

This study has some implications for the government as follows. It is suggested that the government provide better legal framework to improve the efficiency of the stock market since Vietnamese listed firms have weak growth opportunities; as the market suffers from speculative trading; and access to firms' information is limited. Doing so would enhance listed firms' investment. In addition, the government m may consider reforming monetary policies that restrict the freedom of the financial market which might have a negative impact on firm investment. Doing so could lead to the expansion of both the equity market and the banking system. However, this does not always imply an increase in the sources of funding in the economy. Both equity financing from the stock market and bank financing from commercial banks depend on the particular macroeconomic situation and the firms' conditions. For instance, commercial banks may increase their sizes according to the government's regulations, but they are afraid of providing more credit to firms due to high fluctuations in interest rates and high credit risk. Thus, what is most important is that financial markets function properly and allocate capital efficiently.

This study also raises a question concerning an information-related issue in Vietnamese listed firms. Specifically, it appears that information gathered from speculative trading activities is not very new to managers. This suggests the necessity of investigating the effect of insider trading on the correlation between investment and stock

prices since managers have more information about their firm's prospects than outsiders do.

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Appendix

Table A1 Regression for full sample with year dummies

Variables	*Pooled OLS*	*Fixed effects*	*Random effects*	*System GMM*
	(1)	(2)	(3)	(4)
Q	0.207***	0.226***	0.211***	0.146**
	(0.032)	(0.038)	(0.041)	(0.049)
Q × INFO	–0.158***	–0.168***	–0.161***	–0.106*
	(0.034)	(0.040)	(0.042)	(0.050)
LEV	–0.00837	–0.0774***	–0.0112	–0.00583
	(0.007)	(0.020)	(0.008)	(0.007)
CFL	–0.0475*	–0.0380	–0.0497*	–0.0288
	(0.023)	(0.034)	(0.025)	(0.026)
SALE	0.0153***	0.00384	0.0137**	0.0205***
	(0.004)	(0.004)	(0.004)	(0.004)
INFO	0.130***	0.167***	0.135***	0.0921*
	(0.032)	(0.038)	(0.037)	(0.045)
L.INV				0.130***
				(0.033)
Year dummies	Yes	Yes	Yes	Yes
Observations	4,758	4,758	4,758	4,120
Adj. R-squared	0.156	0.166	0.143	
AR(2) test (P-value)				0.131
Hansen test (P-value)				0.190

Notes: *, **, *** shows significance at 10%, 5% and 1%, respectively. Robust standard errors are given the parentheses.

Table A2 Regression results for the sub-samples of firms with high-quality auditors and low-quality auditors with year dummies

Variables	*Firms with low-quality auditors*				*Firms with high-quality auditors*			
	Pooled OLS	*Fixed effects*	*Random effects*	*System GMM*	*Pooled OLS*	*Fixed effects*	*Random effects*	*System GMM*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Q	0.249***	0.238***	0.251***	0.247***	0.189***	0.217***	0.193***	0.078
	(0.046)	(0.055)	(0.053)	(0.067)	(0.044)	(0.051)	(0.054)	(0.147)
Q × INFO	–0.202***	–0.182**	–0.203***	–0.211**	–0.134**	–0.153**	–0.136*	–0.036
	(0.048)	(0.058)	(0.056)	(0.070)	(0.047)	(0.054)	(0.056)	(0.153)
LEV	–0.005	–0.062**	–0.007	–0.002	–0.020	–0.139**	–0.024	–0.021
	(0.008)	(0.023)	(0.009)	(0.008)	(0.015)	(0.046)	(0.017)	(0.020)
CFL	–0.028	–0.011	–0.028	–0.006	–0.120**	–0.140*	–0.127**	–0.049
	(0.026)	(0.039)	(0.029)	(0.030)	(0.046)	(0.067)	(0.048)	(0.067)
SALE	0.014**	0.004	0.013**	0.017***	0.016	–0.000	0.014	0.016
	(0.005)	(0.005)	(0.005)	(0.005)	(0.008)	(0.010)	(0.010)	(0.009)
INFO	0.148***	0.163**	0.151**	0.153**	0.139**	0.202**	0.148**	0.0245
	(0.043)	(0.051)	(0.048)	(0.057)	(0.046)	(0.061)	(0.054)	(0.162)
L.INV				0.097**				0.146**
				(0.037)				(0.055)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,490	3,490	3,490	3,016	1,268	1,268	1,268	1,104
Adj. R-squared	0.137	0.145	0.126		0.216	0.239	0.203	
AR(2) test (P-value)			0.328				0.299	
Hansen test (P-value)			0.502				0.621	

Notes: *, **, *** shows significance at 10%, 5% and 1%, respectively. Robust standard errors are given the parentheses.

Table A3 Regression results for the sub-samples of small firms and large firms with year dummies

Variables	*Small firms*				*Large firms*			
	Pooled OLS	*Fixed effects*	*Random effects*	*System GMM*	*Pooled OLS*	*Fixed effects*	*Random effects*	*System GMM*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Q	0.217***	0.250***	0.229***	0.248**	0.203***	0.232***	0.218***	0.115*
	(0.055)	(0.069)	(0.058)	(0.077)	(0.040)	(0.047)	(0.047)	(0.050)
Q × INFO	–0.182**	–0.203**	–0.189**	–0.232**	–0.144***	–0.180***	–0.160**	–0.081
	(0.057)	(0.070)	(0.059)	(0.078)	(0.043)	(0.050)	(0.050)	(0.053)
LEV	–0.019	–0.062*	–0.029*	–0.013	–0.004	–0.105***	–0.024	–0.022
	(0.010)	(0.024)	(0.011)	(0.011)	(0.011)	(0.031)	(0.014)	(0.013)
CFL	–0.028	–0.036	–0.032	0.004	–0.067	–0.024	–0.065	–0.129*
	(0.028)	(0.044)	(0.032)	(0.039)	(0.037)	(0.052)	(0.043)	(0.052)
SALE	0.016**	0.009	0.013**	0.054	0.015*	0.000	0.009	0.158**
	(0.005)	(0.005)	(0.005)	(0.031)	(0.007)	(0.008)	(0.008)	(0.049)
INFO	0.106*	0.140*	0.117*	0.162*	0.169***	0.242***	0.210***	0.0840
	(0.047)	(0.059)	(0.050)	(0.064)	(0.043)	(0.053)	(0.049)	(0.051)
L.INV				0.136*				0.119***
				(0.054)				(0.031)
Yes dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,331	2,331	2,331	1,975	2,427	2,427	2,427	2,145
Adj. R-squared	0.108	0.115	0.145		0.191	0.207	0.149	
AR(2) test (P-value)				0.140				0.697
Hansen test (P-value)			0.246				0.147	

Table A4 Regression result for full sample with no control variables

Variables	*Pooled OLS*	*Fixed effects*	*Random effects*	*System GMM*
	(1)	(2)	(3)	(4)
Q	0.193***	0.226***	0.198***	0.080***
	(0.034)	(0.040)	(0.043)	(0.016)
Q × INFO	–0.151***	–0.179***	–0.155***	–0.040*
	(0.036)	(0.042)	(0.045)	(0.016)
INFO	0.025	0.022	0.024	–0.039***
	(0.032)	(0.039)	(0.040)	(0.005)
L.INV				0.155***
				(0.033)
Observations	4,758	4,758	4,758	4,120
Adj. R-squared	0.110	0.111	0.124	
AR(2) test (P-value)				0.082
Hansen test (P-value)				0.146

Notes: *, **, *** shows significance at 10%, 5% and 1%, respectively. Robust standard errors are given the parentheses.

Table A5 Regression result for sub-samples of firms with high-quality auditors and low-quality auditors with no control variables

Variables	*Firms with low-quality auditors*				*Firms with low-quality auditors*			
	Pooled OLS	*Fixed effects*	*Random effects*	*System GMM*	*Pooled OLS*	*Fixed effects*	*Random effects*	*System GMM*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Q	0.233***	0.231***	0.234***	0.0883***	0.173***	0.222***	0.180**	0.214***
	(0.047)	(0.057)	(0.054)	(0.020)	(0.047)	(0.055)	(0.059)	(0.058)
Q × INFO	–0.190***	–0.184**	–0.191***	–0.046*	–0.131*	–0.175**	–0.137*	–0.143**
	(0.049)	(0.060)	(0.057)	(0.021)	(0.051)	(0.059)	(0.062)	(0.046)
INFO	0.052	0.027	0.049	–0.041***	0.005	0.016	0.006	–0.095**
	(0.043)	(0.053)	(0.050)	(0.006)	(0.047)	(0.056)	(0.055)	(0.032)
L.INV				0.115**				0.174**
				(0.037)				(0.061)
Observations	3,490	3,490	3,490	3,016	1,268	1,268	1,268	1,104
Adj. R-squared	0.097	0.094	0.116		0.148	0.155	0.158	
AR(2) test (P-value)			0.288				0.153	
Hansen test (P-value)			0.192				0.190	

Notes: *, **, *** shows significance at 10%, 5% and 1%, respectively. Robust standard errors are given the parentheses.

Table A6 Regression results for sub-samples of small firms and large firms with no control variables

Variables	*Small firms*				*Large firms*			
	Pooled OLS	*Fixed effects*	*Random effects*	*System GMM*	*Pooled OLS*	*Fixed effects*	*Random effects*	*System GMM*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Q	0.214***	0.243***	0.222***	0.081**	0.191***	0.233***	0.207***	0.086***
	(0.057)	(0.071)	(0.059)	(0.028)	(0.042)	(0.050)	(0.050)	(0.019)
Q × INFO	–0.182**	–0.204**	–0.187**	–0.054*	–0.140**	–0.187***	–0.157**	–0.038*
	(0.058)	(0.072)	(0.060)	(0.027)	(0.046)	(0.054)	(0.053)	(0.019)
INFO	0.015	0.032	0.020	–0.028***	0.032	0.039	0.031	–0.047***
	(0.047)	(0.059)	(0.050)	(0.007)	(0.044)	(0.052)	(0.050)	(0.008)
L.INV				0.160**				0.148***
				(0.061)				(0.046)
Observations	2,331	2,379	2,379	2,017	2,379	2,427	2,379	2,103
Adj. R-squared	0.076	0.076	0.120		0.132	0.125	0.114	
AR(2) test (P-value)			0.055				0.061	
Hansen test (P-value)			0.102				0.332	

Notes: *, **, *** shows significance at 10%, 5% and 1%, respectively. Robust standard errors are given the parentheses.

Table A7 Regression result for full sample over 2010–2017 period

Variables	*Pooled OLS*	*Fixed effects*	*Random effects*	*System GMM*
	(1)	(2)	(3)	(4)
Q	0.176***	0.226***	0.180**	0.084***
	(0.045)	(0.053)	(0.058)	(0.019)
Q × INFO	–0.137**	–0.185***	–0.140*	–0.053**
	(0.047)	(0.055)	(0.060)	(0.019)
LEV	0.002	–0.062**	0.001	–0.012
	(0.007)	(0.022)	(0.008)	(0.008)
CFL	–0.008	0.004	–0.009	–0.048
	(0.023)	(0.036)	(0.024)	(0.033)
SALE	0.021***	0.011*	0.020***	0.072**
	(0.004)	(0.005)	(0.005)	(0.026)
INFO	0.048	0.056	0.048	–0.027***
	(0.042)	(0.049)	(0.053)	(0.007)
L.INV				0.129***
				(0.033)
Observations	4,308	4,308	4,308	3,927
Adj. R-squared	0.093	0.086	0.150	
AR(2) test (P-value)				0.360
Hansen test (P-value)				0.258

Notes: *, **, *** shows significance at 10%, 5% and 1%, respectively. Robust standard errors are given the parentheses.

Table A8 Regression result for sub-samples of firms with high-quality auditors and low-quality auditors over 2010–2017 period

Variables	*Firms with low-quality auditors*				*Firms with low-quality auditors*			
	Pooled OLS	*Fixed effects*	*Random effects*	*System GMM*	*Pooled OLS*	*Fixed effects*	*Random effects*	*System GMM*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Q	0.328***	0.326***	0.328***	0.099***	0.116*	0.164*	0.119	0.198**
	(0.067)	(0.078)	(0.074)	(0.024)	(0.057)	(0.068)	(0.067)	(0.069)
Q × INFO	–0.291***	–0.288***	–0.291***	–0.062*	–0.079	–0.125	–0.082	–0.162*
	(0.070)	(0.081)	(0.077)	(0.025)	(0.061)	(0.071)	(0.070)	(0.066)
LEV	0.005	–0.047	0.004	–0.003	–0.013	–0.131*	–0.016	–0.058
	(0.008)	(0.024)	(0.009)	(0.008)	(0.016)	(0.058)	(0.016)	(0.031)
CFL	–0.002	0.013	–0.002	0.0120	–0.035	–0.046	–0.038	–0.124
	(0.027)	(0.040)	(0.029)	(0.029)	(0.049)	(0.077)	(0.047)	(0.098)
SALE	0.016**	0.007	0.015**	0.018***	0.034***	0.019	0.033**	0.026*
	(0.005)	(0.005)	(0.005)	(0.005)	(0.009)	(0.011)	(0.011)	(0.011)
INFO	0.169**	0.144*	0.168**	–0.038***	0.000	0.005	–0.000	–0.010
	(0.059)	(0.068)	(0.064)	(0.007)	(0.059)	(0.069)	(0.067)	(0.020)
L.INV				0.114**				0.164**
				(0.036)				(0.063)
Observations	3,189	3,189	3,189	2,889	1,119	1,119	1,119	1,038
Adj. R-squared	0.094	0.083	0.151		0.110	0.106	0.203	
AR (2) test (P-value)			0.346				0.209	
Hansen test (P-value)			0.186				0.133	

Notes: *, **, *** shows significance at 10%, 5% and 1%, respectively. Robust standard errors are given the parentheses.

Table A9 Regression results for sub-samples of small firms and large firms over 2010–2017 period

Variables	*Small firms*				*Large firms*			
	Pooled OLS	*Fixed effects*	*Random effects*	*System GMM*	*Pooled OLS*	*Fixed effects*	*Random effects*	*System GMM*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Q	0.200*	0.226*	0.207*	0.081*	0.170**	0.235***	0.199**	0.083***
	(0.091)	(0.110)	(0.097)	(0.038)	(0.053)	(0.064)	(0.063)	(0.022)
Q × INFO	–0.169	–0.192	–0.175	–0.060	–0.124*	–0.203**	–0.157*	–0.055*
	(0.092)	(0.111)	(0.098)	(0.037)	(0.057)	(0.068)	(0.066)	(0.023)
LEV	–0.005	–0.071*	–0.011	–0.006	0.011	–0.086*	–0.005	–0.032*
	(0.010)	(0.028)	(0.011)	(0.012)	(0.012)	(0.034)	(0.014)	(0.014)
CFL	–0.007	0.003	–0.006	–0.000	–0.008	0.043	–0.002	–0.161**
	(0.028)	(0.049)	(0.032)	(0.049)	(0.040)	(0.058)	(0.044)	(0.062)
SALE	0.018***	0.013*	0.017***	0.044	0.024**	0.013	0.020*	0.189***
	(0.005)	(0.006)	(0.005)	(0.038)	(0.008)	(0.008)	(0.008)	(0.055)
INFO	0.046	0.057	0.046	–0.024**	0.046	0.082	0.061	–0.012
	(0.072)	(0.090)	(0.079)	(0.009)	(0.054)	(0.063)	(0.060)	(0.014)
L.INV				0.127*				0.127***
				(0.058)				(0.034)
Observations	2,071	2,071	2,071	1,866	2,237	2,237	2,237	2,061
Adj. R-squared	0.056	0.056	0.091		0.110	0.095	0.136	
AR(2) test (P-value)			0.125				0.981	
Hansen test (P-value)			0.091				0.454	

Notes: *, **, *** shows significance at 10%, 5% and 1%, respectively. Robust standard errors are given the parentheses.