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Time Lag Effects of IT Investment on Firm Performance: Evidence form Indonesia

(Kesan Jangka Masa Pelaburan IT terhadap Prestasi Syarikat: Bukti dari Indonesia)

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ABSTRACT

The objective of this study is to investigate whether there is a lag effect of IT investment on the financial performance of the firm, both individual and industry-adjusted firm performance. Using a dynamic panel approach of Generalized Method of Moments, we sourced data from 396 firms from multiple companies listed on the Indonesia Stock Exchange over 2013-2017. The results indicate that IT investment improves the firm financial performance after the first year of investment. IT investment in the current period does not affect its current financial performance because it requires a time lag for the firm to realize its benefits due to the organizational learning process, structural effects, and complementary effects. However, we found an immediate impact of IT investment on firm performance when performance is measured by market performance. Information on IT investment is good news for investors hence the stock price that reflects the future performance of the firms.

Keywords: IT investment; time lag; firm performance; generalized method of moments
JEL: M15, M41

ABSTRAK

Objektif kajian ini adalah untuk mengkaji sama ada terdapat kesan jeda pelaburan IT terhadap prestasi kewangan firma, prestasi syarikat dan individu dan industri yang disesuaikan. Dengan menggunakan pendekatan panel dinamik Kaedah Momen Teritlak, kami memperoleh data dari 396 firma dari beberapa syarikat yang tersenarai di Bursa Efek Indonesia selama 2013-2017. Hasil menunjukkan bahawa pelaburan IT meningkatkan prestasi kewangan syarikat setelah tahun pertama pelaburan. Pelaburan IT dalam tempoh semasa tidak mempengaruhi prestasi semasa kewangannya kerana memerlukan jeda waktu bagi syarikat untuk menyedari faedahnya kerana proses pembelajaran organisasi, kesan struktur, dan kesan pelengkap. Namun, kami mendapati kesan langsung pelaburan IT terhadap prestasi syarikat apabila prestasi diukur dengan prestasi pasaran. Maklumat mengenai pelaburan IT adalah berita baik bagi pelabur oleh itu harga saham yang mencerminkan prestasi masa depan syarikat.

Kata kunci: Pelaburan IT; jeda masa; prestasi firma; kaedah momen teritlak

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INTRODUCTION

The phenomenon of IT investment in the digital era is interesting to study especially from aspects of its benefits. Ranganathan and Brown (2006) estimated that almost 40% of capital expenditure is being spent on IT. As a research company and IT advisor, Gartner, Inc. noted that global company expenditure related to IT increased by 0.5% to 3.8% in 2017 and by 0.2 % to 4.5% in the following year. In the following year the percentage of IT expenditure to sales ratio in 2017 also showed an increase from 5.04% to 6.08%. The average of global IT spending over the past ten years is 4.55% of capital expenditure (Kappelman et al. 2018). The International Data Corporation (IDC) recorded that the global financial services industry showed a significant increase in digital and IT expenditure in recent time. In 2017, it was forcasted that IT expenditure would increase by 12.5% in 2022. As with developed economies Indonesia, a developing country, also showed rapid increase in IT investment in many companies (Winarno 2019).

The investment made in IT shows that the technolofy is increasingly valuable for the firm (Winarno & Tjahjadi 2017). However, previous studies have shown inconsistent results (Nwankpa & Datta 2017; Achjari & Wahyuningtyas 2014). Several studies stated that IT investment has a positive relationship with performance of the firm (Mithas & Rust 2016; Mithas et al. 2012; Hitt & Brynjolfsson 1996; Lee & Kim 2006; Ho et al. 2011; Hapsari & Ghozali 2006). Other research results have shown that productivity was not proportionally increased despite enhanced IT investment, thus indicating a productivity paradox (Lim et al. 2015). On the other hand, some researchers have also stated that there was no positive relationship between IT investment and performance of the firm (Chae et al. 2014; Rai et al. 1996; Li et al. 2000; Richardson & Zmud 2002; Li & Ye 1999; Wang et al. 2015; Adrayani & Dewi 2017). The relationship between IT investment and firm performance remained inconsistent and inconclusive. Lee and Kim (2006) stated that the first cause of inconsistency in research results was related to measurement errors (mismeasurement) and the emergence of IT productivity bias was sometime not seen from comparable magnitudes either before or after IT investment (Brynjolfsson 1993). The second is the problem of time lag, which shows that IT's benefits can take several years to show its bottom line (Brynjolfsson 1993; Devaraj & Kohli 2003). According to Shaft et al. (2007) some studies have also investigated the inconsistency regarding the time lag period.

The problem of measuring firms' performance following IT investment represents one of the core causes of inconsistency in research results. First, such firms may not necessarily benefit immediately after the investment as similarly experienced by other firms after investing in IT. The problem can be circumvated through measurement of adjusted firm performance. Secondly, current firm performance may also be influenced by the firm's past accomplishment (Santhanam & Hartono 2003). Other research results supported this. They suggested a halo effect that causes a relationship between current financial performance with a past one and current IT capabilities also with the firm's past performance. This halo phenomenon may integrate the relationship between IT investment and firm performance in a dynamic model. Although there is no perfect method for dealing with the halo effect of past performance (Santhanam & Hartono 2003), the dynamic relationship between these variables can be approached by a dynamic panel model that will provide more efficient and consistent results (Wintoki et al. 2012; Ullah et al. 2018). The objective of this study is to investigate whether there is a lag effect of IT investment on the firm's financial performance, both at individual and industry-adjusted accomplishement of the firm.

This research potentially provides several contributions. First, The International Data Corporation (IDC) stated that the phenomenon of IT and digital spending in the financial services industry in Indonesia showed a significant increase in IT application during the Covid-19 pandemic. The financial industry has also the largest number of firms with IT investments. This reliance is predicted to increase IT spending by 12.5% in 2022 (https://www.indotelko.com/read/1538705973/belanja-ti-keuangan-12-5). Based on this development, this study adopts the time-lag concept to re-examine the relationship between IT investment and firm performance in the Indonesian context; namely as a developing country with different industrial characteristics relative to developed countries.

Second, the pattern of relationship between time-lag that affects IT investment on performance of the firm is examined through a dynamic panel since there is evidence of lag dependance on firm performance variables (Weill 1992; Lim et al. 2015). The dynamic model is therefore more precisely estimated using the GMM approach. In several past studies (Lee & Kim 2006; Brynjolfsson et al. 1994; Shaft et al. 2007), the research model was estimated through the use of dynamic ordinary least squares (DOLS). Such estimation approach used in the previous studies has the potential to produce biased and inconsistent results due to the problem of dynamic endogeneity of the dependent variable that is influenced by values in the preceding period (Schultz et al. 2010; Wintoki et al. 2012; Ullah et al. 2018; Tanjung 2020). Third, the relative adjusted performance measures used in the same industry, adopted and modified in this study, established that abnormal firm performance in similar industries produced consistent performance results.

The structure of the article is organized as follows: Section 2 discusses the literature review and development of hypothesis. Section 3 describes research method. Section 4 explains the empirical results and includes the discussion. The last section, Section 5, states the conclusions and limitations of the study.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

IT INVESTMENT, PRODUCTIVITY PARADOX, AND TIME LAG APPROACH

IT investment is defined as IT's capital expenditure, including hardware, software, data storage media and networks (Dedrick et al. 2003). Aral and Weill (2007) stated that the expected benefits of IT investment or performance depend on the firm's strategic objectives and categories of IT assets. The paradox of productivity for IT investment arises because there is no positive relationship between IT expenditure and its productivity or profitability (Dehning & Richardson 2002). Brynjolfsson (1993) identified four categories that could explain the paradigm of IT productivity: (1) mismeasurement of outputs and inputs; (2) the existence of lags in the learning process and adjustments; (3) redistribution and dissipation of profits; (4) mismanagement of IT investment (Stratopoulos & Dehning 2000).

The time lag in IT investment is one of the exciting things that can explain the productivity paradox. The time lag is defined as the time delay caused by specific properties or behaviors of individuals, organizations, communities, systems and others (Lim et al. 2015). It means that the impact on results will differ significantly depending on how the causal variable is applied, even though the same variable in the causality function is used. In general, the impact of time lag occurs when IT investment benefits are not directly or fully manifested after the investment is made. The actual benefits to be gained by the firm after the initial period may range from a few days to several months and in some cases even years, depending on the size and complexity of the firm's IT implementation (Devaraj & Kohli 2003). The stimulating things about the emergence of time lags on IT investment are the learning effect, structural effect, and complementary effect (Shaft et al. 2007). The learning factor often requires employees to learn how to utilize IT that will be or has been installed in the firm systems. For structural factors, firms often have to adjust their business processes and structure incentives to accommodate the adoption of new IT. Finally, for firms that will fully utilize IT, it may also require capabilities and complementary technology so that IT investment can be fully implemented within the firm. Table I summarizes the studies on the relationship between IT investment and firm performance.

RELATIONSHIP BETWEEN IT INVESTMENT AND FIRM PERFORMANCE

RBT theory explains that resources are essential for improving performance of the firm (Barney 1991). Investment in IT as a potential resource creates competitive advantages for firms (Bharadwaj 2000). IT investment can help firms to increase revenue by creating new value in products, new marketing, and sales channels and improving customer life cycle management (Mithas et al. 2012; Xue et al. 2012). Cobb-Douglas's production function theory stated that the inputs in production factors, including IT capital, non-IT capital, and labor, would increase firm's productivity (Hitt & Brynjolfsson 1996; Dewan & Kraemer 2000). This theory supports the previous statement. Based on this argument, companies that have received benefits in the first year and following IT investment would motivate them to invest more in subsequent periods.

Some research is still focused on testing the relationship between IT investment and firm benefits obtained by firms at time of investment or during the investment year when the new technology also contributes to its long-term performance (Bharadwaj et al. 1999). Researchers may not be able to convince that IT investment will significantly contribute to changes in firm performance because a productivity paradox is still evident (Hu & Plant 2001; Farouk & Dandago

TABLE I. Summary of literature review

Researcher	Relationship between IT Investment and Firm Performance			
	Positive	Negative	Mixed	Not Supported
Rai et al. (1996)			V	
Hitt and Brynjolfsson (1996)			V	
Strassmann (1997)				V
Peslak (2003)				V
Lee and Kim (2006)	V			
Shaft et al. (2007)	V			
			V	
Chari et al. (2008)	V			
Thouin et al. (2008)	V			
Ho et al. (2011)	V			
Mithas et al. (2012)	V			
Xue et al. (2012)				V
Campbell (2012)	V			
Farouk and Dandago (2015)		V		
Lee et al. (2016)			V	
Mithas and Rust (2016)	V			
Adrayani and Dewi (2017)				V

2015). A possible explanation is that there is a lag in IT investment. The relationship between IT investment and firm performance is likely to be dynamic because it has a lag time impact. Performance improvements at the beginning of an investment can be slow, or even harmful, as Lee and Kim (2006) discovered that the current sales growth will decline and so do sales in the first year following IT investment. At the stage around maturity will be greater (Campbell 2012).

The type of IT investment projects and the process of implementing these will take time to add value to the firm. In other words, the investment cannot directly have an impact on the firm's performance in the current year (Lee & Kim 2006; Campbell 2012; Bharadwaj et al. 1999). Karanja and Bhatt (2014) explained that in calculating the benefits derived from IT investments there are usually measurement problems due to introducing or transforming existing IT infrastructure. The lag benefit received from utilizing firm resources such as IT investment is due to the learning process and adaptation to new IT technology (Shaft et al. 2007; Brynjolfsson 1993). The process in each firm or industry varies significantly in a range of months and even years depending on IT's complexity and whether new IT investments are continuous over previous ones (Devaraj & Kohli 2003).

Lee and Kim (2006) examined the time lag effect of IT investment and firm performance. They showed that the immediate investment year's performance was influenced by IT investment and the performance will be higher in the following year. The results showed a positive influence of time lag in IT investment on *return on capital* (ROC). Zhu and Huang (2012) showed that IT companies investing in R&D produced a more significant impact on financial performance the following year. Cline and Guynes (2001) explained that firms' total IT investment requires two years to provide the expected benefits. Improved financial performance will be registered by firms following IT investment in the following year and the peak will occur in the third and fourth year (Campbell 2012). Such outcomes prove that the firms' performance in the current period is influenced by IT investment in previous years.

An IT investment, if it is linked to a time function, will have an impact on performance in the initial stages. The return of investment is relatively slow due to the learning process involving both the individual aspect of the new system and the organization as a whole over their business processes (Shaft et al. 2007). When the firm starts to reach the growth stage and onwards to the maturity phase, the impact of IT investment on firm performance will increase higher than at the initial stage (Phaal et al. 2004; Aharonson & Schilling 2016). The benefits of IT on firm performance can be measured at the individual worker or industry level (Lim et al. 2011). The impact of IT investment will be more visible at the industry level when its performance is compared with that of the firms'. Relative performance of IT investment can also be compared between competing industry groups. Large risk factors external to the industry are eliminated by industry performance (Stratopoulos & Dehning 2000). Based on this argument, it can be hypothesized as follows.

H_{1a} There is a time lag effect in the relationship between IT investment and individual firm performance.

H_{1b} There is a time lag effect in the relationship between IT investment and industry adjusted firm performance.

MATERIAL AND METHOD

DATA AND SAMPLE

Data used in this study were sourced from the firms' annual reports published through the Indonesia Stock Exchange (IDX) and the Indonesian Capital Market Directory (ICMD). Panel data over a 5-year period were used, spanning 2013-2017. Information on IT expenditure was obtained from corporate annual financial statements, while data on other variables were sourced from the ICMD, often used in previous studies. The 5-year span was considered sufficient for overview of time lag as adopted in some past studies (Cline & Guynes 2001; Bryniolfsson 1993; Lee & Kim 2006; Campbell 2012).

The sampling technique was carried out in several stages as follows: (1) The firm was listed on IDX and published an annual report over the study period, 2013 to 2017; (2) the firm discloses IT assets (both fixed assets and intangible assets) and or deferred charges for IT investments in its annual reports, in a series for a minimum of three consecutive years; and (3) firms with IT investments were involved in the range of observations (2013-2017) for immediate and or lag test year. The sampling technique adopted in this study is different from those used by Bharadwaj (2000) and Santhanam and Hartono (2003) who used control group methodology.

In this study the performance of the industry group will be used. Therefore, the relative performance of the company that has considered the performance of the group in the company will be attained.

VARIABLES AND MEASUREMENT

The performance of the firm is measured on two bases, namely accounting-based performance measures and market-based performance measures. Accounting-based performance measures provide evaluative references and indications of past and present organizational adaptation (Keats & Hitt 1988). Some financial performance measures in this study used several proxies that were adopted by previous researchers (Lee & Kim 2006; Hitt & Brynjolfsson 1996; Aral & Weill 2007) namely Return on Assets (ROA), Return on Equity (ROE), and Return on Sales (ROS). In this study, market-based performance measures use Tobin's Q (Bharadwaj et al. 1999; Chari et al. 2008; Mithas & Rust 2016). Tobin's Q value is the firm's market value ratio divided by the replacement cost of assets. Total assets in the study are also used to measure asset replacement cost (Bharadwaj et al. 1999; Chari et al. 2008; Mithas & Rust 2016).

Khallaf et al. (2017) stated that to measure the benefits of IT investment in the same year (immediate) would be appropriate if perceptual measures and or market measures are used. On the other hand, using accounting-based performance measures will be more appropriate if based on industry size, time lag, and pair evaluation to avoid corporate heterogeneity (Khallaf et al. 2017). This study uses a relative performance measure, which is also called Industry Adjusted Firm Performance (IAFP). It is calculated based on individual performance and compared with the firm's average performance in its respective industry group. IAFP operational techniques are calculated from each company's performance selected as a research sample, subtracted by the industry group's average performance (average of all companies in the same group category), where the firm is included in a particular industry category (Winarno 2019). For simplicity, the following table is a hierarchical notation of companies and industry groups.

Industry	1	2	…	J
Companies	1 2 … n_1	1 2 … n_2	…	1 2 … n_J

The following is a notation for obtaining IAFP scores

$$IAFP_{ijt} = FP_{it} - \overline{FP}_{jt}$$

The average value of industry performance is calculated using the following formula.

$$\overline{FP}_{jt} = \frac{\sum_{i=1}^{n_j} FP_{ijt}}{n_j}$$

Where:

i	:	firm
j	:	Group Industry
t	:	Year
$IAFP_{ijt}$	:	Industry adjusted firm performance for firm *i* in the *j* industry group in time period *t*.
FP_{it}	:	Firm performance for firm *i* in time period *t*.
$\overline{FP}_{jt}$	:	Mean industry performance *j* in time period *t*.

IT investment is defined as capital expenditure related to IT investment (IT expenditure); in both capitalized and expensed directly in the current period consisting of tangible assets (such as hardware, data storage, networking) and intangible assets (software, licenses, services) (Ravichandran et al. 2009; Aral & Weill 2007; Chari et al. 2008; Mithas & Rust 2016). We chose to use the ratio of IT expenditure divided by total sales as a measure of IT investment. The following is a formula for measuring IT expenditure (ITEXPS).

$$ITEXPS_{it} = \frac{Total\ IT\ investment_{it} - Total\ IT\ investment_{it-1}}{Net\ Sales_{it}}$$

The control variables in this study are divided into firm-level variables and industry level. The firm-level control variables used are (1) firm size (Bharadwaj et al. 1999; Chari et al. 2008; Mithas & Rust 2016; Haji Abdifatah & Mohd Ghazali Nazli 2018); (2) leverage; and (3) market share (Bharadwaj et al. 1999; Chari et al. 2008). The industrial level control variable in this study is Industry capital Intensity (Chari et al. 2008).

MODEL SPECIFICATION

The framework used to examine IT investment productivity in this study deliberated on the theory of production functions (Hitt & Brynjolfsson 1996). The model in this study was developed based on the Cobb-Douglas (C-D) production function theory approach, that explains the output relationship to several inputs (Revilla & Fernández 2012; Rai et al. 1997). The relationship between input and output of the C-D production function in this study is analogous to the firm's input in IT investment. In contrast, the output is the firm's performance generated on IT investment. The function can be modeled as equation (1) as follows:

$$Q_{it} = A_i L_{it}^{\beta_1} C_{it}^{\beta_2} K_{it}^{\beta_3} e^{\sigma_{it}} \qquad (1)$$

Q_{it} is output for firm *i* in the period *t*, L_{it} is labor input (staff of the information systems) for firm *i* in the period *t*, C_{it} is capital or physical capital for firm *i* in the period *t*, K_{it} is knowledge or technological capital for firm *i* in the period *t*, technological $\beta_{1,2,3}$ is the elasticity parameter concerning different inputs. Based on the assumptions as developed, the C-D equation can be reduced to Q = f (C, K). This equation, if adopted into the equation of input (IT investment) and output (firm performance), then (Firm Performance-FP) is a function of IT investment and TI_{it-k}. Based on these arguments, the research model can be derived logically, as in the following equation:

$$FP_{it} = f\left(ITEXPS_{it}, ITEXPS_{it-1}, \ldots, ITEXPS_{it-k}\right) \qquad (2)$$

$$FP_{it} = \alpha\ ITEXPS_{it}^{\ \beta_1}\ ITEXPS_{it-1}^{\ \beta_2} \ldots ITEXPS_{it-k}^{\ \beta_{k+1}}\ e^{\mu_{it}} \qquad (3)$$

Where:

FP_{it}	:	Firm performance for firm *i* in the period *t*
$ITEXPS_{it}$	:	IT Investment/sales for firm *i* in the period *t*
$ITEXPS_{it-k}$	:	IT Investment/sales for firm *i* in the period *t-k*
TA_{it}	:	Total asset for firm *i* in time period *t*
Lev_{it}	:	Leverage for firm *i* in time period *t*
MS_{it}	:	Market share for firm *i* in time period *t*
ICI_{it}	:	Industry capital intensity for firm *i* in time period *t*
α	:	Constant
$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$	:	Regression Coefficient
k	:	1,2,3,4
μ	:	Error term

Equation (3) is a model developed from C-D, which is non-linear in parameters. The model can be transformed into a natural logarithmic form to obtain a linear model (Gujarati & Porter 2008; Baltagi 2008). Hence, we restate equation (3) as follows:

$$logFP_{it} = log\alpha + \beta_1 logITEXPS_{it} + \beta_3 logITEXPS_{it-k} + \varepsilon_{it} \quad (4)$$

We use several control variables that are often used in previous studies, namely total assets (TA), leverage (LEV), market share (MS), and Industry capital intensity (ICI). Therefore, the empirical model can thus be formulated as follows:

$$\begin{aligned} logFP_{it} &= log\alpha + \beta_1 logITEXPS_{it} + \beta_2 logITEXPS_{it-k} \\ &+ \beta_3 logTA_{it} + \beta_4 logLev_{it} + \beta_5 logMS_{it} \\ &+ \beta_6 logICI_{it} + \varepsilon_{it} \end{aligned} \quad (5)$$

The relationship between IT investment and firm performance has emerging probability autoregressive variables that occur in the dependent variable, which shows the effect of past performance on current firm performance (Weill 1992; Lim et al. 2015). Finally, to test our hypothesis we use the following regression model:

$$\begin{aligned} logFP_{it} &= log\alpha + \beta_1 logFP_{it-1} + \beta_2 logITEXPS_{it} \\ &+ \beta_3 logITEXPS_{it-k} + \beta_4 logTA_{it} + \beta_5 logLev_{it} \\ &+ \beta_6 logMS_{it} + \beta_7 logICI_{it} + \varepsilon_{it} \end{aligned} \quad (6)$$

The lagged value of dependent variables as explanatory variables in equation (6) shows that the model is a dynamic panel model. In several previous studies such as (Lee & Kim 2006; Brynjolfsson et al. 1994; Shaft et al. 2007), the research model was estimated using dynamic ordinary least squares (DOLS). The test approach to dynamic models using DOLS provides biased and inconsistent results due to dynamic endogeneity problems (Schultz et al. 2010; Wintoki et al. 2012; Ullah et al. 2018). The parameter estimation method for the dynamic panel data model would be more appropriate using GMM because this approach considers the correlation between variable dependent lag and residuals (Greene 2008). This model is designed to overcome the autoregressive problems and the potential endogeneity of explanatory variables. The specific characteristics of relevant firms are ignored (Arellano & Bond 1991; Wintoki et al. 2012). The GMM process involves transforming equations into derivatives first and then using lagged endogenous variables as instruments (Arellano & Bond 1991). The results of data transformation and the subsequent lagged value of the dependent variable used as an instrument variable are aopted to control endogeneity (Roodman 2009; Ullah et al. 2018).

RESULT AND DISCUSSION

DESCRIPTIVE STATISTICS

Table 2 shows that the service sector (Industry Sub-Sectors (ISS) - 6, 7, 8, 9) comprised 320 (81%) firms, the manufacturing sector (ISS - 3, 4, 5) 71 (18%) firms, and the remaining 5 (1%) firms are in the industrial sector. The service sector firms, according to the results, dominate the study sample and thus will necessitate IT investment the most. The analysis of level 2 industry sub-sector (ISS-2) shows that the financial industry sub-sector (8.1; 8.2; 8.3; 8.4; and 8.1) ranks first with 152 (38%) finance companies that possess IT investment. In the finance industry sub-sector the most IT investment is in the banking industry sub-sector with 92 (23%) companies, while the remaining 15% comprise the insurance sub-sector 6%, finance institutions sub-sector 4%, securities companies sub-sector 2% and other sub-sectors 3%. The banking companies dominate IT investment in the finance industry thus providing evidence that the banking industry is an industry that relies heavily on IT investment and thus greatly influenced by IT developments.

Table 3 is descriptive statistics that provide an initial overview of data patterns of each variable. The average IT investment in a firm included as research sample is IDR 310,453 million per year. The average investment value has also increased in the past three years from IDR 241,182 million in 2015, to IDR 277,940 million in 2016, and IDR 322,118 million in 2017. The upward investment trend over the three years averaged 15% per year. The result indicates that Indonesian firms manage upward annual investment in IT with investment/expenditure at 3.5% of sale value.

TABLE 2. Sample distribution based on industry classification per year observation

ISS-1	ISS-2	Industrial Classification	All			
			ISS-2		ISS-1	
			n	%	n	%
Mining	2.2	Oli and Gas	5	1%	5	1%
Basic and Chemical Industry	3.1	Cement	8	2%	21	5%
	3.2	Ceramics, Porcelain and Glass	3	1%		
	3.3	Metals	5	1%		
	3.6	Animal feed	5	1%		
Others Industry	4.2	Automotive and Components	3	1%	13	3%
	4.3	Textiles and Garments	5	1%		
	4.5	Cable	5	1%		
Consumer Goods Industry	5.1	Food and Drink	9	2%	37	9%
	5.2	Cigarette	3	1%		
	5.4	Cosmetics & Household Goods	13	3%		
Property and Real Estate	6.1	Property and Real Estate	19	5%	36	9%
	6.2	Building construction	17	4%		
Utility Infrastructure and Transportation	7.1	Energy	9	2%	37	9%
	7.2	Toll Roads, Seaports, Airports & others	5	1%		
	7.3	Telecommunication	8	2%		
	7.4	Transportation	11	3%		
	7.5	Non-Building Construction	4	1%		
Finance	8.1	Bank	92	23%	152	38%
	8.2	Financial institutions	16	4%		
	8.3	Securities Company	10	3%		
	8.4	Insurance	24	6%		
	8.5	Other Sectors	10	3%		
Trade in Services and Investment	9.1	Wolesalers	18	5%	95	24%
	9.2	Retail	9	2%		
	9.3	Restaurants, Hotels and Tourism	19	5%		
	9.4	Advertising, Printing and Media	21	5%		
	9.6	Computer Services and Devices	28	7%		
Observation (n - %)			396	100%	396	100%

TABLE 3. Descriptive statistics

Variables	Obs.	Mean	Min	Med	Max	Std Dev.
ROA	396	0.0599	0.0001	0.0395	0.7151	0.0717
ROE	396	0.1488	0.0006	0.1120	1.3738	0.1787
ROS	396	0.3986	0.0003	0.0990	45.0899	2.7747
Q	396	1.7978	0.1598	1.1183	28.4526	2.6862
ITEXP	396	310453	9	4036	25473000	2140728
ITEXPS	396	0.0355	0.0000	0.0023	1	0.3322
TA	396	54495273	147418	5012808	1126248442	162679454
LEV	396	8168	3.1700	567	1361981	91983
MS	396	0.1581	0.0001	0.0564	1.0000	0.2386
ICI	396	0.3557	0.0019	0.1307	3.0630	0.5549

Notes: ROA, ROE, and ROS, are represent firm financial performance return on assets, return on equity, return on sales, respectively. Q represents firm market performance, namely Tobin's Q. ITEXP and ITEXPS represent total IT expenditure and total IT expenditure divided by total sales, respectively. TA, LEV, MS, ICI represent total assets, firm's leverage (debt-equity ratio), market share, and industry capital intensity, respectively.

CORRELATION MATRICES

Table 4 shows the correlations between IT investment (ITEXPS-as measured by the amount of IT investment/ sales) with three measures of financial base accounting performance (ROA, ROE, ROS), and one measure of market base performance (Tobin's Q). IT investment has a negative correlation of -0.274 (significant at the 5% level) with ROA, a negative correlation of -0.252 (significant at the 5% level) with ROE, and a negative correlation of -0.122 (significant at the 5% level) with Tobin's Q. IT investment is thus negatively correlated with the firm's performance in the year of investment. The investment however has a positive correlation of 0.230 (significant at 1% level) with ROS.

DIAGNOSTIC TESTS OF DYNAMIC PANEL DATA ESTIMATION AND VALIDITY OF RESULTS

Estimation results of the statistical model will be stable and efficient if the endogenous variables show unit root characteristics of stability and stationarity in the model (Schultz et al. 2010). In this study two approaches to test unit-roots were used, namely the Levin, Lin & Chu test (LLC test) and the Phillips and Perron (PP) Fisher test. The p-value < 0.05 (reject the null hypothesis) indicates that the variables are stationary, or there is no unit root in the data. Further, the consistency of GMM estimation results depends on the validity of the instrument variables (Hansen 1982). The validity of the GMM system was based on the assumption that the instruments are strictly exogenous (Roodman 2009). The Sargan-Hansen Specification Test was used for overidentifying restriction. The p-value for each test model (results in Table 5, 6 and 7) exceeded the conventional significance level (Sargan J-statistic >0.05) indicating that the null hypothesis cannot be rejected. It is thus concluded that all instrument variables are exogenous and valid.

The dynamic models cannot eliminate serial correlations for first order (AR1) and there cannot be a serial correlation for second-order (AR2) (Wintoki et al. 2012; Arellano & Bond 1991). The null hypothesis (H_0) for this test states that there is no residual serial correlation in the model tested. The alternative hypothesis is that there is a residual serial correlation in the research model. If the p-value> 0.05, then the null hypothesis cannot be rejected, which means there is no residual serial correlation in the model. Conversely, if p-value <0.05, H_a is accepted, which means there is a residual serial correlation in the model. Results for GMM AR(1) and AR(2) specification tests in Table 5, 6, and 7, it indicate that the requirements are met and there is first-order autocorrelation, but without the second-order as required in GMM.

DISCUSSION

IT INVESTMENT AND INDIVIDUAL FIRM PERFORMANCE

Table 5 shows the four research models with the lag dependent variable influencing the dependent variable. The three models for financial performance are significant at the 5% level, namely LOGROA, LOGROE, and LOGROS with coefficient values respectively at 0.1834, 0.1435 and 0.2789. The market performance model measured by LOGQ is significant at 1% with a coefficient of 0.3899. The four dependent variables in the lag test results provide evidence that all models developed are dynamic and more precisely estimated using a dynamic panel model.

Table 5 shows that IT investment (LOGTIEXPS) does not affect the firm's financial performance. The LOGROA, LOGROE, and LOGROS coefficients are respectively -0.0275, -0.0324 and 0.0096 indicating that

TABLE 4. Correlations matrix among variables

	1	2	3	4	5	6	7	8	9
ROA	1								
ROE	0.821**	1							
ROS	0.468**	0.464**	1						
Q	0.441**	0.382**	0.198**	1					
ITEXPS	-0.274**	-0.252**	0.230**	-0.122*	1				
TA	-0.198**	0.088	0.158**	0.079	0.107*	1			
LEV	0.044	0.062	0.089	-0.142**	-0.004	0.384**	1		
MS	0.482**	0.459**	-0.101*	0.265**	-0.220**	0.282**	0.221**	1	
ICI	0.159**	0.266**	0.305**	0.124*	0.144**	0.624**	0.300**	0.731**	1

Notes: ***, **, and * denote, respectively, significance at the 1, 5, and 10 percent levels, based on two-tailed tests.

TABLE 5. IT Investment and individual firm performance – System GMM two-step estimators with robust standard error

Variables	LOGROA (Model 1)	LOGROE (Model 2)	LOGROS (Model 3)	LOGQ (Model 4)
LOGROA(-1)	0.1834**			
LOGROE(-1)		0.1435**		
LOGROS(-1)			0.2789**	
LOGQ(-1)				0.3899***
LOGITEXPS	-0.0275	-0.0324	0.0096	0.0401**
LOGITEXPS(-1)	0.1182**	0.0861*	0.1121**	0.0321
LOGTA	0.7241***	0.5803***	0.6902***	-0.0006
LOGLEV	-0.1133**	-0.1097	-0.1268***	0.0118
LOGMS	0.6290	0.4493	-0.0936	0.0377
LOGICI	-0.6484	-0.3011	0.0744	-0.4379**
Obs.	396	396	396	396
AR(1)	0.0675*	0.0466**	0.0486**	0.0338**
AR(2)	0.7487	0.9795	0.9001	0.5084
Sargan test	0.4955	10.633	5.3033	3.2822
Prob(J-statistic)	4.3843	0.0591	0.3799	0.6565

Notes: This table contains the results of testing the IT investment and individual firm performance (LOGROA, LOGROE, LOGROS, and LOGQ) with the *System-GMM* estimation technique two-step estimators with robust standard errors. ***, **, and * denote, respectively, significance at the 1, 5, and 10 percent levels

TABLE 6. IT investment and industry adjusted firm performance – System GMM two-step estimators with robust standard error

Variables	ADJLOGROA (Model 1)	ADJLOGROE (Model 2)	ADJLOGROS (Model 3)
ADJLOGROA(-1)	0.2086**		
ADJLOGROE(-1)		0.1773**	
ADJLOGROS(-1)			0.2936**
LOGITEXPS	0.0347	0.0428	0.0424
LOGITEXPS(-1)	0.1666**	0.1196**	0.1875***
LOGTA	0.1254	-0.1862	0.2812
LOGLEV	-0.0716	-0.1000	-0.0722
LOGMS	0.9942	0.7174	0.1696
LOGICI	-0.3093	0.3295	0.4677
Observasi	396	396	396
AR(1)	0.0471**	0.0441**	0.0364**
AR(2)	0.9228	0.8542	0.7742
Hansen J test	5.1049	4.2018	3.2181
Prob(J-statistic)	0.4032	0.5207	0.6663

Notes: This table contains the results of testing the IT investment and industry adjusted firm performance (ADJLOGROA, ADJLOGROE, and ADJLOGROS) with the *System-GMM* estimation technique two-step estimators with robust standard errors. ***, **, and * denote, respectively, significance at the 1, 5, and 10 percent levels the quantum of IT investment in year *t* will not affect the firm's financial performance for that year. Furthermore, market performance measured by Tobin's Q shows a positive coefficient of 0.0401 at 5% level indicating that the quantum of IT investment by the firm elicited positive response by investors. This is reflected in the higher Tobin's Q value the firm has for IT investment in a year (t). Investors will respond to an increase in IT investment in the current period of 1% . It will subsequently be reflected in stock prices, improving market performance as indicated in Tobin's Q value of 0.0401%. The result of IT investment produced immediate effect on market performance. Overall the results indicate that the capital market in Indonesia efficiently reflects the reaction to information on IT investments made by firms as soon as investors was informed of the investments. These results are consistent with those by Bharadwaj et al. (1999) and (Chari et al. 2008) which suggest IT investment will improve firm performance and this will be enhanced if the firm has a related diversification strategy.

Table V shows that the three accounting performance measures are significantly affected by IT investments made in the previous one year. In other words, IT investments in the *t-1* period have a positive effect on firm performance in the *t* period as measured by LOGROA, LOGROE, and LOGROS. Each has a coefficient and significance of 0.1182 (5% level), 0.0861 (10% level) and 0.1121 (5% level) respectively. This result indicates that an increase in IT investment in the previous period of 1% will impact the firm's financial performance in the current year. Otherwise, an increase in investment in the current period of 1% will impact the firm's financial performance in the following year (an increase of 0.1182% for LOGROA, 0.0861 % for LOGROE, and 0.1121% for LOGROS). This result supports H_{1a} for the three financial performance measures LOGROA, LOGROE, and LOGROS, while IT investment for period *t-1* has no specific effect on firm performance as measured by market performance, namely Tobin's Q.

The impact of time lag between IT investment on productivity or on business benefits that firms will receive has different lag periods. Devaraj and Kohli (2000) stated that the variations in lag time for IT investment against the benefits generated could be explained through several studies such as *Customer Relationship Management* (CRM) and *Supply Chain Management* (SCM). These are several types of IT implementation design that requires time for execution until completion between 6-12 months. In the end, the benefits will be gained by investor firms in the post-implementation period in the form of increased ROA and ROS. Another study conducted by firms and included in the Information Week Top 500, in the 1991-1996 period, established that the relationship between lag time of IT investment and firm performance would culminate in the highest post-implementation benefits in the third and fourth year. Differences in gap benefits between firms are mainly due to the inherent time constraints in adopting and implementing new technologies that usually accompany changes in business activities (Karanja & Bhatt 2014).

IT INVESTMENT AND INDUSTRY ADJUSTED FIRM PERFORMANCE

This section examines the relationship between IT investment and financial performance of the industry. In measuring the industry, adjusted performance is used to minimize differences in variability that occur within industry groups.The results in Table V show that the lag effect of IT investment is not significant on the firm's performance as measured by Tobin's Q. Therefore, in our industry-adjusted analysis, we do not include Tobin's Q as a proxy for market performance in order to identify the time lag effect of IT investment. Table VI shows that IT investment does not significantly affect the firm's financial performance during the investment year (t) as measured by ADJLOGROA (coefficient 0.0347) and ADJLOGROE (coefficient 0.0428), and ADJLOGROS (coefficient 0.0424). The result shows that although the firm's IT investment in year (t) has a positive coefficient, it does not significantly increase the firm's financial performance in the year (t). Interestingly, the time lag effect of IT investment on industry-adjusted firm performance is statistically significant. Each has a coefficient and significance of 0.1666 (5%), 0.1196 (5%) and 0.1875 (1%).

Table 6 shows that the coefficients of ADJLOGROA, ADJLOGROE, and ADJLOGROS are higher than the coefficients of financial performance individually presented in Table V. This indicates that an increase in IT investment in the previous period (t-1) of 1% will impact the performance corporate finance in the current year (t). Otherwise, an increase in IT investment in the current period (t) of 1% will impact the firm's financial performance in the following year (t+1) with an increase of 0.1666% for ADJLOGROA, 0.1196% for ADJLOGROE, and 0.1875 % for ADJLOGROS. These results prove that H_{1b} is supported. These results confirm that a time lag for IT investments contribute to the firm's benefits. There is also a relationship between IT investments' time lag with the firms' financial performance. More interestingly, in this section, the coefficient of a firm's financial performance at industry level is higher than than that at the individual firm's level. It can therefore be concluded that the time lag effect of IT investment impacts the firm's financial performance, and this impact is higher for the firm compared to a similar firm in the same industry. These results can be further explained through the RBT concept; namely, firms that invest in IT and become lead IT users, will be able to create unique IT capabilities. Such firms will generate superior business performance compared to those of its competitors (Chae et al. 2014).

CONCLUSIONS

IT investment is capital expenditure aimed at acquiring technological assets to support transactional, tactical or strategic goals (Cline & Guynes 2001). The expectations on performance may be achieved by the firm at the time of investment (immediate) or it may require a time lag before the IT investment manifests its optimal benefits for the firm (Devaraj & Kohli 2003; Campbell 2012; Khallaf et al. 2017). Overall, the study results support the hypothesis that there is a relationship between IT investment and the firm's financial performance, both for the individual performance and industry-adjusted firm performance. Following the RBT concept, this study proves that IT is the primary business resource that provides a competitive advantage over its competitors (Rai et al. 2006).

The findings of this study offer several implications. First, the relationship of financial performance in the form of profitability will be secured by the firm and should increase after one year of IT investment (t + 1). This study extablished that it takes a 1-year time lag on IT investment for an impact to register itself on the firm's financial performance. Managers or decision-makers must pay attention to the time lag for IT investment for the materialization of financial benefits. There is the organizational learning process, structural effects, and complementary effects that need to be understood in order to appreciate that there will be a time lag for IT implementation before the benefits are registered by the firm (Shaft et al. 2007). Secondly, the immediate impact of IT investment on the firm's performance occurs when it is measured by market performance (Tobin's Q). Information about IT investment is good news for investors. It is expected that the firm's future performance will be reflected directly in the stock price in the IT investment period as evident in the findings of earlier studies (Bharadwaj et al. 1999; Chari et al. 2008; Bardhan et al. 2013; Kohli et al. 2012).

Several limitations can be identified in our study. First, the limitations of the IT investment disclosure in financial statements occur in firms that actually have made IT investments, but did not separate this specifically on certain account classifications or fixed asset classifications. As such these companies will not be included in the research sample. Secondly, this study has a short observation period of 5 years, which is insufficient to examine the impact of time lag in the long run. Finally, we cannot control the effect of the ongoing IT implementation or a new one during the observation period. It is also not possible to manage the investment in the form of program packages, or develop it and conduct the customizations.

Based on these research limitations, several suggestions can be made for consideration in future studies. First, researchers need to classify firms into those with high technology and low technology. Firms with high technology tend to have explicit disclosures of IT investment. Second, the researcher can further extend the study period and use balanced panel data to examine it in the long run. Third, following the limitations of IT investment categorization, further research can justify or create sample groups according to the type of classification made by Cline and Guynes (2001); namely, the types of strategic IT investments, including tactical IT investments, IT threshold investments and tractional IT investments.

REFERENCES

Achjari, D. & A.E. Wahyuningtyas. 2014. Information technology investment announcements and firms' value: the case of indonesian firms in the financial and non-financial sectors. *Asian Journal of Business and Accounting* 7(2): 95-116.

Adrayani, I. & Dewi, A.F. 2017. Pengaruh IT spending terhadap kinerja perusahaan pada perusahaan telekomunikasi yang terdafatar di bursa seluruh Asia Tenggara pada tahun 2009-2011. *Modus Journals* 26(2): 93-106.

Aharonson, B.S. & Schilling, MA. 2016. Mapping the technological landscape: measuring technology distance, technological footprints, and technology evolution. *Research Policy* 45(1): 81-96.

Aral, S. & Weill, P. 2007. IT assets, organizational capabilities, and firm performance: How resource allocations and organizational differences explain performance variation. *Organization Science* 18(5): 763-780.

Arellano, M. & Bond, S. 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies* 58(2): 277-297.

Baltagi, B.H. 2008. *Econometrics*. 4th Edition. Berlin, Heidelberg: Springer Berlin Heidelberg.

Bardhan, I., Krishnan, V. & Lin, S. 2013. Research note-business value of information technology: testing the interaction effect of IT and R&D on Tobin's Q. *Information Systems Research* 24 (4): 1147-1161.

Barney, J. 1991. Firm resources and sustained competitive advantage. *Journal of Management* 17 (1):99-120.

Bharadwaj, A.S. 2000. A resource-based perspective on information technology capability and firm performance: an empirical investigation. *MIS Quarterly* 24(1): 169-196.

Bharadwaj, A.S., Bharadwaj, S.G. & Konsynski, B.R. 1999. Information technology effects on firm performance as measured by Tobin's q. *Management Science* 45(7): 1008-1024.

Brynjolfsson, E. 1993. The productivity paradox of information technology. *Communications of the ACM* 36(12): 66-77.

Brynjolfsson, E., Malone, T.W., Gurbaxani, V. & Kambil, A. 1994. Does information technology lead to smaller firms? *Management Science* 40(12): 1628-1644.

Campbell, M. 2012. What a Difference a Year Makes: time lag effect of information technology investment on firm performance. *Journal of Organizational Computing and Electronic Commerce* 22(3): 237-255.

Chae, H.-C., Koh, C.E. & Prybutok, V.R. 2014. information technology capability and firm performance:

contradictory findings and their possible causes. MIS Quarterly 38(1): 305-326.

Chari, M.D.R., Devaraj, S. & David, P. 2008. Research note—The impact of information technology investments and diversification strategies on firm performance. *Management Science* 54(1):224-234.

Cline, M.K. & Guynes, C.S. 2001. A study of the impact of information technology investment on firm performance. *The Journal of Computer Information Systems* 41(3): 15-19.

Dedrick, J., Gurbaxani, V. & Kraemer, K.L. 2003. Information technology and economic performance: a critical review of the empirical evidence. *ACM Computing Surveys* 35 (1):1–28.

Dehning, B. & Richardson, V.J. 2002. Return on investments in information technology: a research synthesis. *Journal of Information Systems* 16(1): 7-30.

Devaraj, S. & Kohli, R. 2000. Information technology payoff in the health-care industry: a longitudinal study. *Journal of Management Information Systems* 16(4): 41-67.

Devaraj, S. & Kohli, R. 2003. Performance impacts of information technology: is actual usage the missing link? *Management Science* 49(3): 273-289.

Dewan, S. & Kraemer, K.L. 2000. Information technology and productivity: evidence from country-level data. *Management Science* 46(4): 548-562.

Farouk, B.K.U. & Dandago, K.I. 2015. Impact of investment in information technology on financial performance of Nigerian Banks: is there a productivity paradox? *Journal of Internet Banking & Commerce* 20(1): 1-22.

Greene, W.H. 2008. *Econometric Analysis*. 6th Edition. New Jersey: Prentice Hall.

Gujarati, D.N. & Porter, D.C. 2008. *Basic Econometrics*. 5th Edition. New York: McGraw-Hill.

Haji Abdifatah, A. & Mohd Ghazali Nazli, A. 2018. The role of intangible assets and liabilities in firm performance: empirical evidence. *Journal of Applied Accounting Research* 19(1): 42-59.

Hansen, L.P. 1982. Large sample properties of generalized method of moments estimators. *Econometrica* 50(4): 1029-1054.

Hapsari, M. & Ghozali, I. 2006. Pengaruh teknologi informasi berbasis sumber daya terhadap kinerja perusahaan. *Jurnal Maksi* 6(1):60-68.

Hitt, L.M. & Brynjolfsson, E. 1996. Productivity, business profitability, and consumer surplus: three different measures of information technology value. *MIS Quarterly* 20(2): 121-142.

Ho, J.L., Wu, A. & Xu, S.X. 2011. Corporate governance and returns on information technology investment: evidence from an emerging market. *Strategic Management Journal* 32(6): 595-623.

Hu, Q. & Plant, R. 2001. An empirical study of the casual relationship between IT investment and firm performance. *Information Resources Management Journal* 14(3): 15-26.

Kappelman, L., Johnson, V., Maurer, C., McLean, E., Torres, R., David, A. & Quynh, N. 2018. The 2017 SIM IT issues and trends study. *MIS Quarterly Executive* 17(1): 53-88.

Karanja, E. & Bhatt, G.D. 2014. The role of IT investments in fostering firm innovations: An empirical study. *Journal of Business Management* 20(2): 25-50.

Keats, B.W. & Hitt, M.A. 1988. A causal model of linkages among environmental dimensions, macro organizational characteristics, and performance. *Academy of Management Journal* 31(3): 570-598.

Khallaf, A., Omran, M.A & Zakaria, T. 2017. Explaining the inconsistent results of the impact of information technology investments on firm performance- a longitudinal analysis. *Journal of Accounting & Organizational Change* 13(1).

Kohli, R., Devaraj, S. & Ow, T.T. 2012. Does information technology investment influence a firm's market value? a case of non-publicly traded healthcare firms. *MIS Quarterly* 36(4): 1145-1163.

Lee, H., Choi, H., Lee, J., Min, J. & Lee, H. 2016. Impact of IT investment on firm performance based on technology IT architecture. *Procedia Computer Science* 91: 652-661.

Lee, S. & Kim, S.H 2006. A lag effect of IT investment on firm performance. *Information Resources Management Journal* 19(1): 43-69.

Li, H., Irani, Z. & Love, P.E. 2000. The IT performance evaluation in the construction industry. Proceedings of the 33rd Annual Hawaii International Conference on System Sciences, 7 Jan. Maui, HI, USA.

Li, M. & Ye, L.R. 1999. Information technology and firm performance: Linking with environmental, strategic and managerial contexts. *Information & Management* 35(1): 43-51.

Lim, G.G., Lee, D.C. & Cole, R.E. 2015. A comparative study on the time lag effect of investments in innovative information systems. *Journal of Theoretical & Applied Information Technology* 77(3): 328-341.

Lim, J.-H., B. Dehning, V. J. Richardson, and R. E. Smith. 2011. A meta-analysis of the effects of IT investment on firm financial performance. *Journal of Information Systems* 25(2):145-169.

Mithas, S. & Rust, R.T. 2016. How Information technology strategy and investments influence firm performance: conjecture and empirical evidence. *MIS Quarterly* 40(1): 223-245.

Mithas, S., Tafti, A.R., Bardhan, I. & Goh, J.M. 2012. Information technology and firm profitability: mechanisms and empirical evidence. *MIS Quarterly* 36(1): 205-224.

Nwankpa, J.K. & Datta, P. 2017. Balancing exploration and exploitation of IT resources: the influence of Digital Business Intensity on perceived organizational performance. *European Journal of Information Systems*: 1-20.

Peslak, A.R. 2003. A firm level study of information technology productivity using financial and market based measures. *Journal of Computer Information Systems* 43(4): 72-80.

Phaal, R., Farrukh, C.J.P. & Probert, D.R. 2004. Technology roadmapping—a planning framework for evolution and revolution. *Technological Forecasting and Social Change* 71(1): 5-26.

Rai, A., Patnayakuni, R. & Patnayakuni, N. 1996. Refocusing where and how IT value is realized: an empirical investigation. *Omega* 24(4): 399-412.

Rai, A., Patnayakuni, R. & Patnayakuni, N. 1997. Technology investment and business performance. *Communications Of The ACM* 40(7): 89-97.

Rai, A., Patnayakuni, R. & Seth, N. 2006. Firm performance impacts of digitally enabled supply chain integration capabilities. *MIS Quarterly* 30(2): 225-246.

Ranganathan, C. & Brown, C.V. 2006. ERP investments and the market value of firms: toward an understanding of influential ERP project variables. *Information Systems Research* 17(2): 145-161.

Ravichandran, T., Liu, Y., Han, S. & Hasan, I. 2009. Diversification and firm performance: exploring the moderating effects of information technology spending. *Journal of Management Information Systems* 25 (4): 205–240.

Revilla, A.J. & Fernández, Z. 2012. The relation between firm size and R&D productivity in different technological regimes. *Technovation* 32(11): 609-623.

Richardson, V.J. & Zmud, R.W. 2002. The value relevance of information technology investment announcements: incorporating industry strategic IT role. Proceedings of the 35th Annual Hawaii International Conference on System Sciences, 10 Jan. Big Island, HI, USA

Roodman, D. 2009. How to do xtabond2: An introduction to difference and system GMM in Stata. *The Stata Journa*l 9(1): 86–136.

Santhanam, R. & Hartono, E. 2003. Issues in linking information technology capability to firm performance. *MIS Quarterly* 27(1): 125-153.

Schultz, E.L., Tan, D.T. & Walsh, K.D. 2010. Endogeneity and the corporate governance-performance relation. *Australian journal of Management* 35(2): 145-163.

Shaft, T., Zmud, R. & and Dao, V. 2007. An examination of lag effects in relationships between information technology investment and firm-level performance. ICIS 2007 Proceedings: 135.

Strassmann, P.A. 1997. Will big spending on computers guarantee profitability? *Datamation* 43(2): 75-82.

Stratopoulos, T. & Dehning, B. 2000. Does successful investment in information technology solve the productivity paradox? *Information & Management* 38(2): 103-117.

Tanjung, M. 2020. A cross-firm analysis of corporate governance compliance and performance in Indonesia. *Managerial Auditing Journal* 35(5): 621-643.

Thouin, M. F., Hoffman, J.J. & Ford, E.W. 2008. The effect of information technology investment on firm-level performance in the health care industry. *Health Care Management Review* 33(1): 60-68.

Ullah, S., Akhtar, P. & and Zaefarian G.J.I.M.M. 2018. Dealing with endogeneity bias: the generalized method of moments (GMM) for panel data. *Industrial Marketing Management* 71: 69-78.

Wang, Y., Shi, S., Nevo, S., Li, S. & and Chen, Y. 2015. The interaction effect of IT assets and IT management on firm performance: A systems perspective. *International Journal of Information Management* 35 (5):580-593.

Weill, P. 1992. The relationship between investment in information technology and firm performance: a study of the valve manufacturing sector. *Information Systems Research* 3(4): 307-333.

Winarno, W.A. 2019. Hubungan non linier antara lag waktu investasi teknologi informasi dengan kinerja perusahaan sesuaian industri. Dissertation, Accounting, Universitas Airlangga, Surabaya, Indonesia.

Winarno, W.A. & Tjahjadi, B. 2017. The moderating effect of industry environments on the relationship between IT asset portfolios, efficiency and innovation in the ERP context. *European Research Studies Journal* 20 (2): 3-15.

Wintoki, M.B., Linck, J.S. & Netter, J.M. 2012. Endogeneity and the dynamics of internal corporate governance. *Journal of Financial Economics* 105(3): 581-606.

Xue, L., Ray, G. & Sambamurthy, V. 2012. Efficiency or innovation: how do industry environments moderate the effects of firms' IT asset portfolios? *MIS Quarterly* 36(2): 509-528.

Zhu, Z. & Huang, F. 2012. The effect of R&D investment on firms' financial performance: evidence from the Chinese listed IT firms. *Modern Economy* 3: 915-919.

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